FAU

FLORIDA ATLANTIC UNIVERSITY

NEW COURSE PROPOSAL
Undergraduate Programs

Department Mathematical Sciences

College College of Science

*(To obtain a course number, contact **erudolph@fau.edu**)*

UUPC Approval 12-7-20
UFS Approval _____
SCNS Submittal _____
Confirmed _____
Banner Posted _____
Catalog _____

Prefix MAP

Number 4112

(L = Lab Course; C = Combined Lecture/Lab; add if appropriate)

Lab Code N/A

Type of Course: Lecture

Course Title: Introduction to Methods in Complex Systems

Credits *(Review Provost Memorandum)*: 3

Effective Date *(TERM & YEAR)*: Spring 2022

Grading *(Select One Option)*: Regular (●) Pass/Fail ( ) Sat/UnSat ( )

Course Description *(Syllabus must be attached; Syllabus Checklist recommended; see Guidelines)*

Introduction to mathematical tools for analyzing and developing complex systems, including neural networks, reinforcement learning, and deep learning systems. Basic principles, methods, and applications of deep artificial neural networks to scientific data with an emphasis on image data.

Prerequisites, with minimum grade*

(MAC 2313 with at least a C) AND (MAS 2103 with at least a C OR MAP 3305 with at least a C)

Corequisites

N/A

Registration Controls *(Major, College, Level)*

N/A

Default minimum passing grade is D-. Prereqs., Coreqs. & Reg. Controls are enforced for all sections of course

WAC/Gordon Rule Course

( ) Yes (●) No

WAC/Gordon Rule criteria must be indicated in syllabus and approval attached to proposal. See WAC Guidelines.

Intellectual Foundations Program (General Education) Requirement *(Select One Option)*

None

General Education criteria must be indicated in the syllabus and approval attached to the proposal. See GE Guidelines.

Minimum qualifications to teach course

Ph.D. in Mathematics, Statistics, or a related field

Faculty Contact/Email/Phone

William Hahn/whahn@fau.edu/561-297-3340

List/Attach comments from departments affected by new course

Comp. & Electr. Eng. & Comp. Sc.,Complex Systems, ITOM, Political Science

Approved by	*Date*
Department Chair R. [signature]	11/27/2020
College Curriculum Chair Jerry Haky	12-3-20
College Dean [signature]	12/3/2020
UUPC Chair Jerry Haky	12-8-20
Undergraduate Studies Dean Edward Pratt	12-8-20
UFS President	
Provost	

Email this form and syllabus to mjenning@fau.edu seven business days before the UUPC meeting.

MAP 4112-001
CRN TBD
Introduction to Methods in Complex Systems

TR 2:00 p.m. – 3:20 p.m., NU 113
3 credits

Spring 2022
William E. Hahn, Ph.D.
Office: BS 311
Office hours: TR 12:30 p.m. – 1:30 p.m.
Telephone: 561-297-3340
Email: whahn@fau.edu

TA name	N/A
Office	BS 311
Office hours	TR 12:30 pm – 1:30 pm
Telephone	561-297-3340
Email	whahn@fau.edu

COVID-19 Statement

All students in face-to-face classes are required to wear masks during class, and students must sanitize their own workstations upon entering the classroom. Taking these measures supports the safety and protection of the FAU community. Students who do not adhere to these rules will be asked to leave the classroom and/or be removed from the course. Students experiencing flu-like symptoms (fever, cough, shortness of breath), or students who have come in contact with an infected person should immediately contact FAU Student Health Services (561-297-3512).

Course Description

Introduction to mathematical tools for analyzing and developing complex systems, including neural networks, reinforcement learning, and deep learning systems. Basic principles, methods, and applications of deep artificial neural networks to scientific data with an emphasis on image data.

Instructional Method

This course is conducted face-to-face in lecture-discussion style.

Prerequisites/Corequisites

(*MAC 2313 Calculus and Analytic Geometry 3* with a minimum grade of C) AND (*MAS 2103 Matrix Theory* with a minimum grade of C OR *MAP 3305 Engineering Mathematics 1* with a minimum grade of C)

Course Objectives/Student Learning Outcomes

Students will learn how to apply deep learning to scientific data analysis including identifying applicable mathematical preprocessing, implementation, and interpretation of results. Students will be able to apply some basic simulation methods including agent-based models and neural networks. Students should be able to explain the importance of complex systems foundations in deep learning, including the role of simulations in the analysis and development of such systems.

Course Evaluation Method

The requirements of the course and structure for evaluation are as follows:

- Weekly Lab Reports 30%
- Presentations and Contributions during class: 15%
- Midterm exam (on the first Thursday in March): 15%
- Final exam (on the date specified in FAU's final exam calendar): 40%

All work must be typed using LATEX or Jupyter Notebook.

Course Grading Scale

Percentages translate to final grades according to the following table:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
94-100	90-93	87-89	84-86	80-83	77-79	74-76	70-73	67-69	64-66	61-63	0-60

Policy on Makeup Tests, Late Work, and Incompletes

Late work is not accepted with the exception of extraordinary circumstances: if you cannot hand in an exam or written assignment in time due to a reason like significant health problems or a university-approved absence and you document this, then you can make up the respective assignment. Extra credit work is not possible.

To master the material covered in this course, it is expected that the student will spend a minimum of two hours per week per credit hour on the out-of-classroom assignments.

A student who is passing a course but has not completed all work due to exceptional circumstances, may, with consent of the instructor, temporarily receive a grade of incomplete ("I"). The assignment of the "I" grade is at the discretion of the instructor but is allowed only if the student is passing the course.

Special Course Requirements

Students are expected to have Colab, GitHub, and Overleaf accounts set up. For more information visit https://colab.research.google.com/, https://education.github.com/, and https://overleaf.com/.

Attendance Policy

Students are expected to attend all scheduled classes and to satisfy all academic objectives as outlined by the instructor. Absences can result in a reduction of the *Presentations and Contributions* portion listed in the *Course Evaluation Method*. Students are responsible for arranging to make up work missed because of legitimate class absence. It is the student's responsibility to give the instructor notice prior to any anticipated absences and within a reasonable amount of time after an unanticipated absence, ordinarily by the next scheduled class meeting.

Counseling and Psychological Services (CAPS) Center

Life as a university student can be challenging physically, mentally, and emotionally. Students who find stress negatively affecting their ability to achieve academic or personal goals may wish

to consider utilizing FAU's Counseling and Psychological Services (CAPS) Center. CAPS provides FAU students a range of services – individual counseling, support meetings, and psychiatric services, to name a few – offered to help improve and maintain emotional well-being. For more information, go to http://www.fau.edu/counseling/

Disability Policy

In compliance with the Americans with Disabilities Act Amendments Act (ADAAA), students who require reasonable accommodations due to a disability to properly execute coursework must register with Student Accessibility Services (SAS) and follow all SAS procedures. SAS has offices across three of FAU's campuses – Boca Raton, Davie, and Jupiter – however disability services are available for students on all campuses. For more information, please visit the SAS website at www.fau.edu/sas/.

Code of Academic Integrity

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty is considered a serious breach of these ethical standards, because it interferes with the university mission to provide a high-quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the university community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see University Regulation 4.001.

Required Texts/Readings

Aston Zhang, Zachary C. Lipton, Mu Li, and Alexander J. Smola: *Dive into Deep Learning*. This text is freely accessible at https://d2l.ai .

Supplementary/Recommended Readings

- Eli Stevens, Luca Antiga, Thomas Viehmann: *Deep Learning with PyTorch*, Foreword by Soumith, Chintala, Manning Publications Co., 2020.
- Ronald Olsen: *Learn Python in a Day and Master It Well*, AUVA Press, 2017.
- Xin-She Yang: *Nature-Inspired Metaheuristic Algorithms: Second Edition*, Luniver Press, 2010.
- L. Andrew Coward: *Towards a Theoretical Neuroscience: from Cell Chemistry to Cognition*, Springer, 2013.
- Uri Wilensky and William Rand: *An Introduction to Agent-Based Modeling: Modeling Natural, Social, and Engineered Complex Systems with NetLogo*, MIT Press, 2015.

Course Topical Outline

- Week 1: *Agent-based Model*
- Week 2: *Stochastic Processes, Random Walks*
- Week 3: *Gradient Descent*
- Week 4: *Monte Carlo Methods, Simulated Annealing*
- Week 5: *Non-convex Optimization, Particle Swarm Optimization*

- Week 6: *Linear Models*
- Week 7: *Nonlinear Models, Neural Networks*
- Week 8: L*oading and Manipulating Data*
- Week 9: *Representations and Visualization*
- Week 10: *Convolution*
- Week 11: *Dot-product Attention Units*
- Week 12: *Dynamical Systems Simulation*
- Week 13: *Dynamical Systems Simulation II*
- Week 14: *Generative Models*
- Week 15: *Adversarial Models*