MAHARISHI UNIVERSITY OF MANAGEMENT

CS582

Machine Learning:

Discovering the Learning Dynamics of the Laws of Nature

Dr. Sanad Aburass

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Maharishi University of Management is an Equal Opportunity Institution.

COURSE TITLE:

Machine Learning:

Discovering the Learning Dynamics of the Laws of Nature

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SYLLABUS

"Problems will disappear as darkness disappears with the onset of light."

— Maharishi

GOAL OF THE COURSE

The Objectives of the Course

Student will

- Develop skill in designing systems that can learn from data.
- Develop the ability to understand the core Machine Learning algorithms and learn how to use such algorithms in practical applications.
- Learn how to evaluate learning & generalization capabilities, and efficiency of Machine Learning algorithms.
- Develop the ability to analyze & design ML systems – use concepts learned in #1 - #3, determine the type of ML algorithms to be used, and optimize the design.
- Be able to read current ML related research papers, understand the concept & issues, and develop ability to apply them in relevant practical applications.
- Become acquainted with the self-referral transcendental foundation of all Machine Learning computation both on a theoretical and experiential level.

STUDENT LEARNING CHART

OBJECTIVES This is what you'll learn to do*	LEARNING ACTIVITIES This is how you'll learn it	ASSESSMENTS This is how you'll show you've learned it
1. Develop skill in understanding systems that can learn from data **(1,3)**	By working individually, in teams and practicing the techniques to understand,	Class interaction, Lab works and results from the midterm exam.

	analyze and design key ML algorithms / systems.	
2. Develop the ability to understand the core Machine Learning algorithms and learn how to use such algorithms in practical applications **(3, 4).**	By practicing various ML algorithms including Supervised, Unsupervised and Reinforcement Learning in class, labs and project.	Class interaction, Lab works, results from the Midterm exam and Project proposal.
3. Learn how to evaluate learning & generalization capabilities, and efficiency of Machine Learning algorithms **(4, 5).**	By working on some practical problems in labs and project focusing on learning and generalization criteria & matrix.	Class interaction, Lab works, results from the Midterm exam and progress in the project.
4. Develop the ability to analyze & design ML systems – use concepts learned in #1 - #3, determine the type of ML algorithms to be used, and optimize the design **(3,5,7,8).**	By practicing various ML applications in labs and project.	Class interaction, Lab works, and progress in the project and results from the Final exam.
5. Be able to read current ML related research papers, understand the concept & issues, and develop ability to apply them in relevant practical applications **(3,5,7,8).**	By practicing various ML papers with well covered applications in labs and project.	Class interaction, Lab works, results of the Project work and results from the Final exam.
6. Learn the connections between the Science of Consciousness and Machine Learning **(3,4,5,9).**	By doing Wholeness of the Lessons, Main Points, Unity Charts and associated explanations in classroom.	Results from the final exam

*The numbers in parentheses refer to the MUM Essential Learning Outcomes that are best supported by this course objective. They appear in **boldface** in the list below.

1. Development of consciousness
2. Health
3. Holistic thinking
4. Creativity

5. Critical thinking
6. Communication
7. Problem solving
8. Teamwork and leadership
9. Local and global citizenship

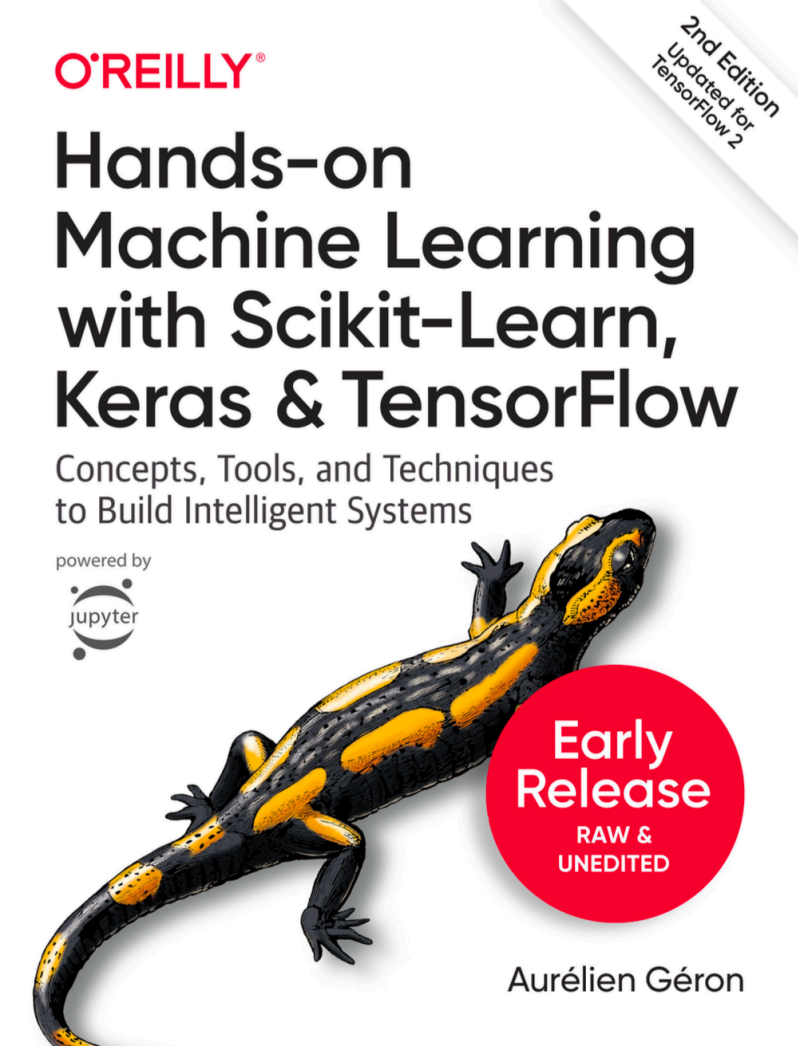
OFFICE HOURS, CONTACT INFORMATION, AND BIOGRAPHICAL SKETCH

Dr. Sanad Aburass

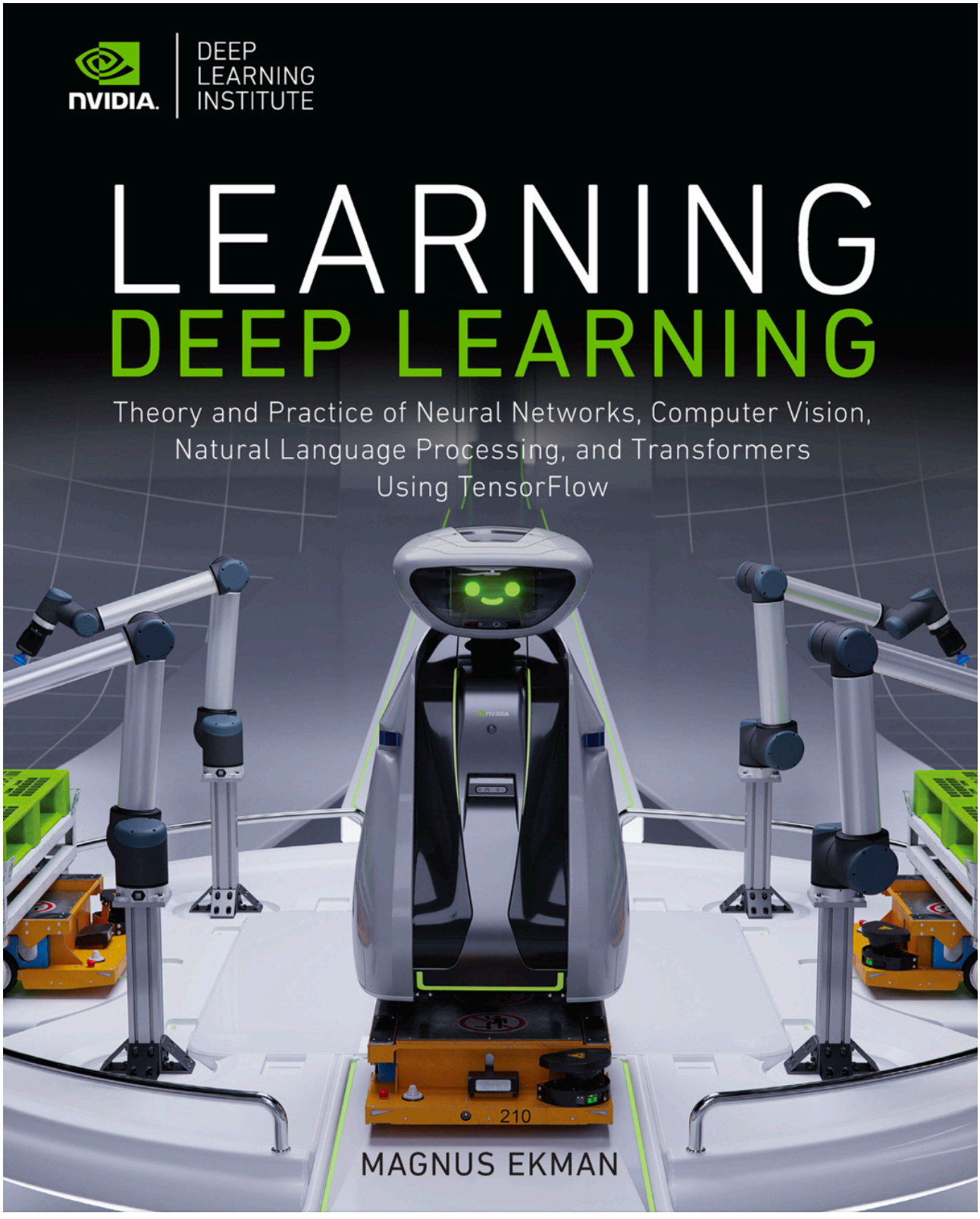
- Email: saburass@miu.edu
- Office: McLaughlin – Room 221

TEXTS AND OTHER REQUIRED CLASS MATERIALS

A. **The strongly recommended text** for the course is *Hands-on Machine Learning with Scikit-Learn, Keras & TensorFlow Concepts, Tools, and Techniques to Build Intelligent Systems, by Aurélien Géron*



L E A R N I N G D E E P L E A R N I N G Theory and Practice of Neural Networks, Computer Vision, Natural Language Processing, a n d Transformers Using TensorFlow, by MAGNUS EKMAN.



Do Labs and Project in Groups

You will need to know how to do every homework problem yourself, but you will have the opportunity to work in a group consisting of 4 people. One way to do homework assignments that I do NOT recommend is to split up the assignment between group members and then combine results. This approach is almost entirely without value – better to just skip the assignment completely. The group is there for you to *discuss* homework that you have done, or to get ideas for you to work out solutions. It is not intended as a means of skipping problems.

Labs are due on the day (indicated on the calendar) on which solutions are presented to class.

Labs are submitted in electronic form, with a cover page to indicate the Lab number and group members. These submissions will be used to compute your Group Lab score.

Guidelines for Lab submission

1. Your work for a particular Lab should be submitted *as a group.*

2. Each problem in a Lab should be worked out on a *separate page* – two problems should never be worked on the same page, even if they are short.

3. If a problem asks you to write code, work it out in a development environment, and upload to the link that will be provided. Please include the following:

    - *Assignment Number*
    - *Group Name* (like "Group 1", "Group 2" etc.)

Your project is 30% of your grade. You can do it either individually or in a group of maximum 4 students.

A good project is one that applies one or more machine learning algorithms covered in class, in novel ways to a dataset. An excellent project is a research project that will result in a paper at a major conference such as ICML, UAI, AISTATS or NIPS.

The project will provide you with a unique opportunity for exploring one or more areas of machine learning. You need to pick some ML algorithms that we did not cover or did not cover in depth in class. Some examples are Recurrent Neural Networks, Swarm Intelligence, graphical models, Hidden Markov Model, and Deep learning. You should **choose a data set**, apply machine learning techniques from these fields to it and compare their performance with the techniques covered in class.

If you want to tie the class project to your research project or a fun application, you are strongly encouraged to do so. In this case you can use algorithms that we have covered in the class or any other algorithms. However, you should be able to **demonstrate novelty**. Simply applying an algorithm to a sub-problem in your research project / application is not acceptable.

Project Deliverables

In a nutshell

- **Initial proposal (Friday, first week of the class)**. 10% of your project grade – see the format below.
- **A video and / or slides of your talk (Tuesday of 4th week)**. 30% of your project grade.
- **A paper describing your work (Due Sunday of 4th week)**. 30% of your project grade.
- **Code and scripts (Due Sunday of 4th week)**. 30% of your project grade.

Project proposal format: Proposals should be one page maximum. Include the following information:

- Project title
- Data set
- Project idea. This should be approximately two paragraphs.
- Software you will need to write.
- Papers to read. Include 1-3 relevant papers. You will probably want to read at least one of them before submitting your proposal.
- Teammates: will you have a teammate (s)? If so, whom? Maximum team size is 4 students.
- 4th Tuesday milestone: What will you complete by 4th Tuesday? Experimental results of some kind are expected here.

- *All names and student ID's of the members of the group*

Group Project
An important part of this course is a group project

Description

Sample Project Topics (and Dataset)

Consider using sample project topics from the following sources (*you can also select from other similar sources e.g. from searching on the Internet*):

- Carlos Guestrin's class at CMU.
- Goeff Gordon's class at CMU
- Ray Mooney's class, UT Austin
- Andreas Krause's class, Caltech
- Apply machine learning algorithms in novel ways to datasets from UCI machine learning repository

Sample Project Reports

Project reports from Andrew Ng's class 2011

Also, see sample project report format on Sakai.

Generative AI Presentation

Each group must prepare and present a one-hour lecture on Generative AI, which will count for 5% of the course grade.

MAHARISHI UNIVERSITY OF MANAGEMENT

CS 582 Machine Learning:

Discovering the Learning Dynamics of the Laws of Nature

Course Overview Chart

Course Overiew Chart	CS 582 – Machine Learning: Discovering the Learning Dynamics of the Laws of Nature					
Week	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**
1 Theme: ML & Supervised Learning	**AM: Lesson 1**: *Introduction: ML Creates Programs using Data* **PM: Lab 1**	**AM: Lesson 1.5: Data Cleaning** **PM: Lab 1.5**	**AM: Lesson 2** Regression **PM: Lab3**	**AM: Lesson 3:** *Classification* **PM: Lab 4**	**AM: Lesson 4**: *Artificial Neural Network* **PM: Lab 5**	*AM: Quiz 1 Week Review* **Initial project proposal due**
2 Theme: Deep Learning	**AM: Lesson 5:** *Convolution Operations* **PM: Lab 6**	**AM: Lesson 6** : *Convolutional Neural Networks* **PM: Lab 7**	**AM: Lesson 7:** Decision Trees and Random Forests **PM: Labs 8**	**AM: Lesson 8:** Ensemble Learning **PM: Labs 9**	AM: Review for Midterm **PM:** Study for midterm	**Midterm Exam**
3 Theme: Unsupervised Learning, Reinforcement Learning	**AM: Lesson 9:** *Advanced CNN Architectures and Transfer Learning* **PM: Labs 10**	**AM: Lesson 10:** *Unsupervised Learning* **PM: Labs 11**	**AM: Lesson 11** *Reinforcement Learning* **PM:** *Lab 12*	**AM:** *Generative AI Presentation* **PM:** *Generative AI Presentation*	**AM:** Reviewfor Final **PM:** Study for final)	**Final Exam**
4 Theme: Project	**AM: Project** **PM: Project**	**AM: Project** **PM: Project**	**AM: Project** **PM: Project**	**AM: Project Presentation** **PM: Project Presentation**		**Project Report (and code) is due**

EVALUATION PLAN

Your class grade represents your performance on the course objectives as measured by assignments and exams, as well as your classroom participation, as measured by attendance and punctuality.

How are grades calculated?

Homework.....10 points

Mid Term.....25 points

Final.....25 points

Project.....30 points

Generative AI Presentation .....5 points

Quiz .....5 points

Total .....100 points

What do grades mean?

A	90–100	Excellent	Meets the course objectives at an exceptionally high level
B	80–89	Good	Meets the course objectives at the expected level
C	70–79	Fair	Meets the course objectives at a basic level
NC	below 70	No credit	Does not meet the course objectives

More Details on Grading:

Range	Letter Grade
93-100	A
90 - 92	A-
87 - 89	B+
83 - 86	B
80 - 82	B-
77 - 79	C+
73 - 76	C
67 - 72	C-
0 - 66	NC

MAJOR ASSIGNMENTS

Assignment 1 • The Project – please see the details above under Project (30 points).

REVIEW ACTIVITY

We'll frequently use the following activity at the end of a class to review the lesson:

- At the end of the lesson, please write down in your own words what you think is the lesson's most important point. (one sentence)
- Relate this main idea to the growth of your own creative potential or the knowledge of full development of consciousness you've gained. (one sentence)
- Draw a diagram or illustration that integrates the two points.
- One participant: Draw your picture on the board and present your review to the class. Others: Share your review with a neighbor.

DAILY SCHEDULE

On Monday–Friday, classes begin at 10:00 a.m. and end at 3:15 p.m. with an hour for lunch. On Saturdays, class meets from 10 AM to noon. For more detail, please see the recommended daily schedule below.

This daily schedule of all courses is designed to help you master specific fields of knowledge while also cultivating higher states of consciousness for success and fulfillment in life.

The more rested you are, the more you'll learn. I recommend you aim to be in bed by 10:00 p.m., so you're rested and fresh each morning. If you haven't finished your homework by then, then instead of staying up late to finish it, get a good night's rest and finish it in the morning before class.

You are also encouraged to participate in physical activity daily.

MORNING	
	Group program for Meditators and Sidhas
10:00 AM – 12:15 PM	Class lecture, discussion, activities, labs
12:15 PM– 12:30 PM	In-class group Transcendental Meditation practice
12:30 – 1:30 PM	Lunch and walk
AFTERNOON	
1:30 – 2:55 PM	Continuation of morning class, projects, exercises, in-class reading, labs
2:55 – 3:15 PM	In-class group Transcendental Meditation practice for Meditators and Rising Sidhas
3:00 – 4:30 PM	Group program for Sidhas
EVENING	
	Dinner
7:00 – 9:00 PM	Homework (2 hours per evening)
9:30 PM	Rest

COURSE POLICIES

This section is meant to remind you of the policies in effect for this course. Most of these are University-wide policies, explained in more detail in either the Student Handbook or the University Catalog's Academic Policy section, available online at https://students.mum.edu/student-handbook/ or https://students.mum.edu/catalogs . If you're unsure how a policy works, feel free to discuss it with me after class.

Development of consciousness component for each class

The Development of Consciousness component in each class includes:

- A 15-minute group meditation in the classroom before lunch, Monday–Saturday.
- At the end of class Monday–Friday:
    - **Meditators** stay for a 20-minute group meditation with class. This is part of each class — five group meditations per week. Because group meditation is part of each class, attendance will be recorded in the same way it is for other parts of the class day.
    - **Sidhas** are excused at 2:45 pm to attend early or evening program in the Domes or flying halls on campus at least 5 times a week. This is part of the homework for each class.
- A group TM-checking before lunch sometime during the course.

All students are encouraged to do their 20-minute morning meditation each day before they come to class. One option is to attend the group meditation in Dalby Hall before breakfast. The 15-minute group meditation before lunch is a special bonus available to students here. Students who practice the TM-Sidhi program are encouraged to join group practice in the Golden Domes as often as possible.

Attendance

Students are expected to attend all class sessions. Much of the value of a university course comes from your class experiences. These experiences can't be made up in other ways or evaluated through quizzes, papers, or exams. For this reason, we highly value attendance at MIU.

Absences are either excused or unexcused:

- An *excused absence* is defined as an absence due to illness or family emergency, including childcare, or medical appointments that cannot be scheduled outside of class hours.
- All other absences are *unexcused*.

Whether the absence is excused or unexcused, you're responsible for all readings and all written assignments during any time you miss. In the interest of efficiency, please arrange to find out adjustments in assignments and other announcements from other classmates rather than from me, if possible. I'll be happy to give you any handouts you missed while absent.

I maintain a strict attendance policy: if you are late for the morning class, you will be considered absent for that day. Similarly, if you miss the lab, you will be marked absent for the entire day.

This absence will be recorded in your student file.

Contact me before class if you will be absent

- In the rare event you must miss class or are sick, please contact me as soon as possible (contact information above) or send a message with a friend. If you keep me informed, I will know how you're doing and how to plan for each class.
- If you miss class without notifying me, I will assume the absence is unexcused.
- Please schedule doctor's appointments and other appointments for outside of class time.

Consequences of absences

- Unexcused absences may result in your course grade being reduced by 3 percentage points for each session missed (morning or afternoon).
- Repeated unexcused absences are a violation of the MUM Code of Student Behavior. In addition to academic consequences, students with repeated unexcused absences are subject to disciplinary actions.
- If you miss more than 6 sessions of a standard 4-unit course, even for illness or family emergency, it's likely you won't have completed enough of the coursework to be eligible for course credit. I may ask you to withdraw from the course.

Punctuality

Students are expected to arrive on time, just as in the professional world. We ask that you arrive a couple minutes early, so everyone is seated and settled when the class begins. Punctuality also extends to returning from lunch and breaks on time.

- **Consequences of arriving late or leaving early** — A class grade may be reduced by one

percentage point for every 20 cumulative minutes late (up to two points per session). This policy also applies to leaving class early.

- **If you do arrive late,** please look for the Attendance/Punctuality Registry posted in the classroom to record your late minutes (with academic honesty).

Turning in assignments late

Late homework (department policy) — Unless illness or family emergency prevents you from turning in work, you need to hand in all assignments on the day they're due. You may turn in homework one day late for a reduced grade, but not after that. Please do not turn in assignments after the end of the course without prior arrangement (see "Incomplete work" below).

"Incomplete work" at the end of the course

At the end of the course, I'll evaluate the work you've turned in according to the grading or evaluation plan announced at the start of the course. If you weren't able to complete assigned work by the end of the course *due to illness, family emergency, or other circumstances beyond your control*, you may petition me to turn in that work late for credit using a "Late Work Contract" (available at the Enrollment Center or downloadable from the MUM website — **s**earch "Late Work Contract.") For further details, please see the MUM Catalog under "Late Work Policy" in "General Policies."

Academic honor code

Personal integrity, honesty, and honor are essential qualities of a capable student, a good citizen, and a developing leader. Our Academic Honor Code sets forth the standards of academic honesty and personal integrity expected of all students for all writing assignments and exams. Abiding by the Academic Honor Code will also help you avoid questions of academic impropriety. For the full Honor Code, see the MUM Catalog and Student Handbook.

Computers and cell phones

Please turn off all cell phones at the start of class, to avoid disruptions and focus fully on the class. We'll discuss when classroom use of computers is appropriate.

Respectful classroom interaction

We enjoy a uniquely harmonious and supportive atmosphere at MUM. We honor diversity of every kind, including diversity of culture, ethnic, religion, race, gender and sexual orientation, and viewpoint. We do not tolerate racism, harassment, or abusive or disrespectful language or behavior. While we welcome all points of view, we ask that you maintain an open and supportive attitude toward your fellow classmates and university staff.

Standards of appearance

The MUM faculty seek to create a coherent, focused, and dignified atmosphere on campus and in class that supports giving and gaining knowledge. In that spirit, we encourage neat, dignified, and modest clothing appropriate to the occasion. Torn, stained, sloppy, immodest, or revealing clothing is not appropriate. Students from other cultures and traditions are welcome to wear traditional dress, provided the appearance is neat and modest.

END-OF-COURSE FEEDBACK

Please give us your feedback about the course. Near the end of the course, you should receive an email from Sonja Gobec, Director of Evaluations, that gives you a one-step login link. If you don't receive this email, you can request access by emailing Sonja at evaluations@mum.edu or go to Smartevals.com/mum and log in there.

- Your Username: your student ID in 000-00-0000 format.
- Your Password: your birth date in MM/DD/YY format.

How it works

- The information you enter on the online form is collected and sorted by an outside company, Gap Technologies.
- Gap Technologies prepares a report for each class that averages the numerical scores and lists your text responses anonymously.
- Your instructor receives the report *only after* turning in grades.

We're committed to continuously improving the curriculum. We value and need your feedback.

SERVICES

Student Support Services

In addition to the normal support you receive from me and your classmates, you can take advantage of extensive on-campus support services for both academic and personal support you may need at any time.

To access these services, please stop by the Student Life department (Dreier 105) between 10 a.m. and 4 p.m., Monday–Friday, or call the department administrator at 641-472-1225 for referral to the appropriate person.

Writing Center

This is an especially valuable resource for all students, for anything you may be writing.

- Location — Arts Center room 112.
- Hours — Monday–Friday 3:30 – 6 p.m. or by appointment.

To schedule an appointment, please stop by or email writingcenter@mum.edu. For questions, comments, concerns, or further information, please contact Leah Waller at ext. 5031 or lwaller@mum.edu.

MAIN POINTS

LESSON 1:

Introduction: ML Creates Programs using Data

Creation Emerging from the Collapse of Wholeness to a Point

WHOLENESS OF THE LESSON

Machine learning (ML) provides computers the ability to learn without being explicitly programmed. Machine learning focuses on the development of computer programs that can teach themselves to grow, reconfigure and change when exposed to new data. Algorithms that are used for computation / programming address only a tiny set of all problems in nature. Thus, for many problems algorithms do not exist. ML tries to develop models / programs to solve problems that algorithms cannot address. However, ML based approach also addresses only a tiny set of all problems in nature. The full range of Nature's computational power is too vast to be grasped by the intellect alone.

Science of Consciousness: *Transcendental Meditation (TM) allows one to easily reach* the state of pure creative intelligence from where the un-manifest abstract ideas and thoughts may be efficiently converted into the fully expressed useful values and objects.

MAIN POINTS

1. Machine learning (ML) provides computers the ability to learn without being explicitly programmed. Machine learning focuses on the development of computer programs that can teach themselves to grow, reconfigure and change when exposed to new data.

Science of Consciousness: *Transcendental Meditation (TM) allows one to reach the pure consciousness state easily and thus enables to become very intelligent. Unbounded awareness enables to use Total Natural Law to easily and efficiently solving problems and helping the society.*

2. Machine Learning addresses simple, complex and very complex problems. Simple problems include Regression, Classification (Predictive Maintenance, Classifying pictures); Complex problems include doing Search (Auto driving car, Speech Recognition); and very complex problems include complex Decision Making, Understanding human language (Semantics, Question Answering, Summarization, Drawing Inference), Thinking capability.

Science of Consciousness:

Scientific research on students practicing TM shows holistic improvement in intellectual performance, personality and individual differences [1] and improved graduate academic performance [2].

[1] "Holistic Improvement in Intellectual Performance Through the Transcendental Meditation Techniques", Intelligence 29 (2001): 419-440; Personality and Individual Differences 12 (1991):1105-1116; College Student Journal 15 (1981): 140-146.

3. Major machine learning types are Supervised, Unsupervised, Reinforcement and Evolutionary.
- Supervised Learning: It is done with input data and some target / output data (like using a teacher). The ML algorithm tries to learn to match the input to the output.

- Unsupervised Learning: Input data but with no target / output data. The algorithms tries to find similarities between input data and group them into different classes or categories.

- Reinforcement Learning: This is somewhere between Supervised and Unsupervised Learning. The algorithm gets told when the answer is wrong but does not get told how to correct it.

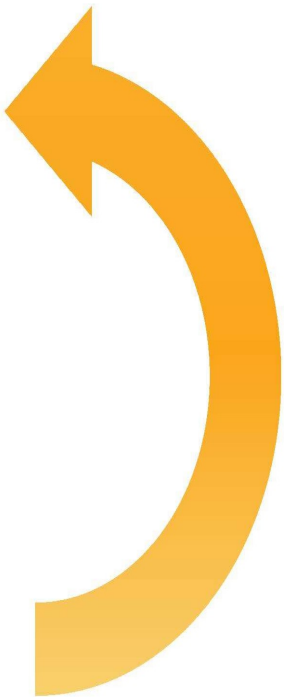
- Evolutionary Learning: Biological evolution can be seen as a learning process. Biological organisms adapt to improve their survival rates and chance of having offspring.

Science of Consciousness: Regular practice of TM is the key to reach higher level consciousness, namely, Cosmic, Refined Cosmic and Unity Consciousness. Reaching such higher states of consciousness is the key to gain complete knowledge and intelligence to clearly understand and solve all problems.

UNITY CHART

CONNECTING THE PARTS OF KNOWLEDGE WITH THE WHOLENESS OF KNOWLEDGE:

THE SELF-REFERRAL BASIS OF COMPUTATION



1. Computation in computer science is represented by sequential procedures.

2. Machine Learning (ML) develops models / programs by learning from data to solve some problems for which appropriate sequential procedures cannot be expressed / computed by algorithms.

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3. *Transcendental Consciousness* is the field of pure unbounded silence, beyond the active field of Nature's computation.

4. *Impulses Within the Transcendental Field*. The hidden self-referral dynamics within the field of pure intelligence, on the ground of pure silence, give rise to the perfectly orderly unfoldment of creation.

5. *Wholeness Moving Within Itself.* In Unity Consciousness, one appreciates the flawless unfoldment of life and existence as the lively impulse of one's own pure consciousness.