

程序代写代做 CS编程辅导

Course overview and logistics



CS861: Theoretical Foundations of Machine Learning

WeChat: cstutorcs

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Fall 2023

<https://tutorcs.com>

September 6, 2023

Machine learning is popular nowadays!

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- “A breakthrough in ML will be worth 10 Microsofts”



Gates

- “ML is the new internet”

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- Tony Tether, Director, DARPA

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- “AI will be the best or worst thing ever for humanity”

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Elon Musk

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ML Application: Object detection & segmentation

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Weather forecasting & Climatology

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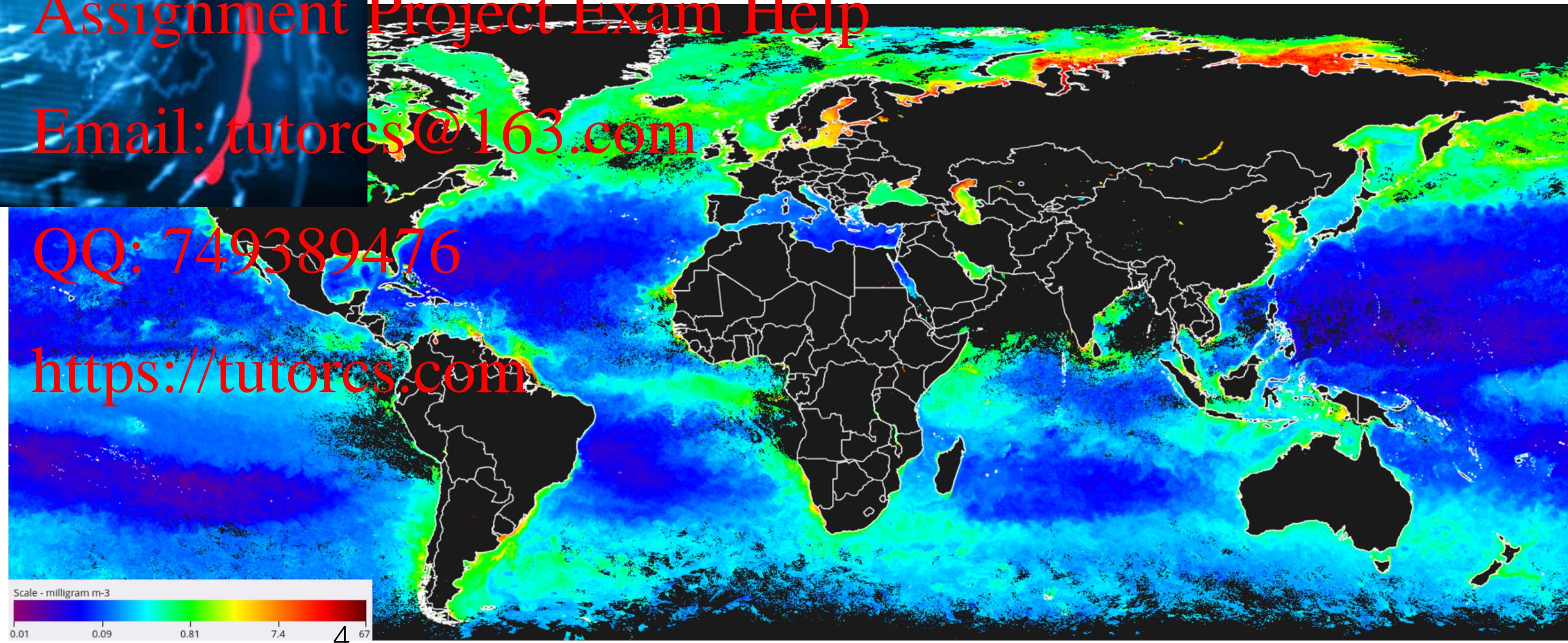
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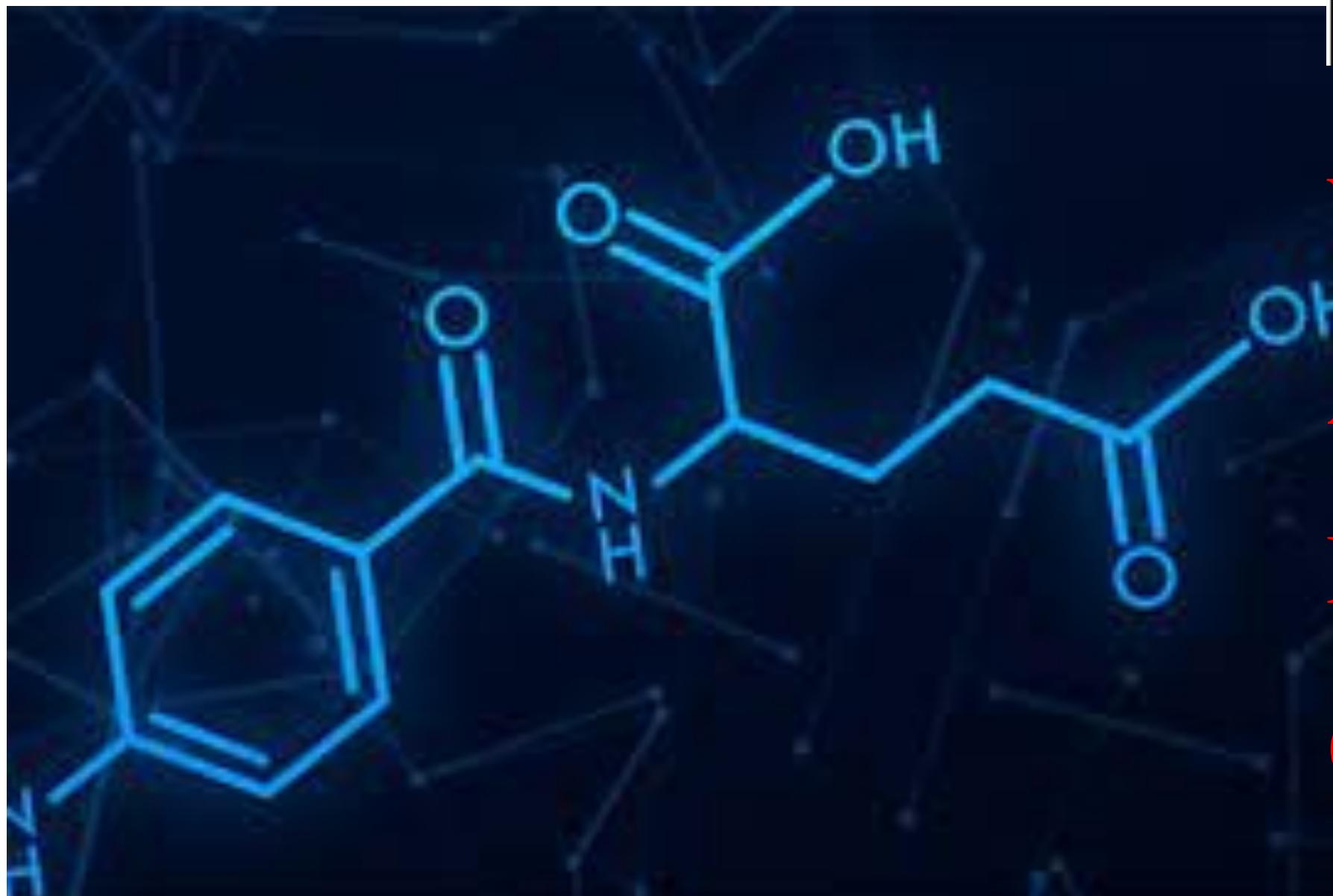
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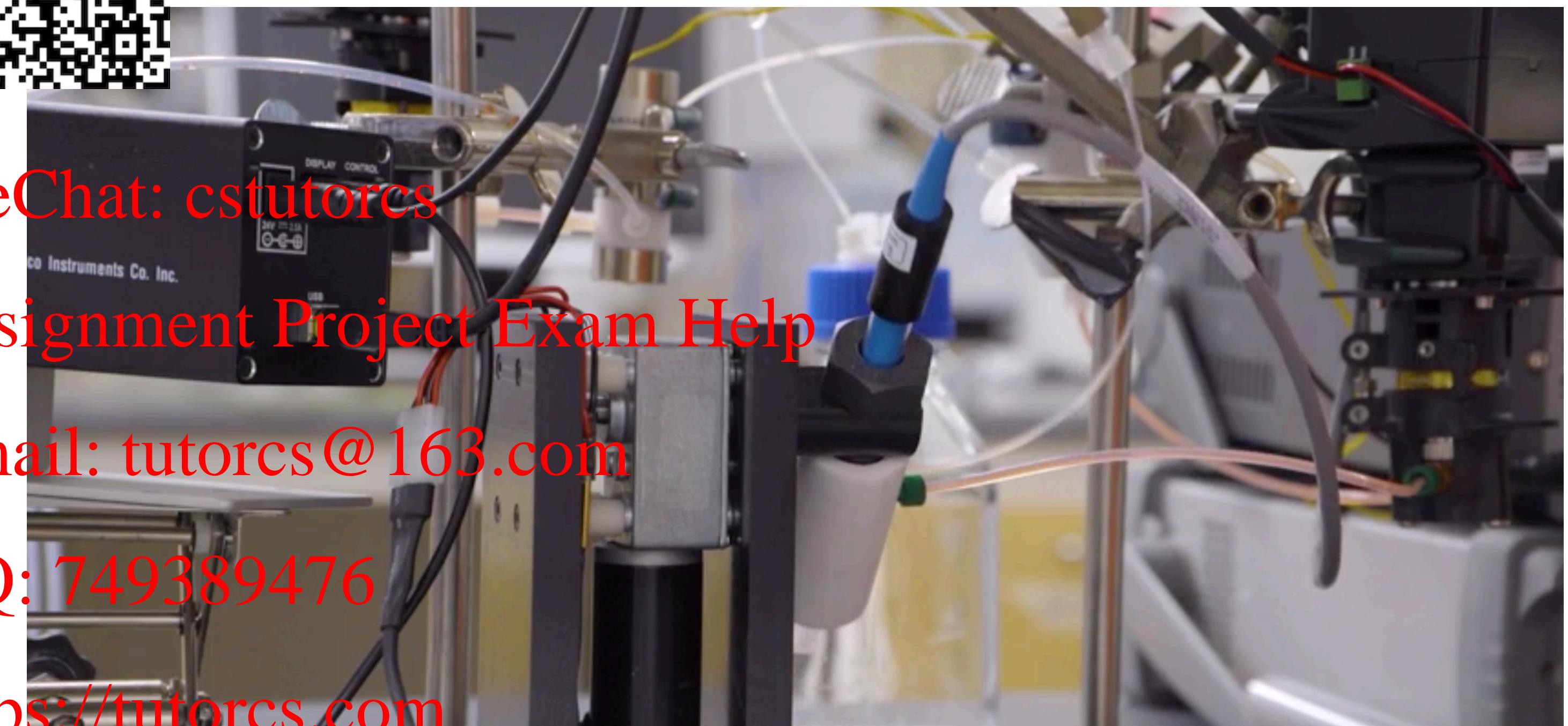


Optimizing drugs and materials

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Autonomous vehicles

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Language generation (e.g GPT)

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Q: What is your favorite animal?

A: My favorite animal is a dog.



Q: Why?

A: Because dogs are loyal and friendly.

Q: What are two reasons that a dog might be in a bad mood?

A: Two reasons that a dog might be in a bad mood are if it is hungry or if it is hot.

Q: How many eyes does a giraffe have?

A: A giraffe has two eyes.

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Q: How many legs does a frog have?

A: A frog has four legs.

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Q: Are there any animals with three legs?

A: No, there are no animals with three legs.

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Q: Why don't animals have three legs?

A: Animals don't have three legs because they would fall over.

Image generation

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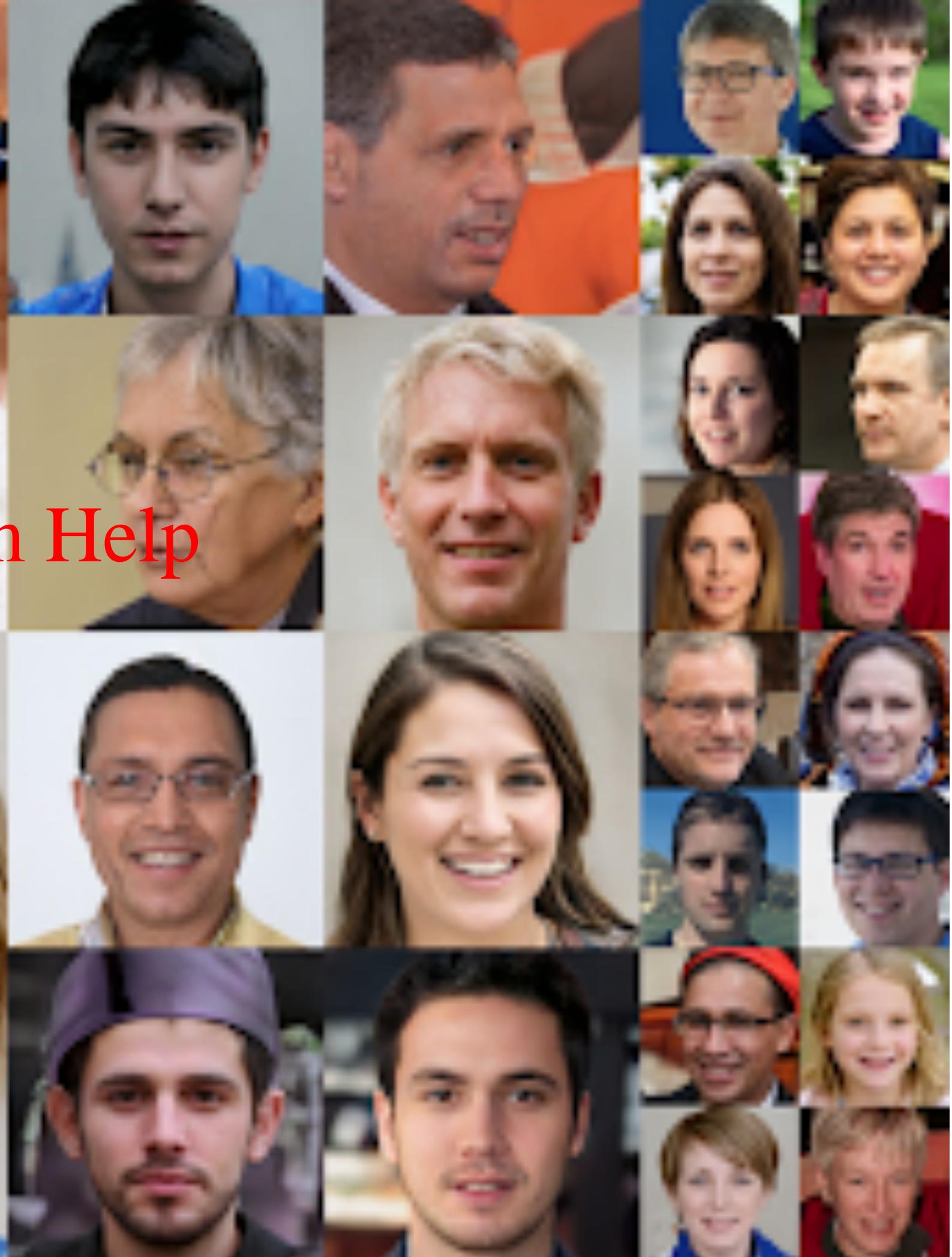


Image to text generation

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This class: *Theoretical Foundations* of ML

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Why take this class? Why study ML theory?



1. Understand fundamental questions about a learning problem.

- Is it even possible to learn using data? WeChat: cstutorcs
- How much data do we need to learn? Assignment Project Exam Help
- What are the primary challenges when learning? Email: tutorcs@163.com

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This class: *theoretical foundations* of ML

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Why take this class? Why study ML theory?



2. Develop fundamental intuitions for designing learning algorithm
 - What is the “correct” approach to solve the primary challenges?
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 - How do we trade-off between multiple challenges?
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 - Will focus on simple (as opposed to “realistic/practical”) settings
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3. It is fun!
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Outline

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1. Course logistics



2. Syllabus

3. Who should take this class? Prerequisites and expectations

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Logistics: Lectures, OHs, Enrollment

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- **Lectures**

- MWF, 11-12.15am at Eng Hall 3349
- Will be on the whiteboard.
- 27-30 lectures.



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My office hours: Wed 1.30 - 3pm at CS5375
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- **Enrollment**

- At capacity, but short waitlist.
- Continue to come to class, some students will likely drop.

Logistics: Webpages

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- Course website

- <https://pages.cs.wisc.edu/~my/courses/23fall-cs861>
- Information on logistics, syllabus, schedule, and grading



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- Piazza

- <https://piazza.com/wisc/fall2023/csece861> (access code: f23cs861)
- Ask public questions whenever possible.
- Announcements, peer discussions on homework/lectures.

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- Canvas

- Homeworks, exams, and some announcements

Logistics: Scribing

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- Each student will scribe ~2 lectures. Two students per lecture.



- These details may change due to student drops.

- Sign up for scribing via the sign-up spreadsheet (see course website for link).

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- **Instructions (see course website as well)**

- Written in *full prose*, proof steps written in detail, intuitions explained well.
- Prepare in Overleaf, and add QQ: 749389476 as a collaborator within 2 days
- If you are unsure about taking the class or on the waitlist, sign up for after Oct 6.
- If you decide to drop, *delete your name and email me*.

Logistics: Homework

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- 4-5 Homeworks
- Physical copy due at the beginning of class (optionally, upload to canvas).
- Late submissions only for documented emergencies.
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- 5 percent extra credit if you ~~Assignment Project Exam Help~~ LaTeX your solutions.
Email: tutorcs@163.com
- Homeworks will be *difficult*. QQ: 749389476
 - Expect to spend multiple hours/days on some problems.
 - Unless otherwise specified, you *are allowed* to collaborate with up to 2 classmates.



Logistics: Grades

- **Scribing:** 10%

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- **Homeworks:** 35%

- **Exam:** 30%

- Take-home exam, available from Tue 11/14 - Fri 11/17.

- 48 hours to finish from start time.

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- **Course project:** 25%

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- A final project. Should have a substantial theory-based component.

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- Project proposal due on 10/20. Final report due on 12/8.

- I will reward high-risk projects.

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Syllabus: Overview

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1. PAC Learning



2. Statistical lower bounds

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3. Online learning & bandits

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Syllabus: PAC Learning (4-6 lectures)

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- Empirical risk minimization
- PAC Learning: realizable vs agnostic
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- Radamacher complexity
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- VC dimension



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Syllabus: Statistical lower bounds (7-10 lectures)

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- Average-risk optimality vs minimax optimality
- Minimax optimal estimators for point estimation
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- From estimation to testing: Le Cam & Fano methods
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- Applications
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 - regression, classification, density estimation



Syllabus: Online learning (8-12 lectures)

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- Learning from experience and the Hedge algorithm
- Adversarial bandits and the EXP-3 algorithm
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- Stochastic bandits and the UCB algorithm
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- Lower bounds for online learning and bandits
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Syllabus: Advanced topics (~4 lectures)

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- Learning in games
- Online learning and bandits in non-stationary environments
- Reinforcement learning



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Target audience for the class

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- Ph.D students doing research in theoretical (**statistical**) machine learning.
- **Background knowledge**
 - **Formal prerequisite:** CS761 or equivalent.
 - Strong background (intermediate-level graduate course) in calculus, statistics, and probability. **WeChat: cstutorcs Assignment Project Exam Help**
- **Who should not take this class.** Email: tutorcs@163.com
 - “I want to learn about ML/AI” (QQ: 749689407, Take 740)
 - “I want to apply ML in an applied area of research” (Take 760) <https://tutores.com>
 - “I want to learn take an introductory ML theory class” (Take 761)



Homework 0

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Three questions, going from ~~easy to hard~~:

1. Mean estimation & confidence interval



2. Maximum risk

3. A simple bandit model and algorithm

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Three Objectives

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I. A preview of what's to come

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II. Calibrate my teaching/expectation

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III. Lets you assess if you are ready to take this class

Be good citizens!

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1. Attend class, ask questions



2. Take your scribing duties seriously



3. Respond to questions on Piazza.

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4. Give me feedback about the course.

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- Are the homework problems useful?

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