Course Change Request

New Course Proposal

Date Submitted: 03/08/24 3:55 pm

Viewing: GGS 788 : Deep Learning for Geoinformation

Last edit: 03/08/24 3:55 pm

Changes proposed by: nburtch

Programs referencing this course

SC-CERG-GISC: Geographic Information Science Graduate Certificate

SC-CERG-GI: Geospatial Intelligence Graduate Certificate

In Workflow

1. **GGS Chair**
2. **SC Curriculum Committee**
3. SC Assistant Dean
4. Assoc Provost-Graduate
5. Registrar-Courses
6. Banner

Approval Path

1. 03/15/24 11:33 am Nathan Burtch (nburtch): Approved for GGS Chair

Are you completing this form on someone else's behalf?

No

Effective Term: Fall 2024

Subject Code: GGS - Geography & Geoinformation Science **Course Number:** 788

Bundled Courses:

Is this course replacing another course? No

Equivalent Courses:

Catalog Title: Deep Learning for Geoinformation

Banner Title: Deep Learning Geoinformation

Will section titles vary by semester? No

Credits: 3

Schedule Type: Lecture

Hours of Lecture or Seminar per week: 3

Repeatable:

May only be taken once for credit (NR)

GRADUATE ONLY

Default Grade Mode: Graduate Regular

Recommended Prerequisite(s):

GGS 560 and GGS 650, or permission of instructor

Recommended Corequisite(s):

Required Prerequisite(s) / Corequisite(s) (Updates only):

Registrar's Office Use Only - Required Prerequisite(s)/Corequisite(s):

And/Or	(	Course/Test Code	Min Grade/Score	Academic Level	)	Concurrency?

Registration Restrictions (Updates only):

Registrar's Office Use Only - Registration Restrictions:

Field(s) of Study:

Class(es):

Level(s):

Degree(s):

School(s):

Catalog Description:

Advanced course on machine learning theory and practice as applied to multi dimensional geoinformation. Includes application of machine learning algorithms to problems involving spatial data and spatial analysis, including image analysis.

Justification:

What: Creation of a new deep learning course specific to application with geoinformation and geoinformatics.

Why: This course has been offered as a special topics for several academic years. Machine learning techniques are quite applicable to geographic problems, especially in geointelligence. We want this opportunity to use ML and AI techniques for our students, listed as a permanent course. Creating this course at the 700-level will allow it to be a proper elective in our MS Geoinformatics and Geospatial Intelligence program, and will also be available for our other graduate programs.

Does this course cover material which crosses into another department? No

Learning Outcomes:

Will this course be scheduled as a cross-level cross listed section?

Attach Syllabus
GGS788_syllabus.pdf

Additional Attachments

Staffing:
Primarily this course will be taught by our adjunct professor Dr. Michael Wolf, as he designed the course. This course can also be taught by full time faculty Dr. Dieter Pfoser. We also have a new tenure-track faculty member starting in Fall 2024 who is capable of teaching a deep learning course.

Relationship to Existing Programs:
This course will be added specifically to the MS GEOI program and to the GI and GISC certificate. It will also be available for the PhD ESGS as an elective.

Relationship to Existing Courses:
This course uses GGS 560 and GGS 650 as recommended prerequisites, as it builds on statistical and algorithmic applications of geoinformation

Additional Comments:

Reviewer Comments

Key: 18682

GGS 788 – Deep Learning for Geoinformation
Spring 2025 – Tuesday – 4:30 to 7:10
Classroom – Exploratory Hall - 2310

Instructors: Mike Wolf, PhD; Adjunct Professor
Email: mwolf7@masonlive.gmu.edu (best way to reach me)
Office: Exploratory Hall
Office Hours: Tuesday right after class or by appointment

Course Materials (reference text):

- Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems second edition by Aurélien Géron
- Various online deep learning instructional videos
- Various peer reviewed journal articles

Catalog Description:
Advanced course on machine learning theory and practice as applied to multidimensional geoinformation. Includes application of machine learning algorithms to problems involving spatial data and spatial analysis, including image analysis.

Course Description:
This course presents the theory and practice of Deep Learning as it applies to Geoinformation. Deep learning is a class of machine learning algorithms which enables computers to learn from known examples. Deep learning techniques have been used successfully for variety of applications, including automatic speech recognition, image recognition, natural language processing, drug discovery, and recommendation systems. Our focus will be on the application of deep learning to problems involving geoinformation. Peer-reviewed literature in deep learning is explored. The computer lab will be used to enhance the subject materials using the Python programming language and other tools. Having prior experience working with Python is required and a very good statistical background is essential to maximize your learning. We will build from the basics in class but move quickly in order to be able to apply basic deep learning techniques. Class attendance is required in that we will be doing multiple in-class exercises which you will leverage for your class project.

Course Objectives:
This is a graduate course and so it is expected that one has advanced research abilities along with refined writing and programming skills. By attending class lectures, performing background topic research and independent study, students will be able to:

- Understand the fundamentals of deep learning and its application to geoinformation
- Develop the ability to effectively and authoritatively research and present executive summaries of deep learning problems.
- Ability to formulate and solve basic problems using various deep learning methods
- Most importantly, learn how to learn from each other in a collaborative environment.

Planned Schedule:

Date	Topic	Lecture Scope
1/16/2024	Introduction	Introduction, Classroom Conduct, Syllabus Review and What is Deep Learning?
1/23/2024	What is Deep Learning? Survey of deep learning	In-class examples Class peer review journal discussion Peer review journal presentation #1
1/30/2024	Mathematics of Deep Learning Part 1	In-class examples Project Scope Due
2/6/2024	Mathematics of Deep Learning Part 2	In-class examples and hands-on exercise Regression Assignment Due and presentation
2/13/2024	Neural Networks: FFN Build a neural network: feed forward	In-class examples and hands-on exercise Peer review journal presentation #2
2/20/2024	PyTorch Part 1	In-class examples and hands-on exercise
2/27/2024	PyTorch Part 2	In-class examples and hands-on exercise Peer review journal presentation #3
3/12/2024	PyTorch Part 3	In-class examples and hands-on exercise
3/19/2024	TensorFlow & CNN Part 1	In-class examples and hands-on exercise Peer review journal presentation #4
3/26/2024	TensorFlow & CNN Part 2 & Image Augmentation	In-class demonstration
4/2/2024	Temporal Learning - LSTM	In-class examples and hands-on exercise Interim Project Due
4/9/2024	Transformer Models & Adversarial Learning	In-class examples and hands-on exercise Peer review journal presentation #5
4/16/2024	Complete Example – Unet on Satellite images	In-class examples and hands-on exercise
4/23/2024	Presentations Wrap-up	Deep Learning Presentation Final Project Due

Grading Policy:

***In-class Exercises and Article Presentations* (25%):**
Students are expected to participate in all in-class exercise and discuss their results. These in-class exercises will be extended as homework for the following class. The student will be asked to find peer review journal articles based on their interests. A summary of these articles will be presented in class with each presentation being no more than 10 minutes.

***Research Project* (50%)**
The research project will count for 50% of the student's grade. The research project will be due on the last day of class along with the associated presentation. All students must attend the presentation lecture in order to receive a passing grade for this course.

***Class Participation* (25%):**
Students are expected to attend the class periods of the courses for which they register. In-class participation is important not only to the individual student, but also to the class as a whole. Instructors may use absence, tardiness, or early departure as de facto evidence of non-participation.

Expectations for Participation:

- Students prepare for and actively engage in class discussion (e.g., demonstrate active listening, not distracted by electronics or peers)
- Students thoughtfully engage in in-class assignments and activities
- Students constructively participate in-group activities
- Students participate in class discussion by:
    - raising informed discussion points;
    - connecting discussion to reading material, news, and relevant experiences;
    - asking questions;
    - listening to other perspectives;
    - sharing the floor with others.

Grading Scale:
This course uses the regular graduate grading scale

97-100%	A+	87-89.9%	B+	70-79.9%	C
93-96.9%	A	83-86.9%	B	< 70%	F
90-92.9%	A-	80-82.9%	B-		

GMU Email Accounts & Blackboard:
You must use and regularly check your GMU email account and Blackboard to receive information for this class. Please do not send emails from non-GMU accounts, they will be ignored. I will normally respond within 24 hours.

Honor Code:
You are expected to follow the George Mason University rules of student conduct as noted in the catalog.

Office of Disability Services:
If you require academic accommodations due to a permanent or temporary disability, please contact the Office of Disability Services (ODS) at (703)993-2474, http://ods.gmu.edu. ODS will then contact me to arrange appropriate accommodations.

Classroom Expectations and other Miscellaneous:
Students are expected to be on time for class.

1. Should circumstances arise that make you late, do not disrupt the class as you enter.
2. In the event of any class cancellation, including inclement weather (e.g. snow), the class will resume where we left off, adjustments, if necessary, will be made later.
3. Please turn cell phone sounds off and do not text or talk during class.
4. Please be respectful of your peers and your instructor and do not engage in activities that are unrelated to the class. Such disruptions show a lack of professionalism and may affect your participation grade.
5. Lecture slides will be provided within 24 hours after the lecture. If you feel note taking is necessary, research has shown that pen and paper is the most effective.

Use of Generative-AI
Mason is an Honor Code university; please see the Office for Academic Integrity for a full description of the code and the honor committee process. Three fundamental principles to follow at all times are that: (1) all work submitted be your own, as defined by the assignment; (2) when you use the work, the words, or the ideas of others, including fellow students or online sites, you give full credit through accurate citations; and (3) if you are uncertain about the ground rules on a particular assignment or exam, ask for clarification. No grade is important enough to justify academic misconduct. Use of Generative-AI tools should be used following the fundamental principles of the Honor Code. This includes being honest about the use of these tools for submitted work and including citations when using the work of others, whether individual people or Generative-AI tools.

All work submitted in this course must be your own original work; use of AI writing tools, such as ChatGPT, are prohibited in this course and will be considered a violation of academic integrity. All academic integrity violations will be reported to the office of Academic Integrity.

More Details

One item to note: This is an upper-level graduate science class so the programming and mathematics skills that should have been learned is expected.

The following python environment has been tested and has no conflicts between packages. This assumes that the student has installed the most recent version of Anaconda python. The “conda” and “pip” commands can be cut & paste into the base “Anaconda Prompt (anaconda3).

****
Build Python environment on Anaconda named - TensorFlow
****

```
conda create --name TensorFlow python=3.9.12 anaconda
conda activate TensorFlow

pip install opencv-python
pip install opencv_contrib_python
pip install imutils
pip install tensorflow  #  includes gpu support, my version 2.10.1
pip install tensorflow_datasets
pip install git+https://github.com/tensorflow/docs
```

****
Build Python environment on Anaconda named - PyTorch
****

```
conda create --name PyTorch python=3.9.12 anaconda
conda activate PyTorch
```

https://pytorch.org/get-started/locally/

conda install pytorch torchvision torchaudio cudatoolkit=11.3 -c pytorch # NOTE: for my PC configuration, my PyTorch version is 1.12.1
