



Advanced Network Management

a.k.a.

AI Ops: Autonomous IT Operations or AI for IT Operations

course#: 80240663

Spring 2022



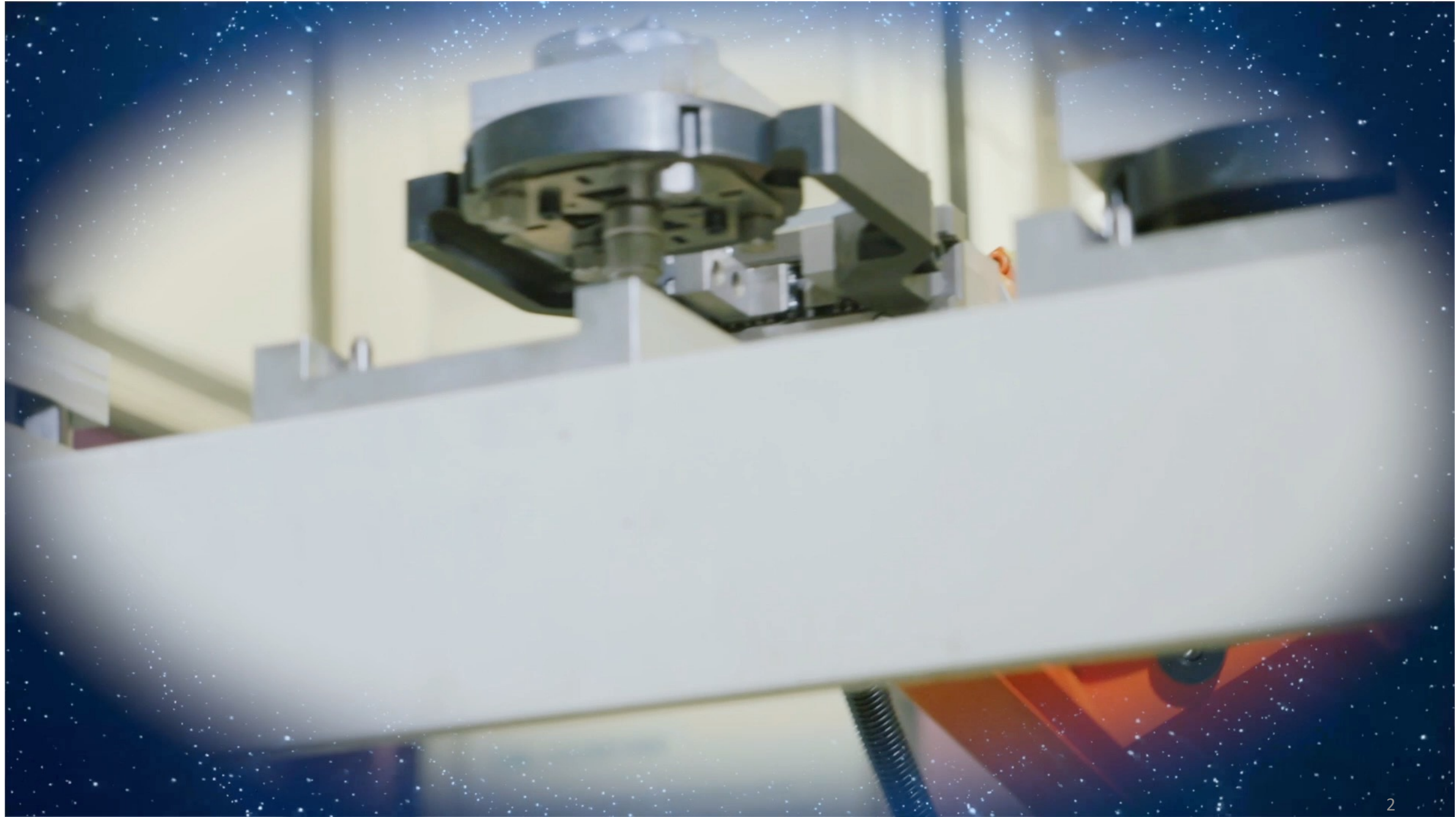
Instructor: Dan Pei

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Teaching Assistant:

Zhe Xie

xiez22@mails.tsinghua.edu.cn



Roadmap

- **Self-Introduction**
- Course Logistics
- What is AIOps?
- Course Coverage (Website)
- Assignments and Projects

How to pronounce “Pei”?

Just pronounce “Pei” as “Pay”

In fact, just call me “Dan”

Louvre Museum



I-M [Pei](#): the famous architect who designed the glass pyramid



About the Instructor

- Tenured Associate Professor.
- UCLA Ph.D. Best Ph.D. Thesis Award in UCLA CS in 2005.
- Joined Tsinghua CS Department in December 2012
- Homepage: <http://netman.aiops.org/~peidan>
- Previously a Principal Researcher at AT&T Research, a co-founder and founding CEO of a mobile health company in Beijing, before joining Tsinghua.
- Supervised interns from CMU, Cornell, Princeton, UCLA, GaTech, Michigan, Northwestern etc. Now @ Google, MSR, IBM, Purdue, Northeastern, HKUST
- ACM/IEEE Senior Member

My Research Group @ Tsinghua: NetMan

<http://netman.aiops.org>

- Currently advising 8 Ph.D. and 6 M.S. students at Tsinghua.
- 2 affiliated associate professors and one affiliated assistant professor
- 3 post-docs
- Graduated 19 PhDs & 6 Masters (4 Huawei “Young Genius” , 3 Kuaishou Star, 2 Ali Star, 4 went to MSRA, 5 became assistant/associate professors)



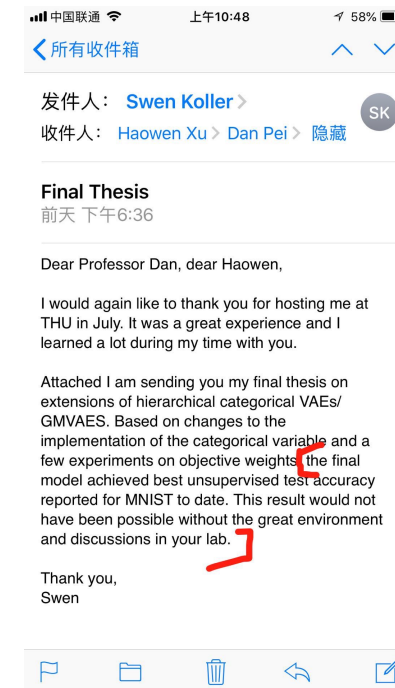
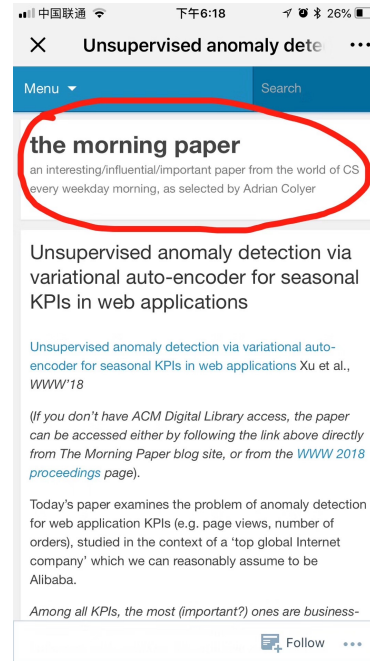
Industry Collaborators



Publications:

180+ AIOps papers and 20+ issued US Patents. Published in SIGCOMM, WWW, KDD, SIGMETRICS, TON, ATC, INFOCOM, FSE, ASE, IMC, CoNEXT, IJCAI etc.

Research results are covered by technology media such as MIT technology Review, Hacker News, Mother Board, Morning paper, and many Chinese media.



MIT Technology Review

Topics+ Top Stories Mag

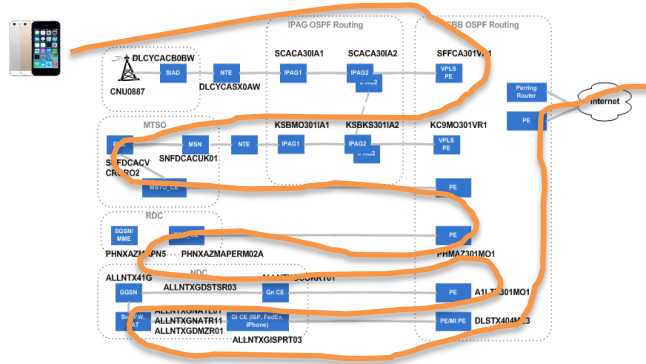
Mobile

Data Mining Solves the Mystery of Your Slow Wi-Fi Connection

Chinese researchers have worked out the reasons for why Wi-Fi can take so long to connect.

AIOps : Autonomous IT Operations through Machine Learning

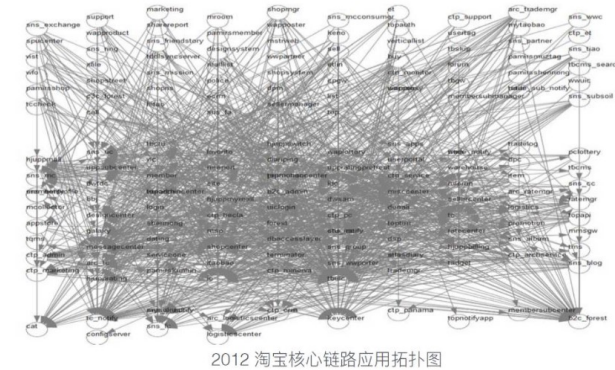
Large & complex access network



Large & complex data center



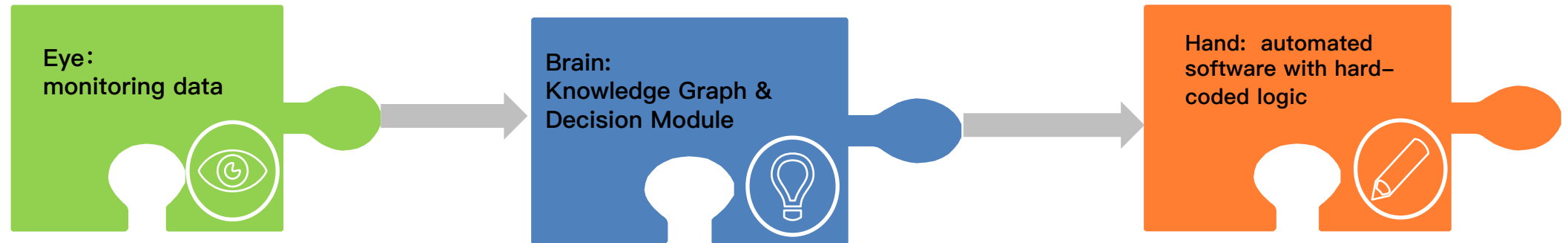
Large & complex application software



- Imagine that you are running an Internet-based service with hundreds of thousands of servers and many software modules, a large, complex, cross-layer, and rapidly evolving distributed system.
- You want to achieve 99.999% service reliability, but machine-generated monitoring data and hundreds of operators (IT operation engineers) alone won't get you there, because of the high complexity and sheer scale of the software/hardware system and the vast amount of machine-generated data.
- Machine learning is the direction to enable Autonomous IT Operations autonomous.



AIOps Architecture & Algorithms



- The major topics of AIOps often coincide with its more general counterparts in Machine Learning:
 1. Anomaly Detection in Time Series, Logs (semi-structured text), Traces (program execution trace), and Graphs
 2. Anomaly Localization
 3. Failure/Event Prediction
 4. Causal Inference and its application in Root Cause Analysis
- State-of-art Machine Learning Algorithms are applied to solve the unique challenges in AIOps:
 1. Deep Neural Networks for Time Series or Sequence
 2. Deep Generative Model (VAE, GAN)
 3. Deep Reinforcement Learning
 4. Natural Language Processing
 5. Causal Inference

PRINCIPLES RAY DALIO

“Ray Dalio has provided me with invaluable guidance and insights that are now available to you in *Principles*.”

—BILL GATES

“I found it to be truly extraordinary. Every page is full of so many principles of distinction and insights—and I love how Ray incorporates his history and his life in such an elegant way.”

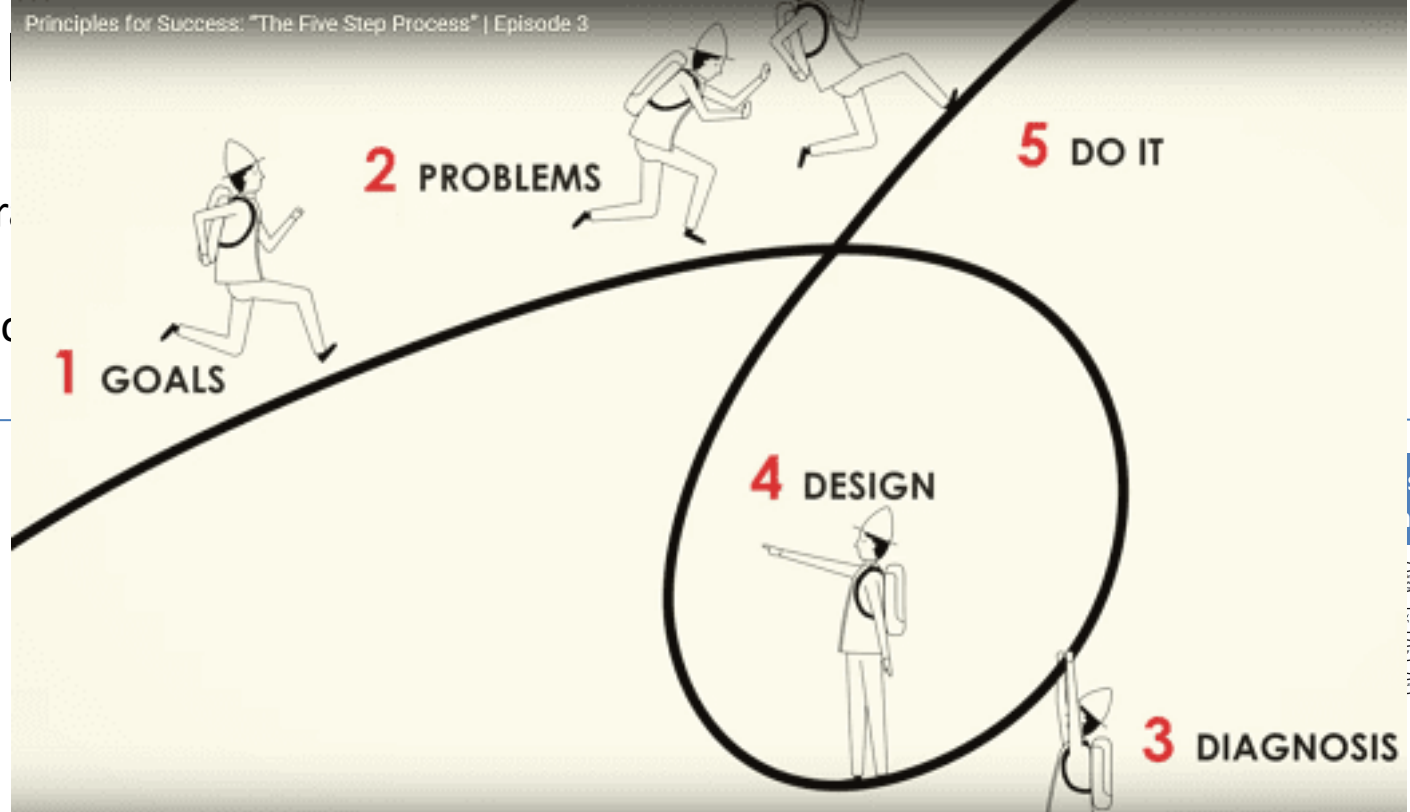
—TONY ROBBINS

#1 NEW YORK TIMES BESTSELLER

INFOCOM 2012

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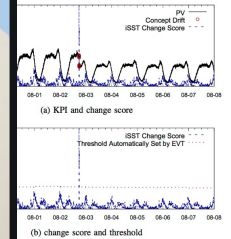
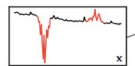
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EPISODE 03 PRINCIPLES FOR SUCCESS

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SSRE 2018 Best
Paper

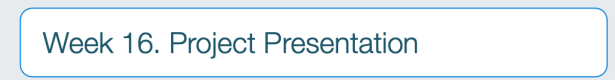
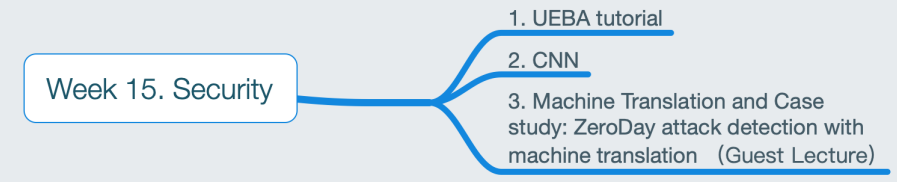
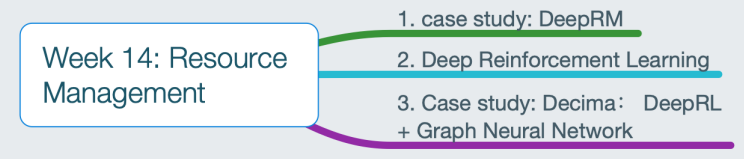
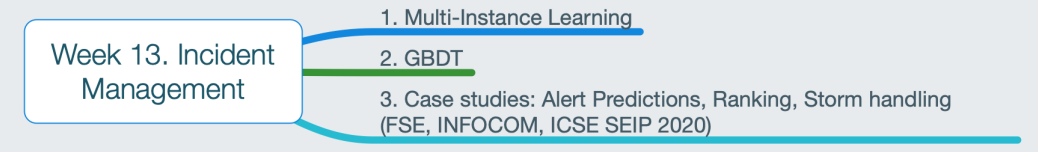
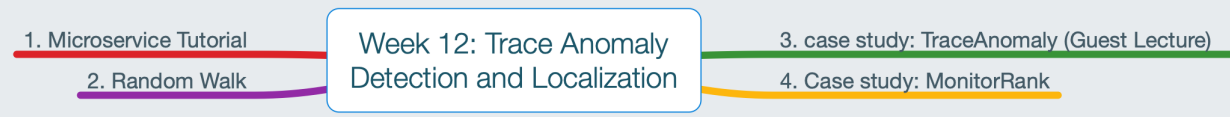
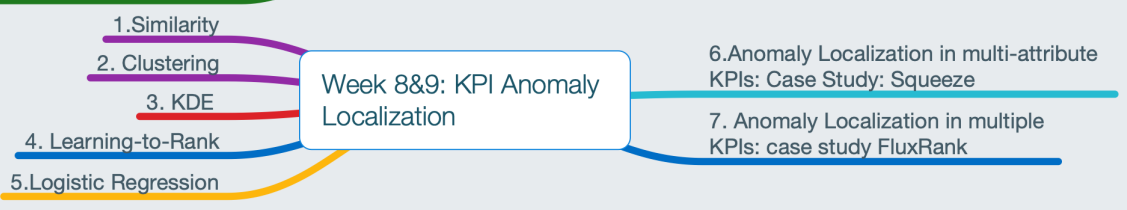
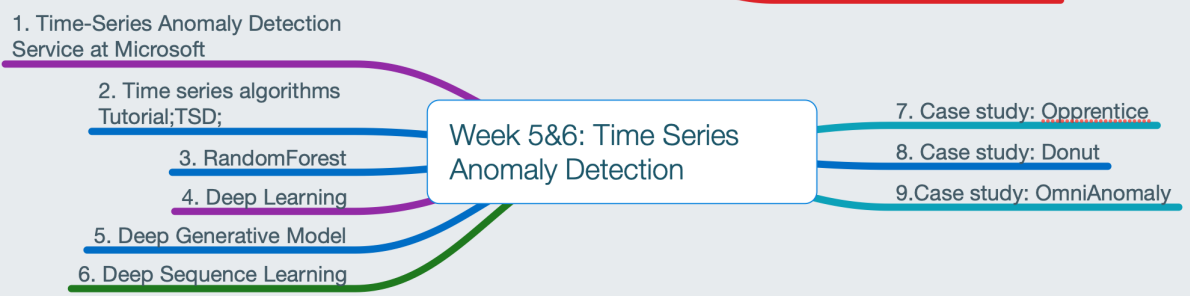
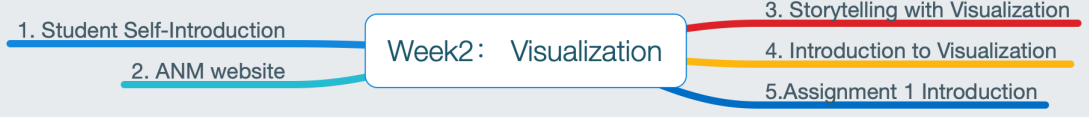
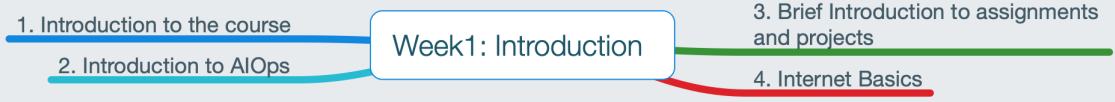
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- **Course Logistics**
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- Assignments and Projects



Course Requirements

- Course website: <http://course.aiops.org/>
- **Prerequisites:**
 - You are expected to be familiar with at least one programming language, preferably Python.
 - If not, please quickly learn one.
 - You don't have to have previous machine learning knowledge.
- Encourage interaction and discussion
 - stop me and ask questions at any time! (online students please “raise your hands” on Tencent Meeting/Voov)
 - You get credits for interaction (Yes, our TA notices your interaction)

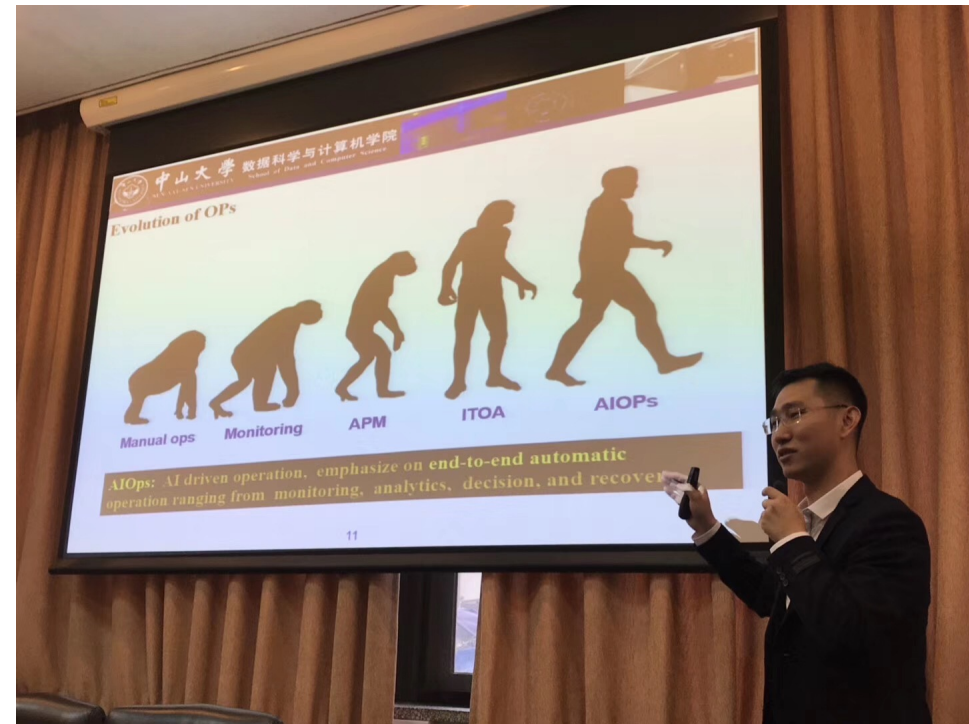
Course Info

- Time: Tuesday **7:20pm-9:45pm**
 - 15 classes, each has three 45-minute sessions.
- Session 1: Machine Learning Basics
- Sessions 2 & 3: AIOps case studies
- Office Hours:
 - After every class.

Grading:

- Attendance & Interaction: **10%**
 - Presence: 0.5% for each lecture in Weeks 3-14. 6% in total
 - 1% for each question asked or answered. 4% maximum.
- Assignments: **25%** (each student finishes each assignment alone)
 - Assignment 1: 10%
 - Assignment 2: 15%
- Project: **65%** (A project team of 2 or 3 students)
- The final grade will be in letter grading scale (e.g., A,B,C,D)

Invited Talks



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Case Studies: Papers and Slides

- Already Posted on the course website
 - Maybe updated before each class, so please check the website weekly.
- Lecture Coverage
 - You were supposed to read these papers carefully
- Reading List
 - Relevant papers, read them if you have time

Why reading papers/case studies?

- Purpose: background knowledge, algorithm, methodology, writing, design principle, solution inspiration, evaluation methodology for the problem you are working on, and (sometimes) vision.
- My strongly biased personal opinion: Papers are not for finding topics for your next AI Ops paper.
 - Instead, if possible, “From Practice, into Practice”: E.g. try existing algorithms in papers in practice to discover where it does not work

What's a good paper

- A new and important problem, solid solution.
- Old and challenging problem, a new *simple but elegant* solution, with straightforward insight and intuition behind it.

Using Google Scholar to find relevant papers (demo)

- Browse latest proceedings of relevant conferences, find one relevant paper p . *Relevant paper set* $S=\{p\}$

for (each new p in S) {

 Browse p 's references, and put relevant ones into S ;

 Browse p 's citations in Google Scholar, and put relevant ones into S ;

}

<https://www.editage.com/insights/8-winning-hacks-to-use-google-scholar-for-your-research-paper>

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Enjoy the course!

Spring 2017



Spring 2018



Fall 2018



Fall 2019



Fall 2020

