Term Information

Effective Term	Autumn 2021

General Information

Course Bulletin Listing/Subject Area	Physics
Fiscal Unit/Academic Org	Physics - D0684
College/Academic Group	Arts and Sciences
Level/Career	Graduate, Undergraduate
Course Number/Catalog	5680
Course Title	Big Data Analytics in Physics
Transcript Abbreviation	BigDataAnalytics
Course Description	Provides an introduction to machine learning and advanced algorithms, with an emphasis on practical physics-based applications, using publicly available data sets. The goal is to provide an introduction to Data Science for students who may want to pursue this as a career option and/or apply these techniques in a research environment.
Semester Credit Hours/Units	Fixed: 3

Offering Information

Length Of Course	14 Week
Flexibly Scheduled Course	Never
Does any section of this course have a distance education component?	No
Grading Basis	Letter Grade
Repeatable	No
Course Components	Lecture
Grade Roster Component	Lecture
Credit Available by Exam	No
Admission Condition Course	No
Off Campus	Never
Campus of Offering	Columbus

Prerequisites and Exclusions

Prerequisites/Corequisites	Enrollment in the Physics or Engineering Physics major; C- or higher in CSE 1222, CSE 1223, Engineering 1281H, or Astronomy 1221; C+ or higher in Physics 1251. Or instructor permission.
Exclusions	
Electronically Enforced	Yes

Cross-Listings

Cross-Listings

Subject/CIP Code

Subject/CIP Code	40.0801
Subsidy Level	Doctoral Course
Intended Rank	Junior, Senior, Masters, Doctoral

Requirement/Elective Designation

The course is an elective (for this or other units) or is a service course for other units

Course Details

Course goals or learning objectives/outcomes

- Understand how to process, clean, and prepare data for further analysis.
- Understand how to visualize data in order to gain insights regarding feature importance.
- Understand and be capable to apply a wide variety of machine learning tools in regression, classification, and clustering, with an emphasis on applications in Physics.
- Design their own machine learning solution to a Physics problem from start to finish.

Content Topic List

- Introduction to Python, manipulating data files, linear regression, classification using support vector machines, the confusion matrix, multi-class classification, decision trees and random forests, logistic regression, using the Ohio SuperComputer;
- Neural networks, multi-layer perceptrons, Siamese Networks, and the iPhone Face Recognition Algorithm.

Sought Concurrence

Yes

Attachments

- Concurrence_Form_Final.pdf

  (Concurrence. Owner: Thaler,Lindsey Nicole)
- Sample_Plan.pdf: Sample 4-year plan

  (Other Supporting Documentation. Owner: Thaler,Lindsey Nicole)
- Curriculum_Map.pdf: Curriculum Map

  (Other Supporting Documentation. Owner: Thaler,Lindsey Nicole)
- Physics_5680_Syllabus.pdf: updated syllabus

  (Syllabus. Owner: Thaler,Lindsey Nicole)

Comments

- Please see Panel feedback email sent 03/10/21. *(by Hilty,Michael on 03/10/2021 03:10 PM)*
- Please upload the updated curriculum map. *(by Humanic,Thomas John on 02/23/2021 09:34 AM)*
- Please upload your updated curriculum map for the BS showing how the new course fulfills what program goal and at what level. *(by Vankeerbergen,Bernadette Chantal on 02/17/2021 05:21 PM)*

Workflow Information

Status	User(s)	Date/Time	Step
Submitted	Thaler,Lindsey Nicole	02/16/2021 09:47 AM	Submitted for Approval
Approved	Humanic,Thomas John	02/16/2021 11:59 AM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	02/17/2021 05:21 PM	College Approval
Submitted	Humanic,Thomas John	02/17/2021 05:48 PM	Submitted for Approval
Approved	Humanic,Thomas John	02/17/2021 06:00 PM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	02/17/2021 09:21 PM	College Approval
Submitted	Humanic,Thomas John	02/18/2021 06:00 AM	Submitted for Approval
Approved	Humanic,Thomas John	02/18/2021 06:02 AM	Unit Approval
Revision Requested	Vankeerbergen,Bernadette Chantal	02/18/2021 10:32 AM	College Approval
Submitted	Humanic,Thomas John	02/18/2021 12:00 PM	Submitted for Approval
Revision Requested	Humanic,Thomas John	02/23/2021 09:34 AM	Unit Approval
Submitted	Thaler,Lindsey Nicole	02/23/2021 09:36 AM	Submitted for Approval
Approved	Humanic,Thomas John	02/23/2021 09:38 AM	Unit Approval
Approved	Vankeerbergen,Bernadette Chantal	02/23/2021 10:40 AM	College Approval
Revision Requested	Hilty,Michael	03/10/2021 03:10 PM	ASCCAO Approval
Submitted	Thaler,Lindsey Nicole	03/12/2021 09:27 AM	Submitted for Approval
Approved	Humanic,Thomas John	03/12/2021 10:49 AM	Unit Approval
Pending Approval	Vankeerbergen,Bernadette Chantal Haddad,Deborah Moore	03/12/2021 10:49 AM	College Approval

Physics 5680: Big Data Analytics in Physics

Credits: 3 credit hours

Instructor: Dr. Richard Hughes (hughes.319@osu.edu)

Course Description: This course provides an introduction to machine learning and advanced algorithms, with an emphasis on practical physics-based applications, using publicly available data sets. The goal is to provide an introduction to Data Science for students who may want to pursue this as a career option and/or apply these techniques in a research environment.

Students are expected to come into the course with the following:

- A laptop/chromebook or similar. Mac/Linux/Windows/ChromeOS are all fine since we will be using a browser-based environment (Jupiter notebooks) for all of our programming.
- Basic programming skills, which could be in any of a number of different languages, such as C++, java, python, etc. All course assignments will be done in python. Entering into the course after doing a simple online python tutorial would be a good idea!
- Basic knowledge of statistics and probability (such as would be obtained in Physics 3700).
- Enthusiasm for learning and a desire to challenge oneself!

Grading:

- 70%: in class and out of class assignments
- 30%: final project

Topics covered:

Week	Topic
1	Python Intro/Python challenge Manipulating data files Visualization with matplotlib and plotly
2	Intro to linear regression Dealing with missing data test/train splits; feature scaling and categorical data
3	Intro to Classification using support vector machines The confusion matrix ROC curves and AUC
4	Multi-class classification k-fold validation
5	Decision Trees and Random Forests Over- and Under-fitting, and the Bias-Variance Tradeoff Feature Importance

6	Linear Regression and Gradient Descent writing your own regressor from scratch Logistic Regression (write your own from scratch)
7	Using the Ohio SuperComputer Center (OSC) batch system Softmax Regression Neural Networks from scratch
8	Introduction to Keras: The Industry Standard Neural Network Library Multi-Layer Perceptrons
9	Convolutional Neural Networks
10	Project Proposal Due Autoencoders; Stacked Autoencoders and Classification
11	Visualization of learned Features in Neural Networks Adversarial Examples Variational Autoencoders
12	1D Convolutional Neural Networks and Sequences Text Classification Project Progress Report Due
13	Siamese Networks and the iPhone Face Recognition Algorithm
14	Possible Additional topics Generative Adversarial Networks Recurrent Neural Networks
15	During Exam Week: Project due (no final exam)

Physics Major (Non-Honors Advanced Physics Option)

Year	Autumn Semester	Credit hours	Comment		Spring Semester	Credit Hours	Comment
1	Physics 1250	5	Intro Physics I		Physics 1251	5	Intro Physics I
	Math 1151	5	Calculus I		Math 1152	5	Calculus II
	ASC 1100	1	Survey		CSE 1222°	3	C++ Programming
	Foreign Lang. 1	4			Foreign Lang. 2	4	
	Total Hours	**15**			**Total Hours**	**17**	
2	Physics 2300	4	Mechanics I		Physics 2301	4	Mechanics II
	Physics 2095	1	Seminar		Physics 3700	3	Data Ana. Lab
	Math 2153	4	Calculus III		Math 2415†	3	Diff. Equations
	Foreign Lang. 3	4			Gen Ed	3	
	Gen Ed	3			Gen Ed	3	
	Total Hours	**16**			**Total Hours**	**16**	
3	Physics 5500	4	Quantum I		Physics 5501	4	Quantum II
	Physics 5680**	3	Big Data Analytics		Physics 5400	4	E&M
	Gen Ed	3			Gen Ed	3	
	Gen Ed	3			Gen Ed	3	
	Free Elective◊	3					
	Total Hours	**16**			**Total Hours**	**14**	
4	Physics 5600	4	Stat. Mech.		Physics 5300	4	Theoretical Mech.
	Physics 5700	3	Senior Lab		Physics Elective*	4	
	Gen Ed	3			Gen Ed	3	
	Free Elective◊	3			Free Elective◊	3	
	Total Hours	**13**			**Total Hours**	**14**	

Courses in yellow are only offered in the term shown

Enrollment information can be found at physics.osu.edu/controlled-access-courses

† Math 5520H can be taken in place of Math 2415 and 2568.

** or Physics 6810 (Computational Physics) or Physics 3201H (Holography) or Physics 4700 (Electonics Lab)

* Acceptable Physics Elective include Physics 3470 (optics) or any of the Physics 68xx courses

° or CSE 1223 or Astronomy 1221

◊ Free electives are only required if a student needs to take extra courses in order to reach the minimum 121 credit hour requirement set by the College of Arts and Sciences.

The Ohio State University
College of the Arts and Sciences Concurrence Form

The purpose of this form is to provide a simple system of obtaining departmental reactions to course requests. **An e-mail may be substituted for this form.**

An academic unit initiating a request should complete Section A of this form and send a copy of the form, course request, and syllabus to each of the academic units that might have related interests in the course. Units should be allowed two weeks to respond to requests for concurrence.

Academic units receiving this form should respond to Section B and return the form to the initiating unit. Overlap of course content and other problems should be resolved by the academic units before this form and all other accompanying documentation may be forwarded to the Office of Academic Affairs.

A. Proposal to review

Physics 5680: Big Data Analytics in Physics

Initiating Academic Unit Course Number Course Title

New — 2/13/2020

Type of Proposal (New, Change, Withdrawal, or other) — Date request sent

Computer Science & Engineering — 2/28/2020

Academic Unit Asked to Review — Date response needed

B. Response from the Academic Unit reviewing

Response: include a reaction to the proposal, including a statement of support or non-support (continued on the back of this form or a separate sheet, if necessary).

On behalf of the CSE Curriculum Committee I am happy to offer concurrence for Physics 5680, "Big Data Analytics in Physics."

Signatures

	Name	Position	Unit	Date
1.	Teodoresan	Chair, Curriculum Comm	CSE	02/17/20
2.				
3.				

Revised 5/27/14

		Physics Major Program Outcomes					
		Undergraduate Physics majors acquire a basic mastery of fundamental areas of physics, from classical mechanics, through electricity and magnetism, and finally to modern physics including quantum mechanics and relativity.	Undergraduate Physics majors develop powerful analytical and problem solving skills in areas involving both physics and mathematics.	Undergraduate Physics majors acquire a basic mastery of experimental physics.	Undergraduate Physics majors have acquired a basic mastery of data reduction and error analysis.	Undergraduate Physics majors effectively communicate their physical understanding both professionally and colloquially (orally and in writing).	Undergraduate majors are apprised of and encouraged to participate in academic research, industrial research and/or outreach activities which are consistent with their interest, ability and postgraduate plans.
required courses	Physics 2095: Physics Seminar						3
	Physics 2300: Mechanics I	3	3	1			
	Physics 2301: Mechanics II	3	3	1			
	Physics 3700: Data Analysis Lab	1	3	3	3	3	1
	Physics 5400: Electromagnetism	3	3				
	Physics 5500: Quantum Mechanics	3	3				2
	Physics 5700: Physics Senior Lab	2	3	3	3	3	
required 3rd lab (choose 1)	Physics 3201H: Holography	2	3	3		2	
	Physics 4700: Electonics Lab	2	3	3	2	3	2
	Physics 5680: Big Data Analytics	1	3	2	3	1	2
	Physics 6810: Computational Physics	1	3	2	2	2	2

Relationship: 1 light, 2 intermediate, 3 high