

# Syllabus

## Contents

Syllabus

- [About](#)
- [Tools and Resources](#)
- [Data Science Achievements](#)
- [Grading](#)
- [Grading Policies](#)
- [Support](#)
- [General URI Policies](#)
- [Help Hours and Course Communications](#)

Welcome to CSC/DSP310: Programming For Data Science.

In this syllabus you will find an overview of the course, information about your instructor, course policies, restatements of URI policies, reminders of relevant resources, and a schedule for the course.

## About

### About this course

Data science exists at the intersection of computer science, statistics, and machine learning. That means writing programs to access and manipulate data so that it becomes available for analysis using statistical and machine learning techniques is at the core of data science. Data scientists use their data and analytical ability to find and interpret rich data sources; manage large amounts of data despite hardware, software, and bandwidth constraints; merge data sources; ensure consistency of datasets; create visualizations to aid in understanding data; build mathematical models using the data; and present and communicate the data insights/findings.

This course provides a survey of data science. Topics include data driven programming in Python; data sets, file formats and meta-data; descriptive statistics, data visualization, and foundations of predictive data modeling and machine learning; accessing web data and databases; distributed data management. You will work on weekly substantial programming problems such as accessing data in database and visualize it or build machine learning models of a given data set.

Basic programming skills (CSC201 or CSC211) are a prerequisite to this course. This course is a prerequisite course to machine learning, where you learn how machine learning algorithms work. In this course, we will start with a very fast review of basic programming ideas, since you've already done that before. We will learn how to *use* machine learning algorithms to do data science, but not how to *build* machine learning algorithms, we'll use packages that implement the algorithms for us.

### About this semester

This semester is a lot of new things for all of us. This course will be completely online all semester, so we will get to use a single instructional format all semester, including when all campus activities move remote after Thanksgiving. I recognize that those last two weeks of the semester may change your obligations with siblings, parents, work, etc. In light of that, we will cover all of the most important topics and you will have the opportunity to achieve all of the course learning outcomes before Thanksgiving.

The material in the last two weeks of the semester will be more advanced, likely interesting and definitely useful material, but if your ability to participate in class is less at that time, it will not hurt your grade.

## About this syllabus

This syllabus is a *living* document and accessible from BrightSpace, as a pdf for download directly online at [rhodyprog4ds.github.io/BrownFall20/syllabus](https://rhodyprog4ds.github.io/BrownFall20/syllabus). If you choose to download a copy of it, note that it is only a copy. You can get notification of changes from GitHub by “watching” the [repository](#). You can view the date of changes and exactly what changes were made on the Github [commits](#) page.

Creating an [issue on the repository](#) is also a good way to ask questions about anything in the course it will prompt additions and expand the FAQ section.

## About your instructor

Name: Dr. Sarah Brown Office hours: TBA via zoom, link in BrightSpace

Dr. Brown is an Assistant Professor of Computer Science, who does research on how social context changes machine learning. Dr. Brown earned a PhD in Electrical Engineering from Northeastern University, completed a postdoctoral fellowship at University of California Berkeley, and worked as a postdoctoral research associate at Brown University before joining URI. At Brown University, Dr. Brown taught the Data and Society course for the Master's in Data Science Program.

The best way to contact me is e-mail or by dropping into my office hours. Please include `[CSC310]` or `[DSP310]` in the subject line of your email along with the topic of your message. This is important, because your messages are important, but I also get a lot of e-mail. Consider these a cheat code to my inbox: I have setup a filter that will flag your e-mail if you use one of those in the subject to ensure that I see it. I rarely check e-mail between 6pm and 9am, on weekends or holidays. You might see me post or send things during these hours, but I will not reliably see emails that arrive during those hours.

### Note

Whether you use CSC or DSP does not matter.

## Tools and Resources

We will use a variety of tools to conduct class and to facilitate your programming. You will need a computer with Linux, MacOS, or Windows. It is unlikely that a tablet will be able to do all of the things required in this course. A Chromebook may work, especially with developer tools turned on. Ask Dr. Brown if you need help getting access to an adequate computer.

All of the tools and resources below are either:

- paid for by URI **OR**
- freely available online.

## BrightSpace

This will be the central location from which you can access all other materials. Any links that are for private discussion among those enrolled in the course will be available only from our course [Brightspace site](#).

This is also where your grades will appear and how I will post announcements.

For announcements, you can [customize](#) how you receive them.

## Prismia chat

Our class link for [Prismia chat](#) is available on Brightspace. We will use this for chatting and in-class understanding checks.

### Important

TL;DR [\[1\]](#)

- check Brightspace
- Log in to Prismia Chat
- Make a GitHub Account
- Install Python
- Install Git

On Prismia, all students see the instructor's messages, but only the Instructor and TA see student responses.

## Course Website

The course manual will have content including the class policies, scheduling, class notes, assignment information, and additional resources. This will be linked from Brightspace and available publicly online at [rhodyprog4ds.github.io/BrownFall22/](https://rhodyprog4ds.github.io/BrownFall22/). Links to the course reference text and code documentation will also be included here in the assignments and class notes.

## GitHub

You will need a [GitHub](#) Account. If you do not already have one, please [create one](#) by the first day of class. If you have one, but have not used it recently, you may need to update your password and login credentials as the [Authentication rules](#) changed over the summer. In order to use the command line with https, you will need to [create a Personal Access Token](#) for each device you use. In order to use the command line with SSH, set up your public key.

## Programming Environment

This is a programming course, so you will need a programming environment. In order to complete assignments you need the items listed in the requirements list. The easiest way to meet these requirements is to follow the recommendations below. I will provide instruction assuming that you have followed the recommendations.

### Requirements:

- Python with scientific computing packages (numpy, scipy, jupyter, pandas, seaborn, sklearn)
- [Git](#)
- A web browser compatible with [Jupyter Notebooks](#)

### Warning

Everything in this class will be tested with the up to date (or otherwise specified) version of Jupyter Notebooks. Google Colab is similar, but not the same, and some things may not work there. It is an okay backup, but should not be your primary work environment.

### Recommendation:

- Install python via [Anaconda](#)
- if you use Windows, install Git with [GitBash](#) ([video instructions](#)).
- if you use MacOS, install Git with the Xcode Command Line Tools. On Mavericks (10.9) or above you can do this by trying to run git from the Terminal the very first time. `git --version`
- if you use Chrome OS, follow these instructions:

1. Find Linux (Beta) in your settings and turn that on.
2. Once the download finishes a Linux terminal will open, then enter the commands: `sudo apt-get update` and `sudo apt-get upgrade`. These commands will ensure you are up to date.
3. Install tmux with:

```
sudo apt -t stretch-backports install tmux
```

4. Next you will install nodejs, to do this, use the following commands:

```
curl -sL https://deb.nodesource.com/setup_14.x | sudo -E bash
sudo apt-get install -y nodejs
sudo apt-get install -y build-essential.
```

5. Next install Anaconda's Python from the website provided by the instructor and use the top download link under the Linux options.
6. You will then see a .sh file in your downloads, move this into your Linux files.

### Note

Seeing the BrightSpace site requires logging in with your URI SSO and being enrolled in the course

### Note

all Git instructions will be given as instructions for the command line interface and GitHub specific instructions via the web interface. You may choose to use GitHub desktop or built in IDE tools, but the instructional team may not be able to help.

7. Make sure you are in your home directory (something like home/YOURUSERNAME), do this by using the `pwd` command.
8. Use the `bash` command followed by the file name of the installer you just downloaded to start the installation.
9. Next you will add Anaconda to your Linux PATH, do this by using the `vim .bashrc` command to enter the `.bashrc` file, then add the `export PATH=/home/YOURUSERNAME/anaconda3/bin/:$PATH` line. This can be placed at the end of the file.
10. Once that is inserted you may close and save the file, to do this hold escape and type `:x`, then press enter. After doing that you will be returned to the terminal where you will then type the `source .bashrc` command.
11. Next, use the `jupyter notebook --generate-config` command to generate a Jupyter Notebook.
12. Then just type `jupyter lab` and a Jupyter Notebook should open up.

Optional:

- Text Editor: you may want a text editor outside of the Jupyter environment. Jupyter can edit markdown files (that you'll need for your portfolio), in browser, but it is more common to use a text editor like Atom or Sublime for this purpose.

Video install instructions for Anaconda:

- [Windows](#)
- [Mac](#)

On Mac, to install python via environment, [this article may be helpful](#)

- I don't have a video for linux, but it's a little more straight forward.

#### 💡 A tip from Dr. Brown

I use [atom](#), but I decided to use it by downloading both Atom and Sublime and trying different things in each for a week. I liked Atom better after that and I've stuck with it since. I used Atom to write all of the content in this syllabus. VScode will also work, if needed

## Textbook

The texts for this class are references and for context and will not be a source of assignments. Both are available free online, but are also relatively affordable if you want a hard copy.

### [Think Like a Data Scientist](#)

It will be a helpful reference and you may be directed there for answers to questions or alternate explanations of topics.

Python for Data Science is available free [online](#):

## Zoom (backup only, Fall 2021 is in person)

This is where we will meet if for any reason we cannot be in person. You will find the link to class zoom sessions on Brightspace.

URI provides all faculty, staff, and students with a paid Zoom account. It *can* run in your browser or on a mobile device, but you will be able to participate in class best if you download the [Zoom client](#) on your computer. Please [log in](#) and [configure your account](#). Please add a photo of yourself to your account so that we can still see your likeness in some form when your camera is off. You may also wish to use a virtual background and you are welcome to do so.

Class will be interactive, so if you cannot be in a quiet place at class time, headphones with a built in microphone are strongly recommended.

For help, you can access the [instructions provided by IT](#).

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[1] Too long; didn't read.

## Data Science Achievements

In this course there are 5 learning outcomes that I expect you to achieve by the end of the semester. To get there, you'll focus on 15 smaller achievements that will be the basis of your grade. This section will describe how the topics covered, the learning outcomes, and the achievements are covered over time. In the next section, you'll see how these achievements turn into grades.

## Learning Outcomes

By the end of the semester

1. (process) Describe the process of data science, define each phase, and identify standard tools
2. (data) Access and combine data in multiple formats for analysis
3. (exploratory) Perform exploratory data analyses including descriptive statistics and visualization
4. (modeling) Select models for data by applying and evaluating multiple models to a single dataset
5. (communicate) Communicate solutions to problems with data in common industry formats

We will build your skill in the **process** and **communicate** outcomes over the whole semester. The middle three skills will correspond roughly to the content taught for each of the first three portfolio checks.

## Schedule

The course will meet MWF 2-2:50pm in Ranger 302. Every class will include participatory live coding (instructor types code while explaining, students follow along)) instruction and small exercises for you to progress toward level 1 achievements of the new skills introduced in class that day.

Each Assignment will have a deadline posted on the page. Portfolio deadlines will be announced at least 2 weeks in advance.

### Note

On the [Course Calendar on BrightSpace](#) page you can get a feed link to add to the calendar of your choice by clicking on the subscribe (star) button on the top right of the page. Class is for 1 hour there because of Brightspace/zoom integration limitations, but that calendar includes the zoom link.

week	topics	skills
1	[admin, python review]	process
2	Loading data, Python review	[access, prepare, summarize]
3	Exploratory Data Analysis	[summarize, visualize]
4	Data Cleaning	[prepare, summarize, visualize]
5	Databases, Merging DataFrames	[access, construct, summarize]
6	Modeling, classification performance metrics, cross validation	[evaluate]
7	Naive Bayes, decision trees	[classification, evaluate]
8	Regression	[regression, evaluate]
9	Clustering	[clustering, evaluate]
10	SVM, parameter tuning	[optimize, tools]
11	KNN, Model comparison	[compare, tools]
12	Text Analysis	[unstructured]
13	Images Analysis	[unstructured, tools]
14	Deep Learning	[tools, compare]

## Achievement Definitions

The table below describes how your participation, assignments, and portfolios will be assessed to earn each achievement. The keyword for each skill is a short name that will be used to refer to skills throughout the course materials; the full description of the skill is in this table.

keyword		skill	Level 1	Level 2	Level 3
	python	pythonic code writing	python code that mostly runs, occasional pep8 adherence	python code that reliably runs, frequent pep8 adherence	reliable, efficient, pythonic code that consistently adheres to pep8
	process	describe data science as a process	Identify basic components of data science	Describe and define each stage of the data science process	Compare different ways that data science can facilitate decision making
	access	access data in multiple formats	load data from at least one format; identify the most common data formats	Load data for processing from the most common formats; Compare and contrast most common formats	access data from both common and uncommon formats and identify best practices for formats in different contexts
	construct	construct datasets from multiple sources	identify what should happen to merge datasets or when they can be merged	apply basic merges	merge data that is not automatically aligned
	summarize	Summarize and describe data	Describe the shape and structure of a dataset in basic terms	compute summary statistics of a whole dataset and grouped data	Compute and interpret various summary statistics of subsets of data
	visualize	Visualize data	identify plot types, generate basic plots from pandas	generate multiple plot types with complete labeling with pandas and seaborn	generate complex plots with pandas and plotting libraries and customize with matplotlib or additional parameters
	prepare	prepare data for analysis	identify if data is or is not ready for analysis, potential problems with data	apply data reshaping, cleaning, and filtering as directed	apply data reshaping, cleaning, and filtering manipulations reliably and correctly by assessing data as received
	evaluate	Evaluate model performance	Explain basic performance metrics for different data science tasks	Apply and interpret basic model evaluation metrics to a held out test set	Evaluate a model with multiple metrics and cross validation
	classification	Apply classification	identify and describe what classification is, apply pre-fit classification models	fit, apply, and interpret preselected classification model to a dataset	fit and apply classification models and select appropriate classification models for different contexts
	regression	Apply Regression	identify what data that can be used for regression looks like	fit and interpret linear regression models	fit and explain regularized or nonlinear regression
	clustering	Clustering	describe what clustering is	apply basic clustering	apply multiple clustering techniques, and interpret results

	skill	Level 1	Level 2	Level 3
keyword				
optimize	Optimize model parameters	Identify when model parameters need to be optimized	Optimize basic model parameters such as model order	Select optimal parameters based of mutiple quantiative criteria and automate parameter tuning
compare	compare models	Qualitatively compare model classes	Compare model classes in specific terms and fit models in terms of traditional model performance metrics	Evaluate tradeoffs between different model comparison types
representation	Choose representations and transform data	Identify options for representing text and categorical data in many contexts	Apply at least one representation to transform unstructured or inappropriately data for model fitting or summarizing	apply transformations in different contexts OR compare and contrast multiple representations a single type of data in terms of model performance
workflow	use industry standard data science tools and workflows to solve data science problems	Solve well strucutred fully specified problems with a single tool pipeline	Solve well-structred, open-ended problems, apply common structure to learn new features of standard tools	Independently scope and solve realistic data science problems OR independently learn releated tools and describe strengths and weakensses of common tools

## Assignments and Skills

Using the keywords from the table above, this table shows which assignments you will be able to demonstrate which skills and the total number of assignments that assess each skill. This is the number of opportunities you have to earn Level 2 and still preserve 2 chances to earn Level 3 for each skill.

	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	#
keyword														
python	1	1	0	1	1	0	0	0	0	0	0	0	0	4
process	1	0	0	0	0	1	1	1	1	1	1	0	0	7
access	0	1	1	1	1	0	0	0	0	0	0	0	0	4
construct	0	0	0	0	1	0	1	1	0	0	0	0	0	3
summarize	0	0	1	1	1	1	1	1	1	1	1	1	1	11
visualize	0	0	1	1	0	1	1	1	1	1	1	1	1	10
prepare	0	0	0	1	1	0	0	0	0	0	0	0	0	2
evaluate	0	0	0	0	0	1	1	1	0	1	1	0	0	5
classification	0	0	0	0	0	0	1	0	0	1	0	0	0	2
regression	0	0	0	0	0	0	0	1	0	0	1	0	0	2
clustering	0	0	0	0	0	0	0	0	1	0	1	0	0	2
optimize	0	0	0	0	0	0	0	0	0	1	1	0	0	2
compare	0	0	0	0	0	0	0	0	0	0	1	0	1	2
representation	0	0	0	0	0	0	0	0	0	0	0	1	1	2
workflow	0	0	0	0	0	0	0	0	0	1	1	1	1	4

### Warning

**process** achievements are accumulated a little slower. Prior to portfolio check 1, only level 1 can be earned. Portfolio check 1 is the first chance to earn level 2 for process, then level 3 can be earned on portfolio check 2 or later.

## Portfolios and Skills

The objective of your portfolio submissions is to earn Level 3 achievements. The following table shows what Level 3 looks like for each skill and identifies which portfolio submissions you can earn that Level 3 in that skill.

		Level 3	P1	P2	P3	P4
keyword						
python	reliable, efficient, pythonic code that consistently adheres to pep8	1	1	0	1	
process	Compare different ways that data science can facilitate decision making	0	1	1	1	
access	access data from both common and uncommon formats and identify best practices for formats in different contexts	1	1	0	1	
construct	merge data that is not automatically aligned	1	1	0	1	
summarize	Compute and interpret various summary statistics of subsets of data	1	1	0	1	
visualize	generate complex plots with pandas and plotting libraries and customize with matplotlib or additional parameters	1	1	0	1	
prepare	apply data reshaping, cleaning, and filtering manipulations reliably and correctly by assessing data as received	1	1	0	1	
evaluate	Evaluate a model with multiple metrics and cross validation	0	1	1	1	
classification	fit and apply classification models and select appropriate classification models for different contexts	0	1	1	1	
regression	fit and explain regularized or nonlinear regression	0	1	1	1	
clustering	apply multiple clustering techniques, and interpret results	0	1	1	1	
optimize	Select optimal parameters based of mutiple quanttiateve criteria and automate parameter tuning	0	0	1	1	
compare	Evaluate tradeoffs between different model comparison types	0	0	1	1	
representation	apply transformations in different contexts OR compare and contrast multiple representations a single type of data in terms of model performance	0	0	1	1	
workflow	Independently scope and solve realistic data science problems OR independently learn releated tools and describe strengths and weakensses of common tools	0	0	1	1	

## Detailed Checklists

### python-level1

*python code that mostly runs, occasional pep8 adherence*

- [ ] logical use of control structures
- [ ] callable functions
- [ ] correct calls to functions
- [ ] correct use of variables
- [ ] use of logical operators

### python-level2

*python code that reliably runs, frequent pep8 adherence*



- ☐ descriptive variable names
- ☐ pythonic loops
- ☐ efficient use of return vs side effects in functions
- ☐ correct, effective use of builtin python iterable types (lists & dictionaries)

### python-level3

*reliable, efficient, pythonic code that consistently adheres to pep8*

- ☐ pep8 adherant variable, file, class, and function names
- ☐ effective use of multi-paradigm abilities for efficiency gains
- ☐ easy to read code that adheres to readability over other rules

### process-level1

*Identify basic components of data science*

- ☐ identify component disciplines OR
- ☐ identify phases

### process-level2

*Describe and define each stage of the data science process*

- ☐ correctly defines stages
- ☐ identifies stages in use
- ☐ describes general goals as well as a specific processes

### process-level3

*Compare different ways that data science can facilitate decision making*

- ☐ describes exceptions to process and iteration in process
- ☐ connects choices at one phase to impacts in other phases
- ☐ connects data science steps to real world decisions

### access-level1

*load data from at least one format; identify the most common data formats*

- ☐ use at least one pandas `read_` function correctly
- ☐ name common types
- ☐ describe the structure of common types

### access-level2

*Load data for processing from the most common formats; Compare and contrast most common formats*

- ☐ load data from at least two of (.csv, .tsv, .dat, database, .json)
- ☐ describe advantages and disadvantages of most common types
- ☐ describe how most common types are different

### access-level3

*access data from both common and uncommon formats and identify best practices for formats in different contexts*

- ☐ load data from at least 1 uncommon format
- ☐ describe when one format is better than another

### construct-level1

*identify what should happen to merge datasets or when they can be merged*

- ☐ identify what the structure of a merged dataset should be (size, shape, columns)

- ☐ identify when datasets can or cannot be merged

## construct-level2

*apply basic merges*

- ☐ use 3 different types of merges
- ☐ choose the right type of merge for realistic scenarios

## construct-level3

*merge data that is not automatically aligned*

- ☐ manipulate data to make it mergable
- ☐ identify how to combine data from many sources to answer a question
- ☐ implement steps to combine data from multiple sources

## summarize-level1

*Describe the shape and structure of a dataset in basic terms*

- ☐ use attributes to produce a description of a dataset
- ☐ display parts of a dataset

## summarize-level2

*compute and interpret summary standard statistics of a whole dataset and grouped data*

- ☐ compute descriptive statistics on whole datasets
- ☐ apply individual statistics to datasets
- ☐ group data by a categorical variable for analysis
- ☐ apply split-apply-combine paradigm to analyze data
- ☐ interpret statistics on whole datasets
- ☐ interpret statistics on subsets of data

## summarize-level3

*Compute and interpret various summary statistics of subsets of data*

- ☐ produce custom aggregation tables to summarize datasets
- ☐ compute multivariate summary statistics by grouping
- ☐ compute custom calculations on datasets

## visualize-level1

*identify plot types, generate basic plots from pandas*

- ☐ generate at least two types of plots with pandas
- ☐ identify plot types by name
- ☐ interpret basic information from plots

## visualize-level2

*generate multiple plot types with complete labeling with pandas and seaborn*

- ☐ generate at least 3 types of plots
- ☐ use correct, complete, legible labeling on plots
- ☐ plot using both pandas and seaborn
- ☐ interpret multiple types of plots to draw conclusions

## visualize-level3

*generate complex plots with pandas and plotting libraries and customize with matplotlib or additional parameters*

- ☐ use at least two libraries to plot

- ☐ generate figures with subplots
- ☐ customize the display of a plot to be publication ready
- ☐ interpret plot types and explain them for novices
- ☐ choose appropriate plot types to convey information
- ☐ explain why plotting common best practices are effective

### **prepare-level1**

*identify if data is or is not ready for analysis, potential problems with data*

- ☐ identify problems in a dataset
- ☐ anticipate how potential data setups will interfere with analysis
- ☐ describe the structure of tidy data
- ☐ label data as tidy or not

### **prepare-level2**

*apply data reshaping, cleaning, and filtering as directed*

- ☐ reshape data to be analyzable as directed
- ☐ filter data as directed
- ☐ rename columns as directed
- ☐ rename values to make data more analyzable
- ☐ handle missing values in at least two ways
- ☐ transform data to tidy format

### **prepare-level3**

*apply data reshaping, cleaning, and filtering manipulations reliably and correctly by assessing data as received*

- ☐ identify issues in a dataset and correctly implement solutions
- ☐ convert variable representation by changing types
- ☐ change variable representation using one hot encoding

### **evaluate-level1**

*Explain basic performance metrics for different data science tasks*

- ☐ define at least two performance metrics
- ☐ describe how those metrics compare or compete

### **evaluate-level2**

*Apply and interpret basic model evaluation metrics to a held out test set*

- ☐ create test train splits
- ☐ describe why test train splits are important
- ☐ apply at least three performance metrics to models
- ☐ choose at least one appropriate metric for each modeling task
- ☐ interpret at least three metrics

### **evaluate-level3**

*Evaluate a model with multiple metrics and cross validation*

- ☐ explain cross validation
- ☐ describe why cross validation is important
- ☐ identify appropriate metrics for different types of modeling tasks
- ☐ use multiple metrics together to create a more complete description of a model's performance

### **classification-level1**

*identify and describe what classification is, apply pre-fit classification models*

- ☐ describe what classification is
- ☐ describe what a dataset must look like for classification
- ☐ identify applications of classification in the real world

## classification-level2

*fit, apply, and interpret preselected classification model to a dataset*

- ☐ fit a classification model
- ☐ apply a classification model to obtain predictions
- ☐ interpret the predictions of a classification model
- ☐ examine parameters of at least one fit classifier to explain how the prediction is made
- ☐ differentiate between model fitting and generating predictions
- ☐ evaluate how model parameters impact model performance

## classification-level3

*fit and apply classification models and select appropriate classification models for different contexts*

- ☐ choose appropriate classifiers based on application context
- ☐ explain how at least 3 different classifiers make predictions
- ☐ evaluate how model parameters impact model performance and justify choices when tradeoffs are necessary

## regression-level1

*identify what data that can be used for regression looks like*

- ☐ identify data that is/not appropriate for regression
- ☐ describe univariate linear regression
- ☐ identify applications of regression in the real world

## regression-level2

*fit and interpret linear regression models*

- ☐ fit univariate linear regression models
- ☐ interpret linear regression models
- ☐ fit multivariate linear regression models

## regression-level3

*fit and explain regularized or nonlinear regression*

- ☐ fit nonlinear or regularized regression models
- ☐ interpret and explain nonlinear or regularized regression models

## clustering-level1

*describe what clustering is*

- ☐ differentiate clustering from classification and regression
- ☐ identify applications of clustering in the real world

## clustering-level2

*apply basic clustering*

- ☐ fit Kmeans
- ☐ interpret kmeans

## clustering-level3

*apply multiple clustering techniques, and interpret results*

- ☐ apply at least two clustering techniques

- ☐ explain the differences between two clustering models

### **optimize-level1**

*Identify when model parameters need to be optimized*

- ☐ identify when parameters might impact model performance

### **optimize-level2**

*Optimize basic model parameters such as model order*

- ☐ automatically optimize multiple parameters
- ☐ evaluate potential tradeoffs
- ☐ interpret optimization results in context

### **optimize-level3**

*Select optimal parameters based of mutiple quanttiateve criteria and automate parameter tuning*

- ☐ optimize models based on multiple metrics
- ☐ describe when one model vs another is most appropriate

### **compare-level1**

*Qualitatively compare model classes*

- ☐ compare models within the same task on complexity

### **compare-level2**

*Compare model classes in specific terms and fit models in terms of traditional model performance metrics*

- ☐ compare models in multiple terms
- ☐ interpret cross model comparisons in context

### **compare-level3**

*Evaluate tradeoffs between different model comparison types*

- ☐ compare models on multiple criteria
- ☐ compare optimized models
- ☐ jointly interpret optimization result and compare models
- ☐ compare models on quanttiateve and qualitative measures

### **representation-level1**

*Identify options for representing text and categorical data in many contexts*

- ☐ describe the basic goals for changing the representation of data

### **representation-level2**

*Apply at least one representation to transform unstructured or inappropriately data for model fitting or summarizing*

- ☐ transform text or image data for use with ML

### **representation-level3**

*apply transformations in different contexts OR compare and contrast multiple representations a single type of data in terms of model performance*

- ☐ transform both text and image data for use in ml
- ☐ evaluate the impact of representation on model performance

### **workflow-level1**

*Solve well structured fully specified problems with a single tool pipeline*

- [ ] pseudocode out the steps to answer basic data science questions

## **workflow-level2**

*Solve well-structured, open-ended problems, apply common structure to learn new features of standard tools*

- [ ] plan and execute answering real questions to an open ended question
- [ ] describe the necessary steps and tools

## **workflow-level3**

*Independently scope and solve realistic data science problems OR independently learn related tools and describe strengths and weaknesses of common tools*

- [ ] scope and solve realistic data science problems
- [ ] compare different data science tool stacks

# Grading

This section of the syllabus describes the principles and mechanics of the grading for the course. This course will be graded on a basis of a set of *skills* (described in detail the next section of the syllabus). This is in contrast to more common grading on a basis of points earned through assignments.

## Principles of Grading

Learning happens through practice and feedback. My goal as a teacher is for you to learn. The grading in this course is based on your learning of the material, rather than your completion of the activities that are assigned.

This course is designed to encourage you to work steadily at learning the material and demonstrating your new knowledge. There are no single points of failure, where you lose points that cannot be recovered. Also, you cannot cram anything one time and then forget it. The material will build and you have to demonstrate that you retained things.

- Earning a C in this class means you have a general understanding of Data Science and could participate in a basic conversation about all of the topics we cover. I expect everyone to reach this level.
- Earning a B means that you could solve simple data science problems on your own and complete parts of more complex problems as instructed by, for example, a supervisor in an internship or entry level job. This is a very accessible goal, it does not require you to get anything on the first try or to explore topics on your own. I expect most students to reach this level.
- Earning an A means that you could solve moderately complex problems independently and discuss the quality of others' data science solutions. This class will be challenging, it requires you to explore topics a little deeper than we cover them in class, but unlike typical grading it does not require all of your assignments to be near perfect.

Grading this way also is more amenable to the fact that there are correct and incorrect ways to do things, but there is not always a single correct answer to a realistic data science problem. Your work will be assessed on whether or not it demonstrates your learning of the targeted skills. You will also receive feedback on how to improve.

## How it works

There are 15 skills that you will be graded on in this course. While learning these skills, you will work through a progression of learning. Your grade will be based on earning 45 achievements that are organized into 15 skill groups with 3 levels for each.

These map onto letter grades roughly as follows:

- If you achieve level 1 in all of the skills, you will earn at least a C in the course.
- To earn a B, you must earn all of the level 1 and level 2 achievements.
- To earn an A, you must earn all of the achievements.

You will have at least three opportunities to earn every level 2 achievement. You will have at least two opportunities to earn every level 3 achievement. You will have three *types* of opportunities to demonstrate your current skill level: participation, assignments, and a portfolio.

Each level of achievement corresponds to a phase in your learning of the skill:

- To earn level 1 achievements, you will need to demonstrate basic awareness of the required concepts and know approximately what to do, but you may need specific instructions of which things to do or to look up examples to modify every step of the way. You can earn level 1 achievements in class, assignments, or portfolio submissions.
- To earn level 2 achievements you will need to demonstrate understanding of the concepts and the ability to apply them with instruction after earning the level 1 achievement for that skill. You can earn level 2 achievements in assignments or portfolio submissions.
- To earn level 3 achievements you will be required to consistently execute each skill and demonstrate deep understanding of the course material, after achieving level 2 in that skill. You can earn level 3 achievements only through your portfolio submissions.

For each skill these are defined in the [Achievement Definition Table](#)

## Participation

While attending synchronous class sessions, there will be understanding checks and in class exercises. Completing in class exercises and correctly answering questions in class can earn level 1 achievements. In class questions will be administered through the classroom chat platform Prisma.chat; these records will be used to update your skill progression.

## Office Hours

If you miss questions during class, you can make up level 1 achievements in office hours in the following two weeks. You can earn up to 2 level 1 achievements in a single visit to office hours. To earn them in office hours, you will be asked similar questions, but have the opportunity to answer verbally.

## Assignments

For your learning to progress and earn level 2 achievements, you must practice with the skills outside of class time.

There will be an assignment each week. Assignments will be a chance to analyze data using the new skills and they will build so that you can get continuous practice with the skills. After your assignment is reviewed, you will get qualitative feedback on your work, and an assessment of your demonstration of the targeted skills. In an assignment, you can earn level 1 achievements in the designated skills by including an outline, you can earn level 2 by completing the analysis as prescribed.

Assignments are also an opportunity to get a head start on your portfolio. You can propose extensions of the analysis and get feedback on that proposal before you implement it. This way you can have more guidance on what goes in your portfolio and do the work for it continually.

Feedback on assignments is designed to be a two way *conversation* about your work to help you become a better data science programmer. Reading and acknowledging (reply or emoji reaction) your feedback is required. There is a limit of 2 assignments worth of unacknowledged feedback. If you have 2 unacknowledged assignments, your future assignments will not get feedback, they will be considered unsubmitted.

## Portfolio Checks

To earn level 3 achievements, you will build a portfolio consisting of reflections, challenge problems, and longer analyses over the course of the semester. You will submit your portfolio for review 4 times. The first two will cover the skills taught up until 1 week before the submission deadline.

### Warning

If you will skip an assignment, please accept the GitHub assignment and then close the Feedback pull request with a comment. This way we can make sure that you have support you need.

The third and fourth portfolio checks will cover all of the skills. The fourth will be due during finals. This means that, if you have earned all of your targeted achievements by the 3rd portfolio check, you do not need to submit the fourth one.

Portfolio prompts will be given throughout the class, some will be structured questions, others may be questions that arise in class, for which there is not time to answer.

## TLDR

You *could* earn a C through in class participation alone, if you make nearly zero mistakes. To earn a B, you must complete assignments and participate in class. To earn an A you must participate, complete assignments, and build a portfolio.

## Detailed mechanics

The table below shows the minimum number of skills at each level to earn each letter grade.

	Level 3	Level 2	Level 1
letter grade			
A	15	15	15
A-	10	15	15
B+	5	15	15
B	0	15	15
B-	0	10	15
C+	0	5	15
C	0	0	15
C-	0	0	10
D+	0	0	5
D	0	0	3

For example, if you achieve level 2 on all of the skills and level 3 on 7 skills, that will be a B+.

If you achieve level 3 on 14 of the skills, but only level 1 on one of the skills, that will be a B-, because the minimum number of level 2 achievements for a B is 15. In this scenario the total number of achievements is 14 at level 3, 14 at level 2 and 15 at level 3, because you have to earn achievements within a skill in sequence.

The letter grade can be computed as follows

## Late work

Late assignments will not be graded. Every skill will be assessed through more than one assignment, so missing assignments occasionally not necessarily hurt your grade. If you do not submit any assignments that cover a given skill, you may earn the level 2 achievement in that skill through a portfolio check, but you will not be able to earn the level 3 achievement in that skill. If you submit work that is not complete, however, it will be assessed and receive feedback. Submitting pseudocode or code with errors and comments about what you have tried could earn a level 1 achievement. Additionally, most assignments cover multiple skills, so partially completing the assignment may earn level 2 for one, but not all. Submitting *something* even if it is not perfect is important to keeping conversation open and getting feedback and help continuously.

Building your Data Science Portfolio should be an ongoing process, where you commit work to your portfolio frequently. If something comes up and you cannot finish all that you would like assessed by the deadline, open an [Extension Request](#) issue on your repository.

In this issue, include:

1. A new deadline proposal

### Note

In this example, you will have also achieved level 1 on all of the skills, because it is a prerequisite to level 2.

### Note

You may visit office hours to discuss assignments that you did not complete on time to get feedback and check your own understanding, but they will not count toward skill demonstration.



2. What additional work you plan to add
3. Why the extension is important to your learning
4. Why the extension will not hinder your ability to complete the next assignment on time.

This request should be no more than 7 sentences.

Portfolio due dates will be announced well in advance. You should spend some time working on it each week, applying what you've learned so far and building on the feedback on previous assignments.

## Grading Examples

If you always attend and get everything correct, you will earn an A and you won't need to submit the 4th portfolio check or assignment 13.

### Getting an A Without Perfection

## Map to an A

How Achievements were earned

	Level 1	Level 2	Level 3
python	A1	A3	P1
process	A1	P1	P2
access	2	A2	P1
construct	5	A5	P1
summarize	3	A3	P1
visualize	3	A3	P2
prepare	4	A5	P2
classification	A10	P2	P3
regression	8	A11	P2
clustering	9	A9	P3
evaluate	7	A11	P3
optimize	10	A11	P4
compare	11	A13	P3
unstructured	12	A13	P4
tools	11	A13	P3

### Activity Legend

In class Assignment Portfolio Check



### Other Activities

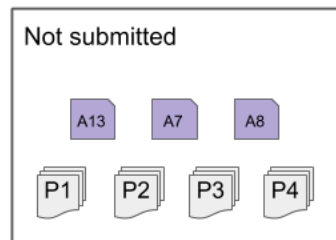
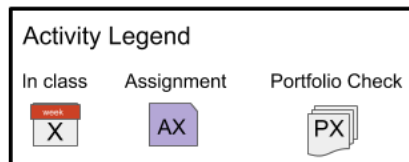
- 1 Attended, but did not understand
- A4 Submitted, but incorrect
- 6 Missed class
- A6 Not submitted
- A7 Submitted, but incorrect
- A8 Not submitted
- A12 Not submitted
- 13 Attended, but all level 1 complete
- 14 Attended, but all level 1 complete

In this example the student made several mistakes, but still earned an A. This is the advantage to this grading scheme. For the **python**, **process**, and **classification** skills, the level 1 achievements were earned on assignments, not in class. For the **process** and **classification** skills, the level 2 achievements were not earned on assignments, only on portfolio checks, but they were earned on the first portfolio of those skills, so the level 3 achievements were earned on the second portfolio check for that skill. This student's fourth portfolio only demonstrated two skills: **optimize** and **unstructured**. It included only 1 analysis, a text analysis with optimizing the parameters of the model. Assignments 4 and 7 were both submitted, but didn't earn any achievements, the student got feedback though, that they were able to apply in later assignments to earn the achievements. The student missed class week 6 and chose to not submit assignment 6 and use week 7 to catch up. The student had too much work in another class and chose to skip assignment 8. The student tried assignment 12, but didn't finish it on time, so it was not graded, but the student visited office hours to understand and be sure to earn the level 2 **unstructured** achievement on assignment 13.

### Getting a B with minimal work

## Map to a B easily

	Level 1	Level 2	Level 3
python			
process			
access			
construct			
summarize			
visualize			
prepare			
classification			
regression			
clustering			
evaluate			
optimize			
compare			
unstructured			
tools			

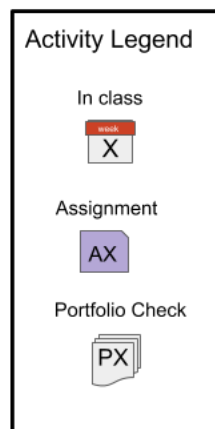


In this example, the student earned all level 1 achievements in class and all level 2 on assignments. This student was content with getting a B and chose to not submit a portfolio.

Getting a B while having trouble

## Map to a B, having trouble

	Level 1	Level 2	Level 3
python			
process			
access			
construct			
summarize			
visualize			
prepare			
classification			
regression			
clustering			
evaluate			
optimize			
compare			
unstructured			
tools			



In this example, the student struggled to understand in class and on assignments. Assignments were submitted that showed some understanding, but all had some serious mistakes, so only level 1 achievements were earned from assignments. The student wanted to get a B and worked hard to get the level 2 achievements on the portfolio checks.

## Grading Policies

### Late Work

Late assignments will not be graded. Every skill will be assessed through more than one assignment, so missing assignments occasionally not necessarily hurt your grade. If you do not submit any assignments that cover a given skill, you may earn the level 2 achievement in that skill through a portfolio check, but you will not be able to earn the level 3 achievement in that skill. If you submit work that is not complete, however, it will be assessed and receive feedback. Submitting pseudocode or code with errors and comments about what you have tried could earn a level 1 achievement. Additionally, most assignments cover multiple skills, so partially completing the assignment may earn level 2 for one, but not all. Submitting *something* even if it is not perfect is important to keeping conversation open and getting feedback and help continuously.

Building your Data Science Portfolio should be an ongoing process, where you commit work to your portfolio frequently. If something comes up and you cannot finish all that you would like assessed by the deadline, open an [Extension Request](#) issue on your repository.

In this issue, include:

1. A new deadline proposal
2. What additional work you plan to add
3. Why the extension is important to your learning
4. Why the extension will not hinder your ability to complete the next assignment on time.

This request should be no more than 7 sentences.

Portfolio due dates will be announced well in advance and prompts for it will be released weekly. You should spend some time working on it each week, applying what you've learned so far, from the feedback on previous assignments.

## Regrading

Re-request a review on your Feedback Pull request.

For general questions, post on the conversation tab of your Feedback PR with your request.

For specific questions, reply to a specific comment.

If you think we missed *where* you did something, add a comment on that line (on the code tab of the PR, click the plus (+) next to the line) and then post on the conversation tab with an overview of what you're requesting and tag @brownsarahm

## Collaboration

You may talk to other students about the general approach or ask clarifying questions about instructions by posting to the [GitHub discussions](#) for our course.

You may only view one another's code, when explicitly instructed to share for peer review, and only *via GitHub* by adding a classmate as a collaborator. If you do not have permission to share your repository or an assignment is not created as a team assignment, then you may not collaborate on that assignment at the code level.

## Support

### Academic Enhancement Center

Academic Enhancement Center (for undergraduate courses): Located in Roosevelt Hall, the AEC offers free face-to-face and web-based services to undergraduate students seeking academic support. Peer tutoring is available for STEM-related courses by appointment online and in-person. The Writing Center offers peer tutoring focused on supporting undergraduate writers at any stage of a writing assignment. The UCS160 course and academic skills consultations offer students strategies and

#### Note

You may visit office hours to discuss assignments that you did not complete on time to get feedback and check your own understanding, but they will not count toward skill demonstration.

activities aimed at improving their studying and test-taking skills. Complete details about each of these programs, up-to-date schedules, contact information and self-service study resources are all available on the [AEC website](#).

- **STEM Tutoring** helps students navigate 100 and 200 level math, chemistry, physics, biology, and other select STEM courses. The STEM Tutoring program offers free online and limited in-person peer-tutoring this fall. Undergraduates in introductory STEM courses have a variety of small group times to choose from and can select occasional or weekly appointments. Appointments and locations will be visible in the TutorTrac system on September 14th, 2020. The TutorTrac application is available through [URI Microsoft 365 single sign-on](#) and by visiting [aec.uri.edu](#). More detailed information and instructions can be found on the [AEC tutoring page](#).
- **Academic Skills Development** resources helps students plan work, manage time, and study more effectively. In Fall 2020, all Academic Skills and Strategies programming are offered both online and in-person. UCS160: Success in Higher Education is a one-credit course on developing a more effective approach to studying. Academic Consultations are 30-minute, 1 to 1 appointments that students can schedule on Starfish with Dr. David Hayes to address individual academic issues. Study Your Way to Success is a self-guided web portal connecting students to tips and strategies on studying and time management related topics. For more information on these programs, visit the [Academic Skills Page](#) or contact Dr. Hayes directly at [davidhayes@uri.edu](mailto:davidhayes@uri.edu).
- The **Undergraduate Writing Center** provides free writing support to students in any class, at any stage of the writing process: from understanding an assignment and brainstorming ideas, to developing, organizing, and revising a draft. Fall 2020 services are offered through two online options: 1) real-time synchronous appointments with a peer consultant (25- and 50-minute slots, available Sunday - Friday), and 2) written asynchronous consultations with a 24-hour turn-around response time (available Monday - Friday). Synchronous appointments are video-based, with audio, chat, document-sharing, and live captioning capabilities, to meet a range of accessibility needs. View the synchronous and asynchronous schedules and book online, visit [uri.mywconline.com](http://uri.mywconline.com).

## General URI Policies

### COVID/Viral Illness Precautions Statement

The University is committed to delivering its educational mission while protecting the health and safety of our community. As members of the URI community, students are required to comply with standards of conduct and take precautions to keep themselves and others safe.

#### Important

Masks are required in all classrooms, laboratories, and spaces where direct academic instruction and research are taking place, unless the instructor or staff member expressly waives that requirement.

#### Warning

not waived

We strongly recommend surgical or higher grade masks where face coverings are required. Masks should be properly worn, well-fitting, and high quality.

Students who do not comply with the classroom/lab masking requirement will be asked to leave class and will be reported through the Student Conduct process.

Students who are experiencing symptoms of viral illness should NOT go to class/work. Those who test positive for COVID-19 should follow the isolation guidelines from the Rhode Island Department of Health and CDC.

### Anti-Bias Statement:

We respect the rights and dignity of each individual and group. We reject prejudice and intolerance, and we work to understand differences. We believe that equity and inclusion are critical components for campus community members to thrive. If you are a target or a witness of a bias incident, you are encouraged to submit a report to the URI Bias Response Team at [www.uri.edu/bri](http://www.uri.edu/bri). There you will also find people and resources to help.

## Disability Services for Students Statement:

Your access in this course is important. Please send me your Disability Services for Students (DSS) accommodation letter early in the semester so that we have adequate time to discuss and arrange your approved academic accommodations. If you have not yet established services through DSS, please contact them to engage in a confidential conversation about the process for requesting reasonable accommodations in the classroom. DSS can be reached by calling: 401-874-2098, visiting: [web.uri.edu/disability](http://web.uri.edu/disability), or emailing: [dss@etal.uri.edu](mailto:dss@etal.uri.edu). We are available to meet with students enrolled in Kingston as well as Providence courses.

## Academic Honesty

Students are expected to be honest in all academic work. A student's name on any written work, quiz or exam shall be regarded as assurance that the work is the result of the student's own independent thought and study. Work should be stated in the student's own words, properly attributed to its source. Students have an obligation to know how to quote, paraphrase, summarize, cite and reference the work of others with integrity. The following are examples of academic dishonesty.

- Using material, directly or paraphrasing, from published sources (print or electronic) without appropriate citation
- Claiming disproportionate credit for work not done independently
- Unauthorized possession or access to exams
- Unauthorized communication during exams
- Unauthorized use of another's work or preparing work for another student
- Taking an exam for another student
- Altering or attempting to alter grades
- The use of notes or electronic devices to gain an unauthorized advantage during exams
- Fabricating or falsifying facts, data or references
- Facilitating or aiding another's academic dishonesty
- Submitting the same paper for more than one course without prior approval from the instructors

## URI COVID-19 Statement

The University is committed to delivering its educational mission while protecting the health and safety of our community. While the university has worked to create a healthy learning environment for all, it is up to all of us to ensure our campus stays that way.

As members of the URI community, students are required to comply with standards of conduct and take precautions to keep themselves and others safe. Visit [web.uri.edu/coronavirus/](http://web.uri.edu/coronavirus/) for the latest information about the URI COVID-19 response.

- [Universal indoor masking](#) is required by all community members, on all campuses, regardless of vaccination status. If the universal mask mandate is discontinued during the semester, students who have an approved exemption and are not fully vaccinated will need to continue to wear a mask indoors and maintain physical distance.
- Students who are experiencing symptoms of illness should not come to class. Please stay in your home/room and notify URI Health Services via phone at 401-874-2246.
- If you are already on campus and start to feel ill, go home/back to your room and self-isolate. Notify URI Health Services via phone immediately at 401-874-2246.

If you are unable to attend class, please notify me at [brownsarahm@uri.edu](mailto:brownsarahm@uri.edu). We will work together to ensure that course instruction and work is completed for the semester.

# Help Hours and Course Communications

We have several different ways to communicate in this course. This section summarizes them

## Help Hours

```
/tmp/ipykernel_2318/2146052215.py:1: FutureWarning: this method is deprecated in
favour of `Styler.hide(axis="index")`
help_df.style.hide_index()
```

Day	Time	Location	Host
Tuesday	11am-12pm	139 Tyler Hall	Aiden
Wednesday	11am-12pm	139 Tyler Hall	Aiden
Wednesday	7pm-8:30pm	Zoom	Dr. Brown
Thursday	11am-12pm	139 Tyler Hall	Aiden
Friday	11am-12pm	139 Tyler Hall	Aiden
Friday	3:30-4:30	134 Tyler Hall	Dr. Brown

## To reach out, By usage

```
/tmp/ipykernel_2318/3027175348.py:2: FutureWarning: this method is deprecated in
favour of `Styler.hide(axis="index")`
display(HTML(df.style.hide_index()._repr_html_()))
```

usage	platform	area	note
in class	prismia	chat	outside of class time this is not monitored closely
any time	prismia	download transcript	use after class to get preliminary notes eg if you miss a class
private questions to your assignment	github	issue on assignment repo	eg bugs in your code"
for general questions that can help others	github	issue on course website	eg what the instructions of an assignment mean or questions about the syllabus
to share resources or ask general questions in a semi-private forum	github	discussion on community repo	include links in your portfolio
matters that don't fit into another category	e-mail	to brownsarahm@uri.edu	remember to include `[CSC310]` or `[DSP310]` (note `verbatim` no space)

### Note

e-mail is last because it's not collaborative; other platforms allow us (Proessor + TA) to collaborate on who responds to things more easily.

## By Platform

Use e-mail for

```
/tmp/ipykernel_2318/2135006347.py:3: FutureWarning: this method is deprecated in
favour of `Styler.hide(axis="index")`
display(HTML(data.drop(columns='platform').style.hide_index()._repr_html_()))
```

usage	area	note
matters that don't fit into another category	to brownsarahm@uri.edu	remember to include `[CSC310]` or `[DSP310]` (note `verbatim` no space)

Use github for

```
/tmp/ipykernel_2318/2135006347.py:3: FutureWarning: this method is deprecated in
favour of `Styler.hide(axis="index")`
display(HTML(data.drop(columns='platform').style.hide_index()._repr_html_()))
```

usage	area	note
private questions to your assignment	issue on assignment repo	eg bugs in your code"
for general questions that can help others	issue on course website	eg what the instructions of an assignment mean or questions about the syllabus
to share resources or ask general questions in a semi-private forum	discussion on community repo	include links in your portfolio

Use prisma for

```
/tmp/ipykernel_2318/2135006347.py:3: FutureWarning: this method is deprecated in
favour of `Styler.hide(axis="index")`
display(HTML(data.drop(columns='platform').style.hide_index()._repr_html_()))
```


usage	area	note
in class	chat	outside of class time this is not monitored closely
any time	download transcript	use after class to get preliminary notes eg if you miss a class

Tips

For assignment help


- **send in advance, leave time for a response** I check e-mail/github a small number of times per day, during work hours, almost exclusively. You might see me post to this site, post to BrightSpace, or comment on your assignments outside of my normal working hours, but I will not reliably see emails that arrive during those hours. This means that it is important to start assignments early.

Using issues

- use issues for content directly related to assignments. If you push your code to the repository and then open an issue, I can see your code and your question at the same time and download it to run it if I need to debug it
- use issues for questions about this syllabus or class notes. At the top right there's a GitHub logo  that allows you to open a issue (for a question) or suggest an edit (eg if you think there's a typo or you find an additional helpful resource related to something)

For E-mail

- use e-mail for general inquiries or notifications
- Please include `[CSC310]` or `[DSP310]` in the subject line of your email along with the topic of your message. This is important, because your messages are important, but I also get a lot of e-mail. Consider these a cheat code to my inbox: I have setup a filter that will flag your e-mail if you use one of those in the subject to ensure that I see it.

 **Note**

Whether you use CSC or DSP does not matter.

