ME 597 Artificial Intelligence in Thermal Systems
Fall 2020
Course Syllabus

Course Instructor: Prof. Hasti Veeraraghava Raju, School of Mechanical Engineering
Contact Details: vhasti@purdue.edu
Audience: Graduate, Professional, Undergraduate
Mode of Delivery: Online (Asynchronous Learning)
Number of Credit Hours: 3
Class Timings: 1:30 P.M. – 2.45 P.M. on Tuesday and Thursday
Course Prerequisites: ME200 or Basic Thermodynamics (can also be taken concurrently). Basic programming with Python would be helpful but not required.

Course Registration: https://mypurdue.purdue.edu/

Virtual Office Hours: 10.00 A.M. – 11.00 A.M. Eastern Time(ET) on Monday and Wednesday
Course Discussion Forum: Piazza
Course Materials and homework will be posted on **Brightspace** learning management system (LMS)

Course Description:
This course covers an introduction to mathematical concepts, exploratory data analysis, data preparation, data visualization, supervised learning, unsupervised learning, deep learning, and reinforcement learning with applications in thermal systems. Detailed instructions on how to get started with Python using Jupyter Notebook and TensorFlow will be provided at the beginning of the course. There will be presentations from the industry experts on the uses of AI for real-world applications. Students have the freedom to identify the course project based on their interests and work individually or in a group. Students who have difficulty can take help from Instructor to identify the project topics. Students will apply the concepts learned from lectures in their course projects.

Course Learning Outcomes: Students completing this course will be able to:

- Formulate a data driven modelling framework for engineering problems
- Apply data science techniques in engineering
- Develop Python and TensorFlow codes
- Perform exploratory data analysis, data preparation, and data visualization
- Interpret the results and write technical project reports
- Identify and implement the appropriate Artificial Intelligence (AI) techniques for autonomous intelligent systems
- Identify new applications of AI in thermal engineering
- Discover knowledge from the data

Software Tools: Jupyter Notebook, Python 3.7, TensorFlow 2.2.0
Reading Materials: Lecture notes with relevant references will be provided

Grading:

Homework: 50%
Course project: 50%

Grading Scale:

Grade	A+	A	A-	B+	B	B-
Score (%)	95-100	90-95	85-90	80-85	75-80	70-75

Grade	C+	C	C-	D+	D	D-	F
Score (%)	65-70	62-65	59-62	56-59	53-56	50-53	<50

Course Schedule (Tentative):

Module	Date	Lecture Topic	Assignment
Introduction	8/25	1.Course overview, getting started with Python and TensorFlow, hands-on tutorial	Course introductory survey
Review Foundational Knowledge for AI	8/27	2.Linear Algebra	Homework 1 available
	9/01	3.Calculus	
	9/3	4.Statistics and Probability	Homework 1 due
Supervised Learning	9/8	5.Regression : Linear and Polynomial	
	9/10	6. Demo on regression application*	Homework 2 available
	9/15	7. Classification: LR, SVM	
	9/17	8. Demo on LR, SVM application*	Homework 2 due, Homework 3 available
	9/22	9. Classification : Naïve-Bayes (NB)	
	9/24	10. Demo on NB application*	Homework 3 due, Homework 4 available
Presentation from Industry	9/29	11. Machine Learning for Engine Design, Dr. Janardhan Kodavasal, Cummins	
Unsupervised Learning	10/1	12. Dimensionality Reduction	
	10/6	13. Demo on DR application*	Homework 4 due, Homework 5 available
	10/8	14. Clustering	
	10/13	15. Demo on clustering application*	Homework 5 due
Presentation from National Lab	10/15	16. AI for Grid-Interactive Efficient Buildings, Dr. Vikas Chandan, Pacific Northwest National Lab	

Module	Date	Lecture Topic	Assignment
Deep Learning	10/20	17. Artificial Neural Networks (ANN)	Due: project problem statement
	10/22	18. Demo on ANN application*	
	10/29	19. Convolutional Neural Networks (CNN)	Due: literature review
	11/3	20. Demo on CNN application*	
	11/5	21. Recurrent Neural Networks (RNN)	Due: methodology
	11/10	22. Demo on RNN application*	
Presentation from Industry	11/12	23. AI for 3D Printing, Dr. Anand Jebakumar, Hewlett-Packard (HP)	
Reinforcement Learning	11/17	24. Q-learning, SARSA, & Deep Q	
	11/19	25. Demo on RL application*	Due: ML model & Results
Advanced Topic[$]	11/24	26. Discussion on advanced topics	
	12/1	27. Discussion on advanced topics	
	12/3	28. Discussion on advanced topics	Due: Final report, and code submission

Note: These are subject to change
[$]Decided based on students' interest.
*Thermal systems related applications

Policies

Teaching Philosophy:
As an instructor, it is my responsibility to maximize opportunities for every student in the class to learn, grow, and succeed in reaching both my own outcomes for the course and their personal goals and desires related to the class. To meet this responsibility, I draw on theory, frameworks, and practices rooted in principles of collaborative learning and student-faculty partnership. For some students, this may feel awkward. Much of our society's discussions about teaching focus on a banking system, in which an instructor deposits knowledge into a student's mind, and students receive, file, store, and ultimately return that information in the same format in which it was deposited. Instead, I focus on student learning, which I define as a process of individual change. This means developing skills to view the world in new ways, and engaging in different types of debates, discussions, and dialogues.

Missed or Late Homework and Project:
Missed assignments may only be made up when you notify me ahead of time with an explanation and plan for completion. These requests will be accepted at my discretion and may include a point penalty of 5% per day late. These are permitted only under special circumstances like illness, family emergency, etc. The missed homework and final project will receive zero credit.

Copyright:
Students may not distribute, copy, reproduce or post to any other outlet (e.g., YouTube, Facebook, or other open media sources or websites) any lectures and other course materials without the written permission of the course instructor.

Academic Integrity:
Academic integrity is one of the highest values that Purdue University holds. Individuals are encouraged to alert university officials to potential breaches of this value by either emailing integrity@purdue.edu or by calling 765-494-8778. While information may be submitted anonymously, the more information is submitted the greater the opportunity for the university to investigate the concern. More details are available on our course Brightspace table of contents, under University Policies.
Purdue's Honor Pledge: "As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."

See the Purdue's student guide for academic integrity:
https://www.purdue.edu/odos/osrr/academic-integrity/index.html

Emergency Preparation:
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this course will be posted onto the course website or can be obtained by contacting the instructor via email or phone. You are expected to read your purdue.edu email on a frequent basis.

Nondiscrimination Statement:
Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. In pursuit of its goal of academic excellence, the University seeks to develop and nurture diversity. The University believes that diversity among its many members strengthens the institution, stimulates creativity, promotes the exchange of ideas, and enriches campus life.

Purdue University views, evaluates, and treats all persons in any University related activity or circumstance in which they may be involved, solely as individuals on the basis of their own personal abilities, qualifications, and other relevant characteristics.

Purdue University prohibits discrimination against any member of the University community on the basis of race, religion, color, sex, age, national origin or ancestry, genetic information, marital status, parental status, sexual orientation, gender identity and expression, disability, or status as a veteran. The University will conduct its programs, services and activities consistent with applicable federal, state and local laws, regulations and orders and in conformance with the procedures and limitations as set forth in Purdue's Equal Opportunity, Equal Access and Affirmative Action policy which provides specific contractual rights and remedies. Additionally, the University promotes the full realization of equal employment opportunity for women, minorities, persons with disabilities and veterans through its affirmative action program.

Any question of interpretation regarding this Nondiscrimination Policy Statement shall be referred to the **Vice President for Ethics and Compliance** for final determination.

Accessibility:
Purdue University strives to make learning experiences as accessible as possible. If you anticipate or experience physical or academic barriers based on disability, you are welcome to let me know so that we can discuss options. You are also encouraged to contact the Disability Resource Center at: drc@purdue.edu or by phone: 765-494-1247. More details are available on our course Brightspace under Accessibility Information.

Violent Behavior Policy:
Purdue University is committed to providing a safe and secure campus environment for members of the university community. Purdue strives to create an educational environment for students and a work environment for employees that promote educational and career goals. Violent Behavior impedes such goals. Therefore, Violent Behavior is prohibited in or on any University Facility or while participating in any university activity. See the University's full policy for more detail: https://www.purdue.edu/policies/facilities-safety/iva3.html.

Academic Guidance in the Event a Student is Quarantined/Isolated:
If you become quarantined or isolated at any point in time during the semester, in addition to support from the Protect Purdue Health Center, you will also have access to an Academic Case Manager who can provide you academic support during this time. Your Academic Case Manager can be reached at acmq@purdue.edu and will provide you with general guidelines/resources around communicating with your instructors, be available for academic support, and offer suggestions for how to be successful when learning remotely. Importantly, if you find yourself too sick to progress in the course, notify your academic case manager and notify me via email or Brightspace. We will make arrangements based on your particular situation. The Office of the Dean of Students (odos@purdue.edu) is also available to support you should this situation occur. Please contact the Protect Purdue Health Center at **765-496-4636** if you have any concerns.

Attendance Policy during COVID-19:
Students should stay home and contact the Protect Purdue Health Center (**496-INFO**) if they feel ill, have any symptoms associated with COVID-19, or suspect they have been exposed to the virus. In the current context of COVID-19, in-person attendance will not be a factor in the final grades, but the student still needs to inform the instructor of any conflict that can be anticipated and will affect the submission of an assignment or the ability to take an exam. Only the instructor can excuse a student from a course requirement or responsibility. When conflicts can be anticipated, such as for many University-sponsored activities and religious observations, the student should inform the instructor of the situation as far in advance as possible. For unanticipated or emergency conflict, when advance notification to an instructor is not possible, the student should contact the instructor as soon as possible by email, through Brightspace, or by phone. When the student is unable to make direct contact with the instructor and is unable to leave word with the instructor's department because of circumstances beyond the student's control, and in cases of bereavement, quarantine, or isolation, the student or the student's representative should contact the Office of the Dean of Students via email or phone at **765-494-1747**. Our course Brightspace includes a link on Attendance and Grief Absence policies under the University Policies menu.

Disclaimer

This is a tentative syllabus and subject to change during the semester. The necessary changes to correct errors, to include any latest updates in the subject, to accommodate students interest, to accommodate the changes in the semester schedule will be incorporated in the syllabus. These changes will be notified to all students.