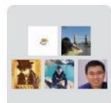


Advanced Network Management *a.k.a.*

AIOps: Autonomous IT Operations or AI for IT Operations

course#: 80240663
Spring 2018



ANM 2018 Fall



该二维码7天内(9月25日前)有效, 重新进入将更新

Instructor: Dan Pei

peidan@tsinghua.edu.cn

Teaching Assistants:

Nengwen Zhao znw17@mails.tsinghua.edu.cn



Please scan QR code to join class WeChat Group

Roadmap

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

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, with Government Endorsement (“Recruitment Program of Global Talents”)
- 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

- Currently advising ~15 of Ph.D. and M.S. students at Tsinghua.
- Two affiliated assistant professors and two post-docs
- Graduated 10 PhDs (3 went to MSRA, two went to Nankai University, one becomes a CEO, one goes to Alibaba)



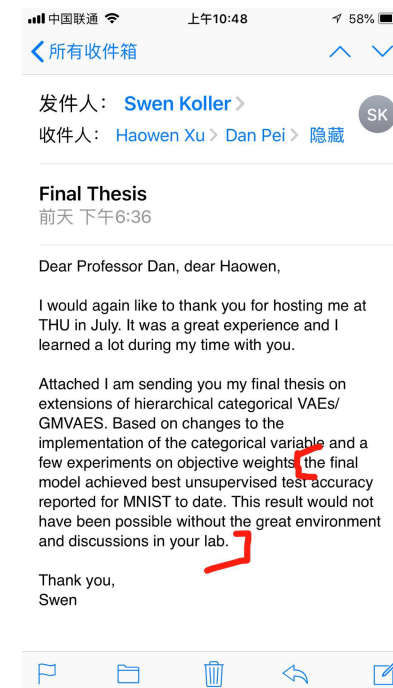
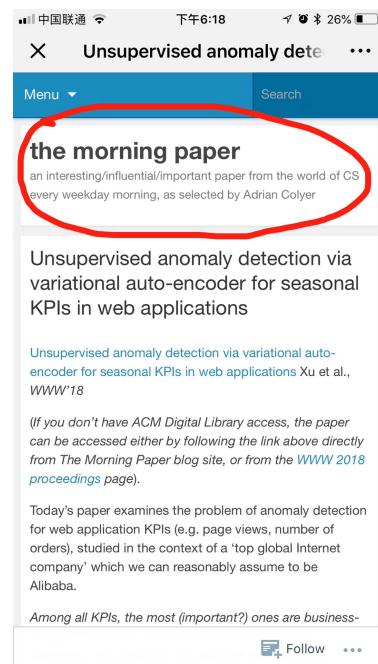
Industry Collaborators



Publications:

100+ AIOps papers and 20+ issued US Patents. Published in SIGCOMM、WWW、SIGMETRICS、TON、INFOCOM、IMC、CoNEXT 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

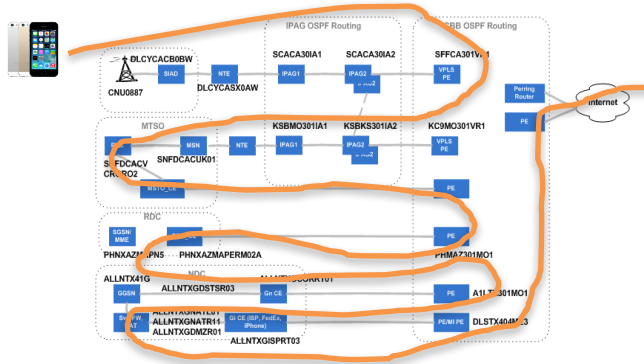
Mobile

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

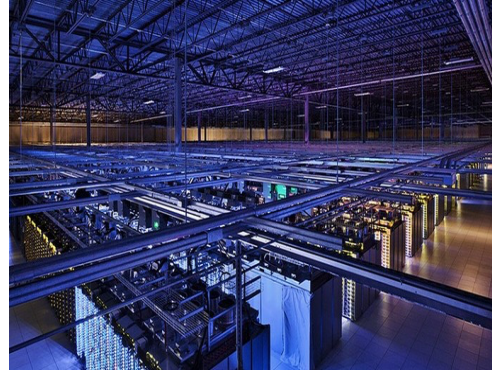
Chinese researchers have worked out the reasons for why Wi-Fi can take so long to connect.

AIOps : Autonomous IT Operations through Machine Learning

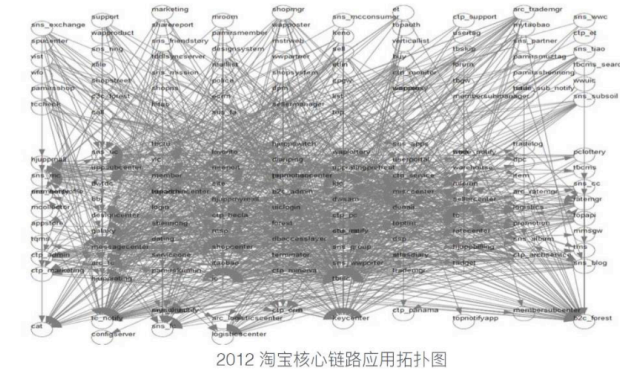
Large & complex access network



Large & complex data center



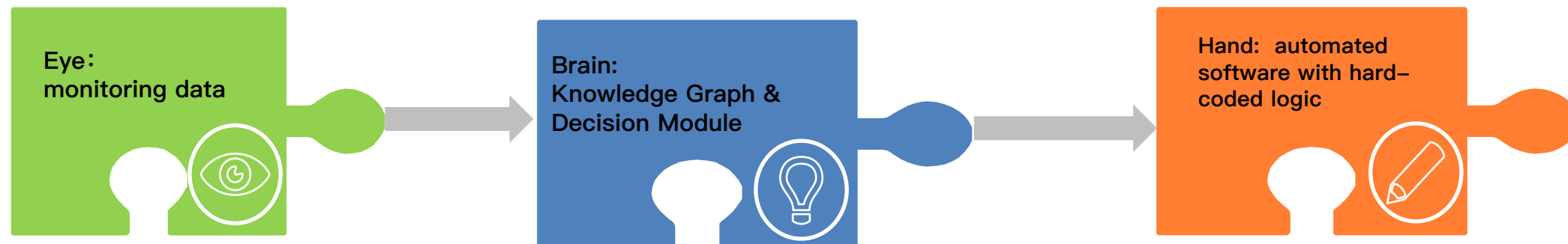
Large & complex application software



- 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

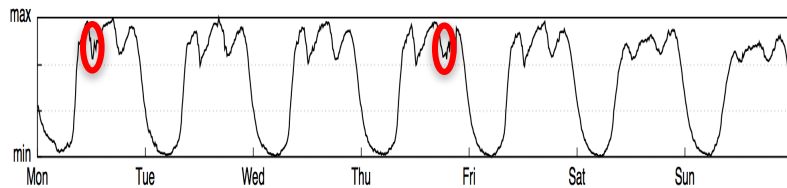


- The major topics of AIOps often coincide with its more general counterparts in Machine Learning:
 1. Anomaly Detection in Time Series, Logs (semi-structured text), Traces (program execution trace), and Graphs
 2. Anomaly Localization
 3. Failure/Event Prediction
 4. Causal Inference and its application 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

My research methodology: From Practice, into Practice

- 1. Discover challenging problems from Practice (specifically, IT Operations)
- 2. Design AI Algorithms to solve problem
- 3. Deploy the algorithms in practice. If not working perfectly? go to step 1.

Example project: time series anomaly detection



朴素方法异常检测（人工
选算法调参）

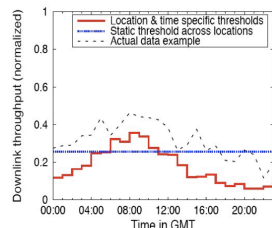
Supervised
Ensemble
learning

Unsupervised
Learning (VAE)

Active
Learning

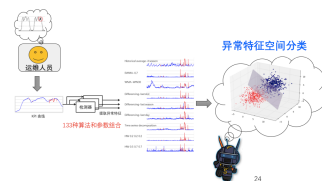
Clustering-based
transfer learning
for millions of
KPIs

Transfer
Learning for
concept drift

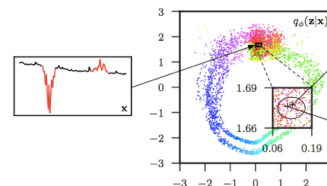


(a) Location 1

INFOCOM 2012



IMC 2015



WWW2018

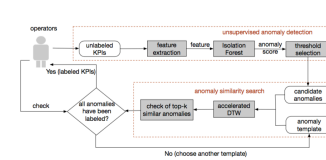
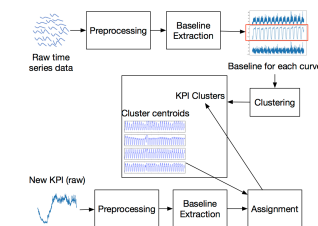


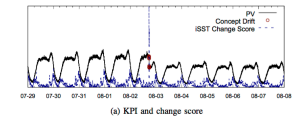
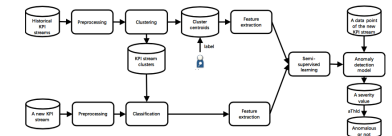
Figure 2: The overall framework of Label-Less.

INFOCOM 2019

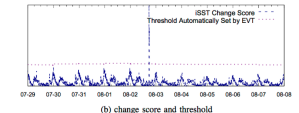


IWQOS 2018

Semi-supervise learning for fast
anomaly detection of new time series



(a) KPI and change score



ISSRE 2018

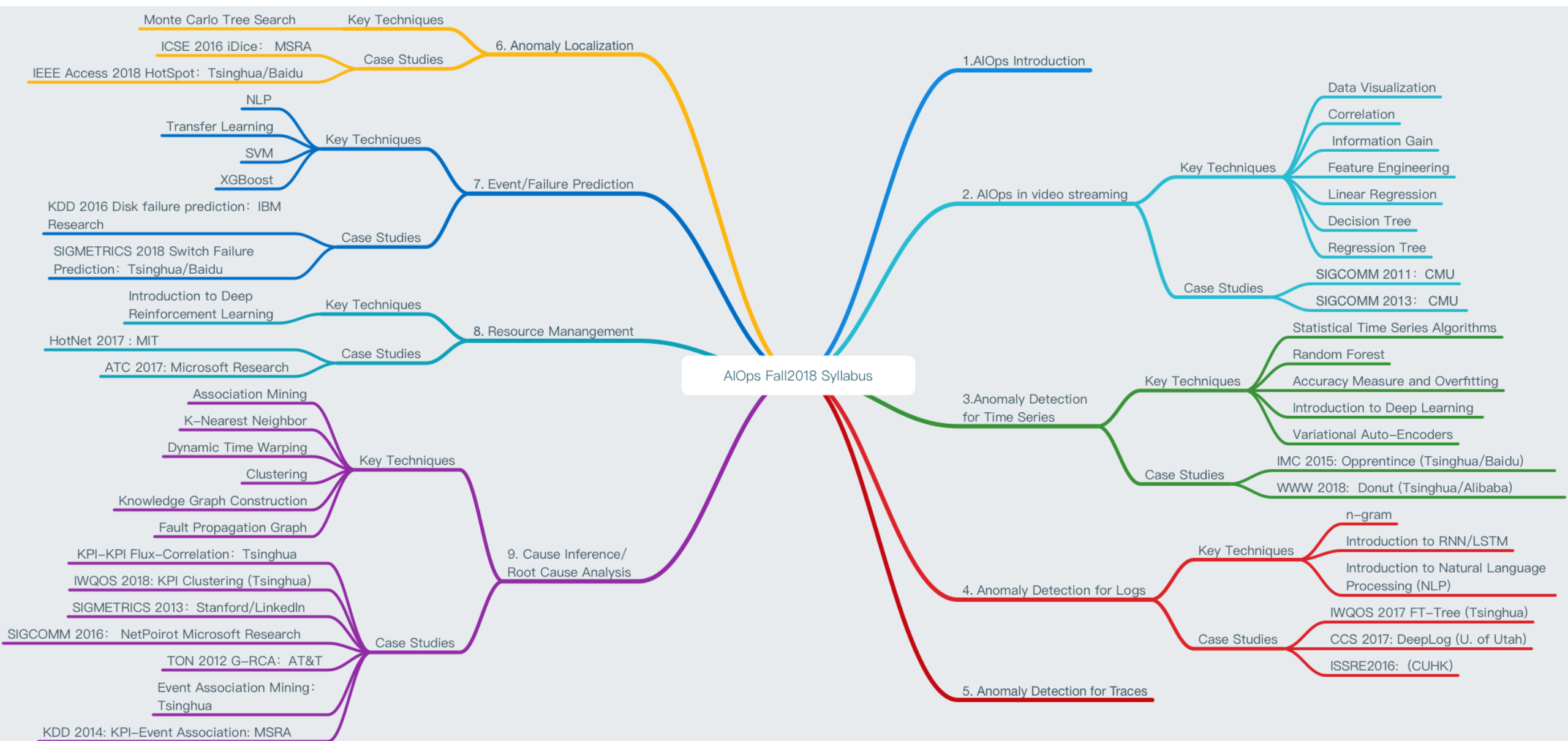
Roadmap

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

Summary

- AIOps is an interdisciplinary research field between Machine Learning and Systems/Networking, which is why this course had this historical title “Advanced Network Management”. If you are interested in learning how a large distributed system can be better run with the help of machine learning, this course is for you. If you want to learn how machine learning can help solve challenging problems in a very complex system, this course is for you.
- This course will cover the latest progress in major topics of AIOps using case studies from recent research papers in top conferences in all major computer science fields, including Machine Learning, Data Mining, System/Networking, Software Engineering, Database, Multimedia, etc
- Through these case studies, we will show how the latest Machine Learning Algorithms are applied to solve the unique challenges in AIOps. The basics of these Machine Learning algorithms will be briefly reviewed in an easy-to-understand way, without going through the detailed theory behind them. Thus by the end of the course, you will be able to learn roughly how these algorithms work, and how it can be applied to solve real-world problems.





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.
- Encourage interaction and discussion
 - stop me and ask questions at any time!
 - You get credits for interaction

Course Info

- Time: Wednesday **9:50pm-12:15pm** (Weeks 1,2,4-16)
 - 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 4-15. 6% in total
 - 1% for each question asked or answered. 4% maximum.
- Assignments: **30%** (each student finishes each assignment alone)
 - Assignment 1: 10%
 - Assignment 2: 20%
- Project: **60%** (A project team of 2 or 3 students)
 - Ranking in algorithm competition & report: 50%
 - Presentation in week 16 (scored by all students, TA, and instructor): 10%
- The final grade will be in letter grading scale (e.g., A,B,C,D)

Roadmap

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

Roadmap

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

Case Studies: Papers and Slides

- Already Posted on the course website
- 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, 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 paper.

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 ;

}

Roadmap

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

Roadmap

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

Enjoy the course!



Spring 2017



Spring 2018