

WHAT YOU WILL LEARN

GIS PROGRAMMING FUNDAMENTALS (WITH PYTHON)



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Center for Geospatial Analytics
North Carolina State University



What do we hope to teach

1. The foundations of programming and Python syntax
2. Python access to ArcGIS.
3. Combine data processing and analysis to create a meaningful tool with an easy interface that eliminates tedious manual processing.

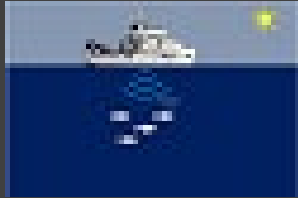
Course learning outcomes

Students will be able to...

- interpret **basic Python syntax** (indentation, context highlighting)
- write Python scripts in an **integrated development environment** (PythonWin)
- use Python to construct code using **core data structures** (strings, lists, ...)
- call **ArcGIS tools** with Python (arcpy.buffer...)
- handle **contingencies** within Python (if, else...)
- construct basic **batch processing** Python code (looping)
- read/modify **data files** with Python
- create a graphical **user interface**
- do more...

Course project examples

Course project example



Data preparation for Generating NOAA Acoustic Trawl Survey Fish Species Biomass Estimates - Shannon Dolan

Input: NOAA acoustic trawl navigational and cluster csv tables.

Output: Cleaned daytime data for specific species, a map of the data, and an HTML page to show the result.

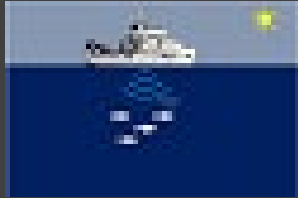


Recreational Aviation Navigation - Aaron Jones

Input: Departure and destination airports, operational range, planned altitude for the flight.

Output: Flight map and HTML page including flight map plan and recommended stops.

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Updates and reading

ArcMap to ArcGIS Pro & Python 2 to Python 3

- Noticeable differences

1. mapping in ArcGIS

Python 2: `arcpy.mapping....`

Python 3: `arcpy.mp....`

2. Script tools look different.

3. Printing

Python 2: `print "hello"`

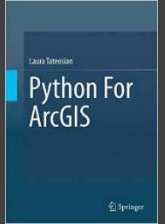
Python 3: `print("hello")`

- Prioritizing semantic differences

- Some videos // slides may contain old-style print statements

Textbook readings

1. Selected readings from an **updated (Python 3) version** of Tateosian, Laura. Python For ArcGIS. Cham, Switzerland: Springer, 2015.

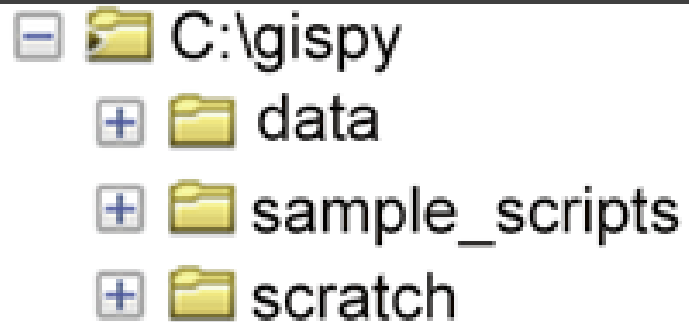


- These reading will be provided as **PDF documents linked to the course Moodle page**.
- The electronic version of this textbook available through the library is Python 2 and uses ArcMap, so please refer to the chapters linked in Moodle instead, unless otherwise notified.
- Caution: If you read ahead, you might outpace me as I work to update the chapters this semester.

2. Selected readings from: Zandbergen, Paul A. Python Scripting for ArcGIS Pro. Redlands, CA, USA: Esri Press, 2020.

Data and sample scripts

- Download the data and sample scripts from <http://go.ncsu.edu/gispy>

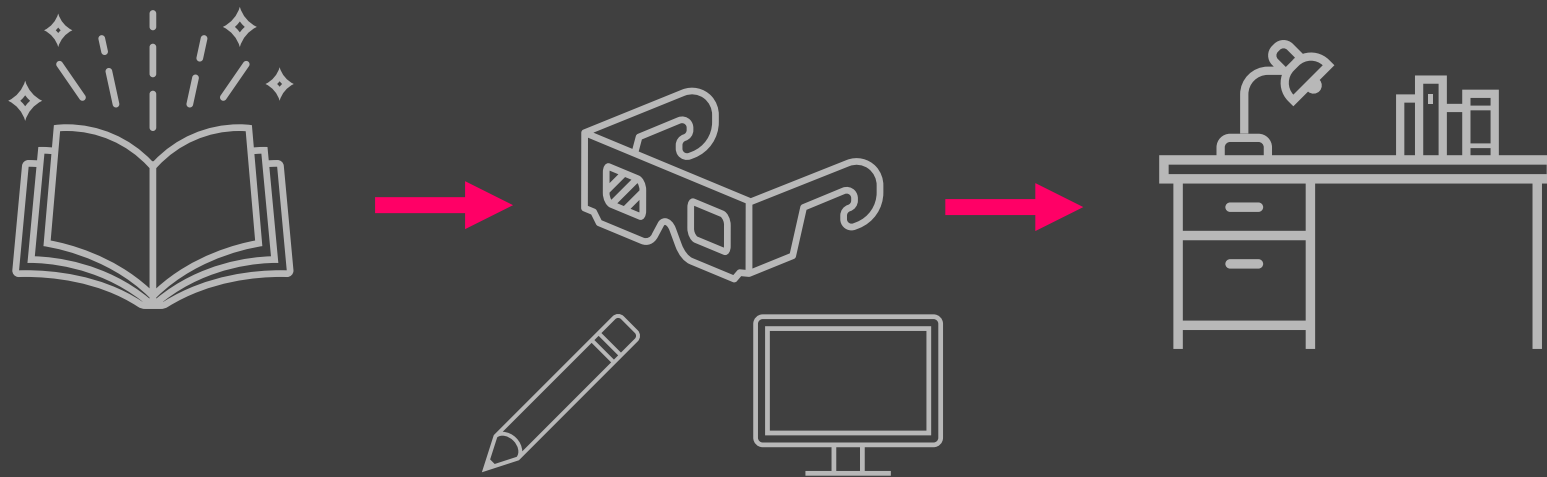


GRADING AND EXPECTATIONS

What to expect

“Although the lectures provided a nice introduction to the material, I definitely learned to code best by reading the textbook and working through assignments (I think this is just the nature of coding).”

--Anonymous student on course eval.



Put more in, expect more

GIS Cartographer Salaries

Job Title	Salary
Maps.com GIS Cartographer salaries - 1 salaries reported	\$44,270/yr
Jeppesen Cartographer/GIS salaries - 1 salaries reported	\$73,383/yr
DATA SOLUTIONS & TECHNOLOGY Cartographer/GIS Technician I salaries - 1 salaries reported	\$51,826/yr

GIS Developer Salary

	Annual Salary
Top Earners	\$147,000
75th Percentile	\$124,500
Average	\$110,411
25th Percentile	\$95,000



30%

Grading



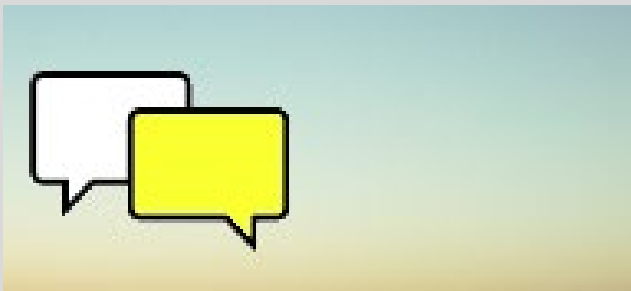
40%

- 4-5 timed quizzes (30%)
- Homework (40%)
 - Python scripts (10 pts each)
 - Python tutorials (4 pts each)
 - Moodle exercises (~21 pts each)



25%

- Project (25%)
- Participation (5%)
 - Piazza message board usage
 - Participation in help sessions
 - Lecture questions
 - Python notebooks



5%



30%

Grading



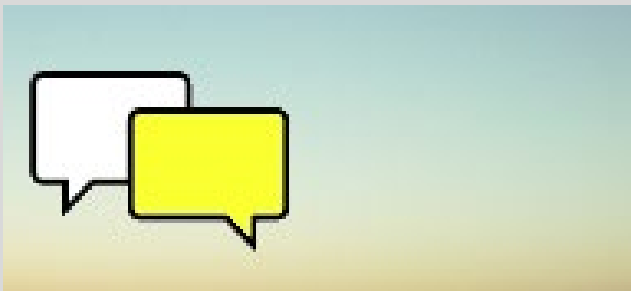
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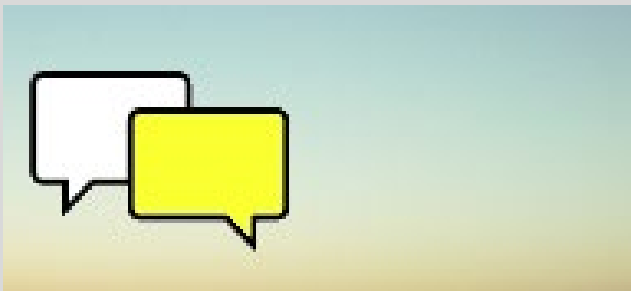
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Final Project Instructions

Stage 1: Preliminary project proposal (~week 10)



Feedback



Stage 2: Project progress (~week 13)



Feedback



Stage 3: Final project submission (1st day of finals week)



30%

Grading



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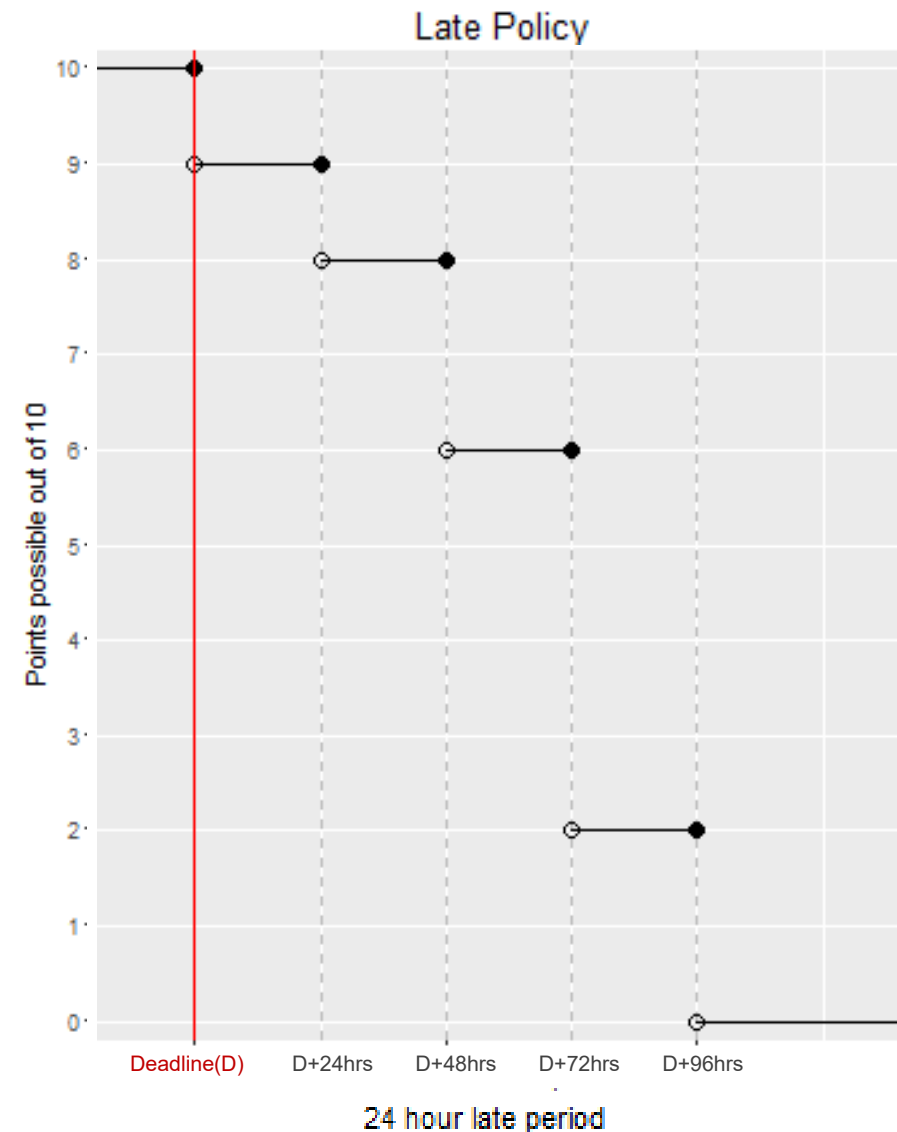
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5%

Late homework

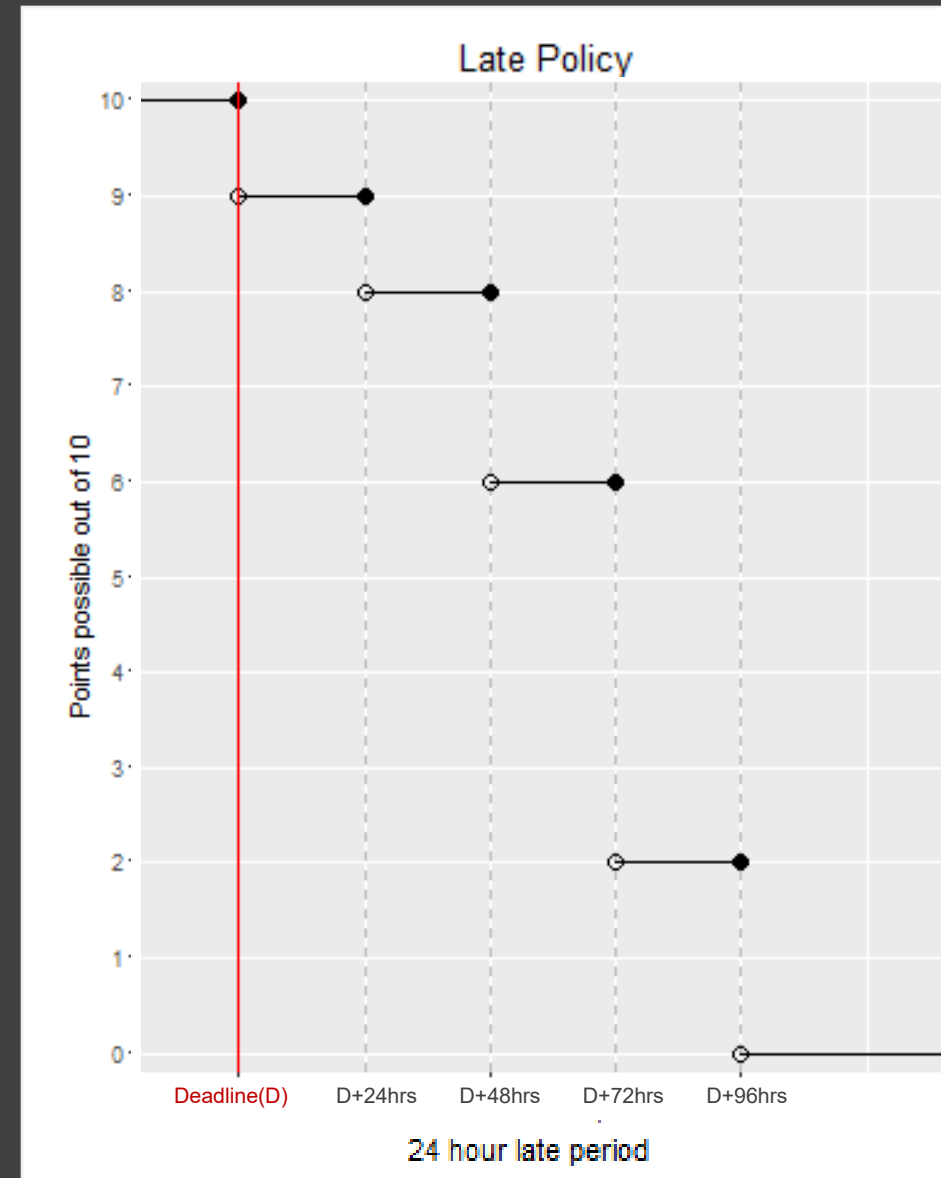
penalty = $10 * 2^{(r-1)}\%$
where r is the number of
24-hour periods late.



Late homework

penalty = $10 * 2^{(r-1)}\%$
where r is the number of
24-hour periods late.

“Lateness” applies to
each homework item
separately.



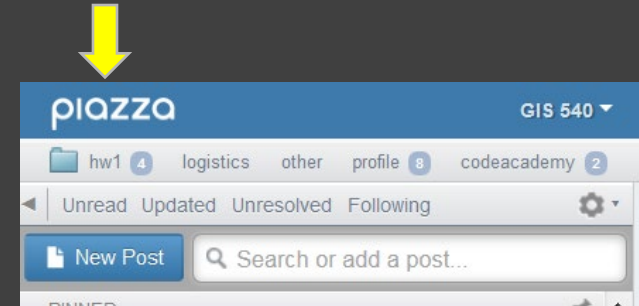
Academic integrity

- Material challenging -> utilize teaching staff help. Otherwise, **homework assignments must be completed alone.**
- University policy is strict. Read the NCSU policy overview and Sections 8 and 9 of the Code of Student Conduct linked to the syllabus.
- Building fundamental skills in this class. Group work not allowed unless specified.
- Study groups can discuss code from in-class exercises, slides, and assigned reading, but not from homework.
- Not allowed:
 - Copying.
 - Talking someone through the solution.
- If you need more help go to office hours, Skype with TAs, or use private posts on the message board.
- Otherwise, the work you submit for homework must be entirely your own.

GETTING HELP

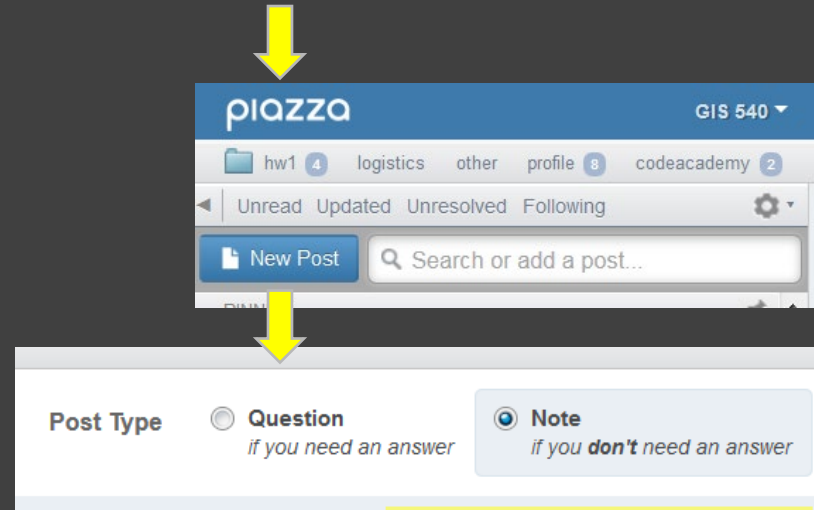
Message board (Piazza)

- Post Type: **question** or **note**
- Post To: **public** or **private** (to instructors)
- Select folder(s)
- Filtering and searching



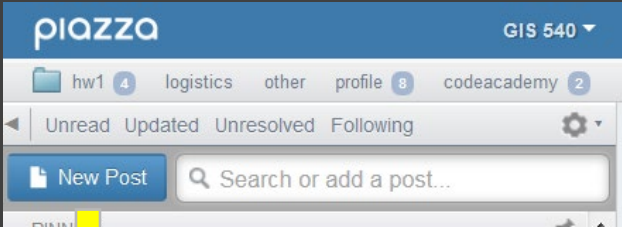
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The screenshot shows the Piazza interface. At the top, a yellow arrow points to the 'piazza' header. Below the header, there are navigation tabs: 'hw1' (4), 'logistics', 'other', 'profile' (8), and 'codeacademy' (2). A filter bar shows 'Unread', 'Updated', 'Unresolved', and 'Following'. A 'New Post' button is visible. Below this, another yellow arrow points to the 'Post Type' section. The 'Post Type' section has two options: 'Question' (if you need an answer) and 'Note' (if you **don't** need an answer). The 'Note' option is selected. Below this, the 'Post to' section has two options: 'Entire Class' and 'Individual Student(s) / Instructor(s)'. The 'Individual Student(s) / Instructor(s)' option is selected and highlighted with a yellow background. Below this, there is a text input field with the placeholder 'Enter one or more names...'. At the bottom, there is a note: 'Type "Instructors" to include all instructors.'

piazza GIS 540 ▾

hw1 4 logistics other profile 8 codeacademy 2

Unread Updated Unresolved Following

New Post Search or add a post...

Post Type

☐ Question
if you need an answer

☒ Note
if you **don't** need an answer

Post to

☐ Entire Class

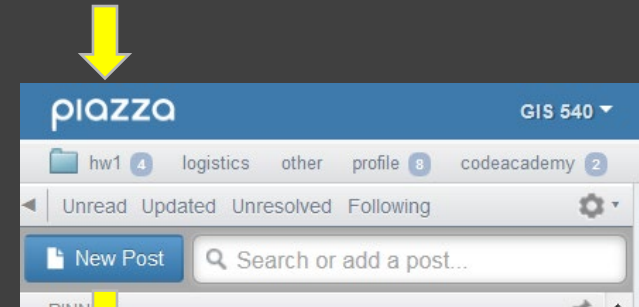
☒ Individual Student(s) / Instructor(s)

Enter one or more names...

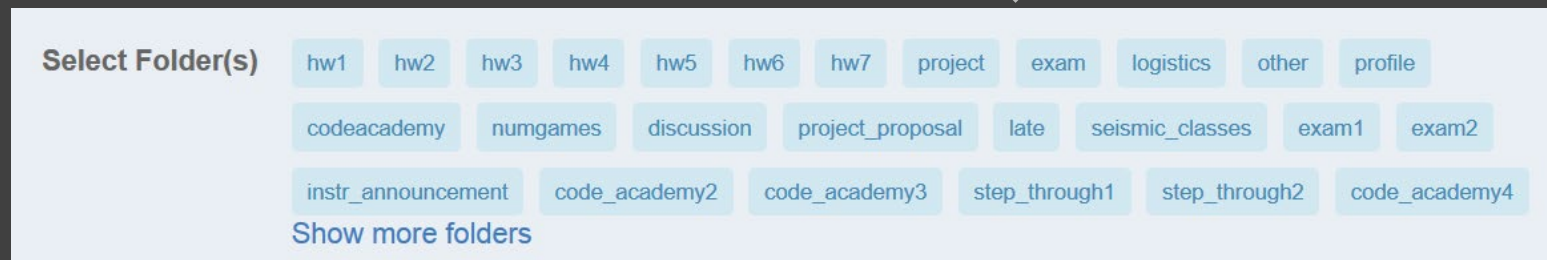
Type "Instructors" to include all instructors.

Message board (Piazza)

- Post Type: **question** or **note**
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A screenshot of the 'New Post' form in Piazza. The 'Post Type' section has two radio buttons: 'Question' (with the subtext 'if you need an answer') and 'Note' (with the subtext 'if you **don't** need an answer'). The 'Post to' section has two radio buttons: 'Entire Class' and 'Individual Student(s) / Instructor(s)'. Below the 'Post to' section is a text input field with the placeholder text 'Enter one or more names...'. Below the input field is a hint: 'Type "Instructors" to include all instructors.'



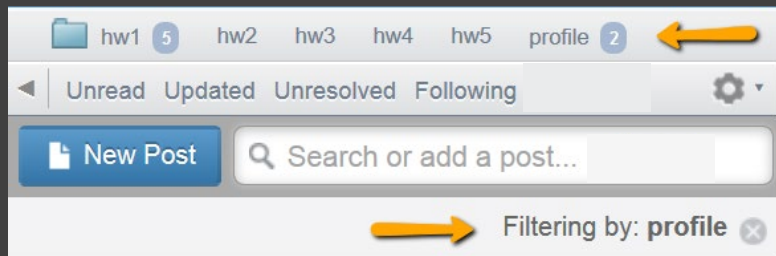
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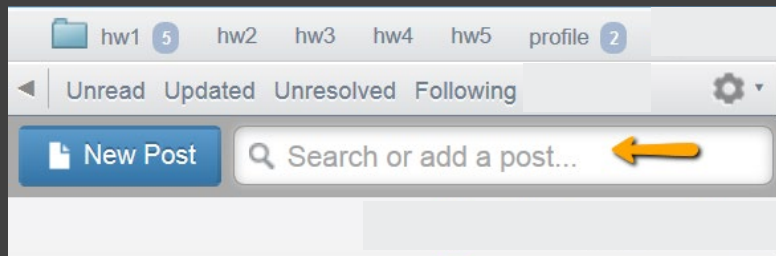
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HELP!

Use the message board
Meet with instructors/TAs

Grade changes

- Grades and comments posted in the Moodle gradebook.
- Grade change requests must be submitted within one week of being returned.
- Submit grade change requests via private (to instructors) note on the message board. Be sure to provide the assignment number and question name and briefly explain the issue.
- Our goal is fair grading and we want to correct any errors.

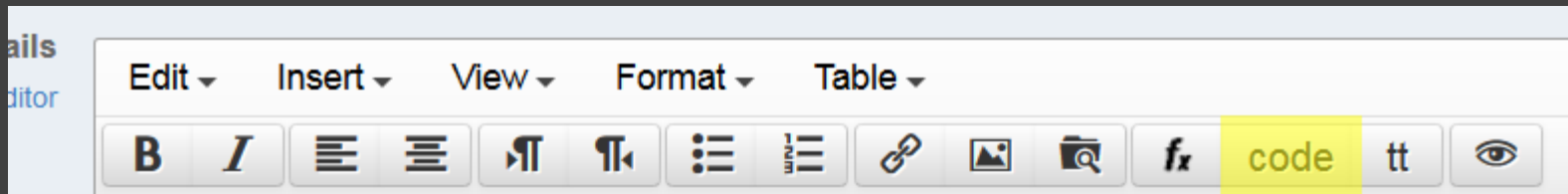
The screenshot shows the Moodle 'Post' form for submitting a grade change request. Several fields are highlighted with yellow boxes:

- Post Type:** The 'Question' radio button is selected, with the subtext 'if you need an answer'.
- Post to:** The 'Individual Student(s) / Instructor(s)' radio button is selected.
- Enter one or more names...:** The text 'Instructors' is entered, with a note 'Type "Instructors" to include all instructors.'
- Select Folder(s):** The 'hw2' folder is selected from a list of folders (hw1 through hw9).
- Summary:** The text 'HW 2 Chapter 2 #5) times.py possible grading error' is entered.

Below the summary, there is a 'Details' section with a 'plain text editor' and a rich text editor toolbar. The text 'Hi all, I think the graders might have made a mistake' is visible in the editor.

Posting code questions on forums

- [How to create a minimal, complete, and verifiable example](#)
- make questions as specific and focused on one particular problem.
- post the error message and what you're trying to do.
- use the chapter where the homework question comes from.



- use the 'code' button to post code.
- enable students to discover mistakes.

Course schedule

- **1st Quarter**
Intro to Python basics, integrated development environments, data structures, ArcGIS API, decision making, looping
- **2nd Quarter** project proposal
Batch processing, debugging, error handling, functions, cursors
- **3rd Quarter** updated proposal
Dictionaries, reading and writing text files, file GUI's, modules, classes, Mapping with Python
- **4th Quarter**
Reading and writing HTML and KML, script tools, additional modules, project work

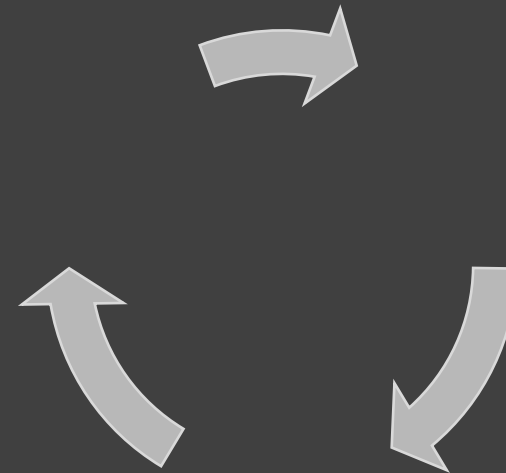
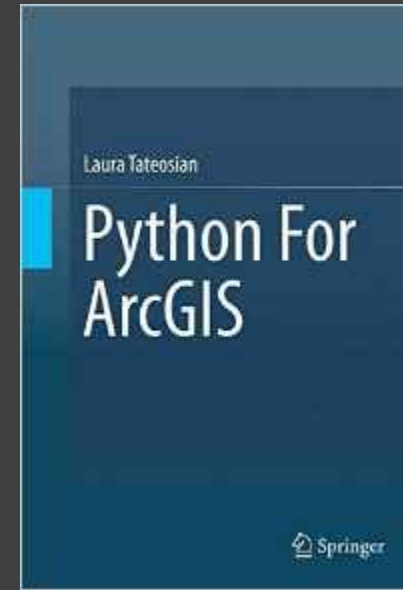
Submitting homework scripts

- All deadlines are given in EST.
- Scripts should be named as specified.
- Put your unityID (e.g., jkrowlin) and name in each script.
- Don't zip submissions.

ESSENTIAL RESOURCES

Py4All

- A tool designed to accompany the textbook, *Python for ArcGIS*
- How to use it:
 1. Watch the Intro to Py4All video
 2. Browse to go.ncsu.edu/py4all
 3. Login with your NCSU unity ID and password
 4. Upload a Python script for feedback.
- Can be used iteratively



Essential Resources

- Announcements (“FOLLOW” THESE)
 - General news and announcements will be posted here.
- Syllabus
 - Guidelines, expectations, and responsibilities for GIS540 participants.
- Piazza message board
 - Post your questions or comments (see the how-to) regarding assignments, software issues, and coding challenges here.
- Instructors (a.k.a. Meet the instructor)
 - Professor and Teaching Assistant names, photos, and office hour arrangements.
- Py4All
 - upload textbook exercise scripts to receive automated feedback, compare your output to the solution output, and use this information to improve the script prior to submitting it for a grade.
- gispy.zip
 - the data and sample scripts to accompany textbook
- Course project
- Gradebook
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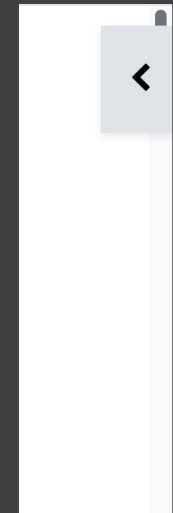
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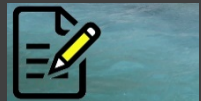
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Schedule

- Week blocks
 - Topic 1
 - Readings
 - Videos
 - Slides
 - In-class exercises
 - Topic 2
 - Readings
 - Videos
 - ...



Homework blocks

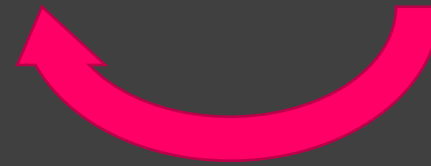


Quiz blocks

- Links to the quiz

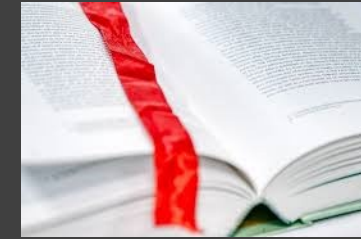
TRY IT

↓
READ → WATCH → TRY IT → CHECK IT



READ AGAIN → TRY IT

Essential Resources

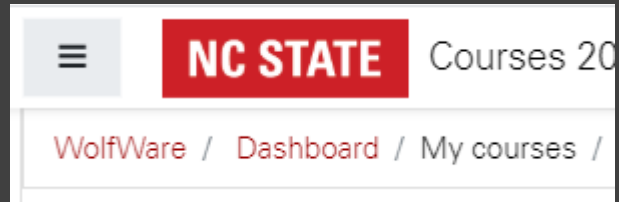


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Moodle navigation

Click the hamburger to expand or collapse the navigation bands on the left –hand side.

“hamburger”







Hello world!

Essential Resources

[Course ZOOM Link](#) | [Announcements](#) | [Syllabus](#) | [Py4All code checker](#)

[Course project instructions](#) | [Data & scripts \(gispy.zip\)](#) | [Schedule overview](#)



HELP! PIAZZA MESSAGE BOARD (using Moodle login)

Software you need to install

- ArcGIS Pro
- DO NOT install Python (it is already installed with ArcGIS)
- PythonWin
 - Python is automatically installed with ArcGIS
 - PythonWin is not.
- Test if PythonWin is installed correctly
 - Type this at the prompt in the PythonWin Interactive Window:
`import arcpy`
 - If you don't get an error message, you've got it.
- PyCharm is another easy IDE has some advantages over PythonWin (e.g., tabbed script windows and immediate tab completion) but has a steeper learning curve than PythonWin
- VS Code
 - We will use this to run Python notebooks when we run them outside of ArcGIS Pro