Optimization Theory and Algorithm

Lecture 1: Introduction

Xiangyu Chang(常象宇)

Email: xiangyuchang@xjtu.edu.cn
Center for Intelligent Decision-Making and Machine Learning
School of Management
Xi'an Jiaotong University

Self Introduction

Associate Professor

Center of Intelligent Decision-Making and Machine Learning

Department of Information Management and E-business

School of Management

Address

Room #750, Main Building of Management School

Xi'an Jiaotong University (XJTU)

China

Email

xiangyuchang AT xjtu DOT edu DOT cn

Employment Experience

- 2018.12-Present, Visiting Associate Professor (Full time position)
  Department of Industrial & Systems Engineering, University of Washington, Seattle.
- 2016.01-2016.02, Research Associate
  Deparmet of Mathematics, City University of Hong Kong
- 2015.04-2016.04, Visiting Asistant Professor
  Department of Business Statistics and Econometrics, Guanghua School of Management, Peking University

Education

- 2013-2014, Ph.D., Applied Math, XJTU, China
- 2010-2012, Visiting Ph.D. Student, Statistics, UC Berkeley, U.S.
- 2009-2010, Ph.D. Candidate, Applied Math, XJTU, China
- 2008-2009, M.S., Applied Math, XJTU, China
- 2003-2007, B.S., Applied Math, XJTU, China

Research Interests

- Statistics & Machine Learning
- Business Data Science

http://xiangyuchang.github.io/

SOM-XJTU

Optimization Theory and Algorithm

Spring & Fall 2021

HOME SCHEDULE LECTURES ASSIGNMENTS PROJECT MATERIALS

Optimization Theory and Algorithm / Spring & Fall 2021

Updates

- New Assignment released: [HW1: Master LaTeX Template]
- New Lecture is up: Lecture 1 Introduction [slides] [notes]
- New course in Spring 2021 is comming soon.

Course Description

https://som-course.github.io/opt-spring-2021/

Course Description

This course is to present the basic theories and algorithms in optimization fields for undergraduate students at School of Management, Xi'an Jiaotong University. The aim is to give students a thorough understanding of how to constructe algorithms for solving optimization problems, and how to develop theories to analyze optimization problems and corresponding algorithms.

Optimization is a special field that is built on three interwined pillars:

- **Models** give rise to optimization problems.
- **Algorithms** solve optimization probelms.
- **Theoretical foundations** support algorithms and models.

Optimization = Modeling + Algorithm + Theory

Instructors

Xiangyu Chang

Yao Wang

Teaching Assistants

Yi Yang

Junbo Hao

Zhikai Yang

https://som-course.github.io/opt-spring-2021/

Course Introduction

- 32hr, 9-16 week
- To learn the basic theory and algorithm of optimization
- Why not include the modeling part?
- To learn LaTeX for the scientific writing (HW)
- To practice Python or R for handling optimization problems

Outline

Part I: Introduction

- Introduction to Optimization
- Related Mathematical Analysis
- Related Linear Algebra
- ...

Part II: First-order Method

- Motivation
- Gradient Decent
- Subgradient Decent
- Proximal Gradient Decent
- Convex, Smooth, ...

Part III: Second-order Method

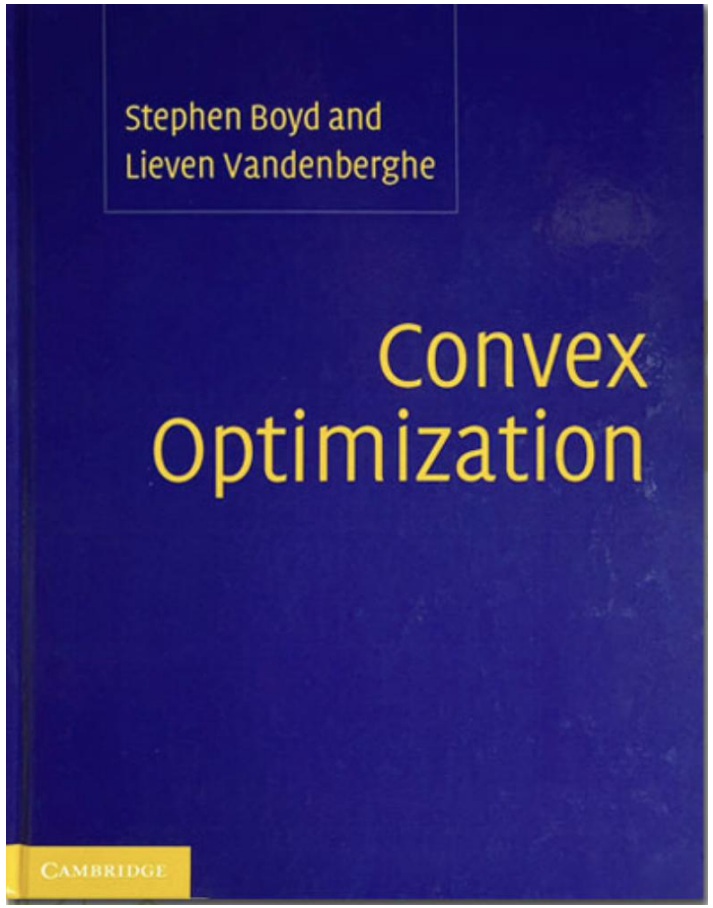
- Motivation
- Newton Method
- BFGS Method
- Quasi-Newton Method
- ...

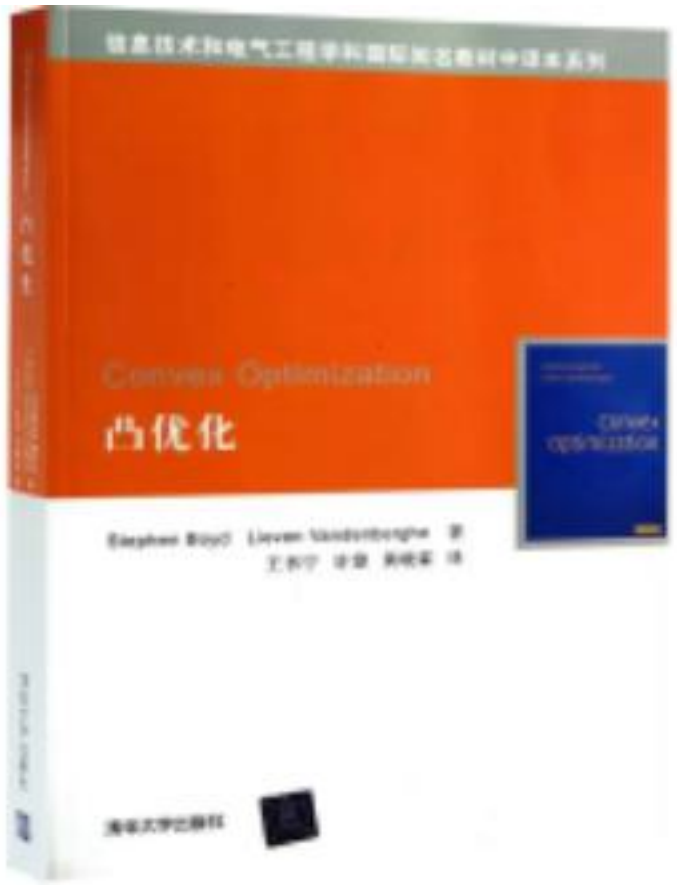
Evaluation

- 50%HW + 50%Final Exam = 100%

- Edit your homeworks by LaTeX!

Text Book


Stephen Boyd and
Lieven Vandenberghe
Convex
Optimization
CAMBRIDGE


Convex Optimization
凸优化

最优化：建模、
算法与理论

Materials

Suggested Text Book

- Convex Optimization by Stephen Boyd and Lieven Vandenberghe: a very famous book.
- 最优化：建模、算法与理论 by 刘浩洋、户将、李勇锋、文再文编著.

R

- R
- RStudio: Suggested IDE
- R Cheatsheet
- An introduction course of R by Xiangyu Chang: Lecture 1, Lecture 2, Lecture 3, Lecture 4, Lecture 5, Lecture 6

Python

- Python for Beginners
- Python Cheatsheet
- Python 数据科学实践 by 常象宇，曾智亿，李春艳，程茜著
- SciPy Tutorial
- NumPy Quickstart Tutorial

LaTeX

- MacTeX

https://som-course.github.io/opt-spring-2021/materials/

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Optimization Theory and Algorithm

Spring & Fall 2021

HOME SCHEDULE LECTURES ASSIGNMENTS PROJECT MATERIALS

Lectures

You can download the lectures here. We will try to upload lectures prior to their corresponding classes.

Lecture 1 Introduction

tl;dr: introduction lecture

[slides] [notes]

Suggested Readings:

- LaTeX Materials
- Section 1.1 and 1.5 of Liu et al.

课后复习用，每次课结束后公布

课前预习用，每次课之前公布

https://som-course.github.io/opt-spring-2021/materials/

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Optimization Theory and Algorithm

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Assignments

You can download the assignments here. Also check out each assignment page for any additional info.

HW1: Master LaTeX Template

https://som-course.github.io/opt-spring-2021/assignments/

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Optimization Theory and Algorithm

Spring & Fall 2021

HOME SCHEDULE LECTURES ASSIGNMENTS PROJECT MATERIALS

HW1: Master LaTeX Template

Released on Tuesday 04/27/2021

Due Date: 2021-04-30 10:00
Download [problems] [attachment]

Late Policy

- Late homework will not be accepted.

This is a sample assignment.

https://som-course.github.io/opt-spring-2021/assignments/01_HW_Template

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Optimization Theory and Algorithm

Spring & Fall 2021

Schedule

EVENT	DATE	DESCRIPTION	COURSE MATERIAL
Lecture	04/27/2021 Tuesday	Lecture 1 Introduction [slides]	**Suggested Readings:** ◦ LaTeX Materials ◦ Section 1.1 and 1.5 of Liu et al.
Assignment	04/27/2021 Tuesday	**HW1: Master LaTeX Template released!**	[HW1: Master LaTeX Template]
Due	**04/30/2021 10:00 Friday**	**Master LaTeX Template for Course Notes.**	

https://som-course.github.io/opt-spring-2021/schedule/

LaTeX vs. Word

$$B_{t,\alpha} = \begin{cases} 1 - i\beta \mathrm{sgn}(t) \tan(\frac{\pi\alpha}{2}) & if \quad \alpha \neq 1 \\ 1 + i\beta \mathrm{sgn}(t) \frac{2}{\pi} \log|t| & if \quad \alpha = 1 \end{cases} \qquad (2)$$

Where $-\infty < \delta < +\infty$, $\gamma > 0$, $0 < \alpha \leq 2$, $-1 \leq \beta \leq 1$. $\alpha(0 < \alpha \leq 2)$ is the characteristic exponent and sets the degree of impulsiveness of the distribution. The smaller the value of

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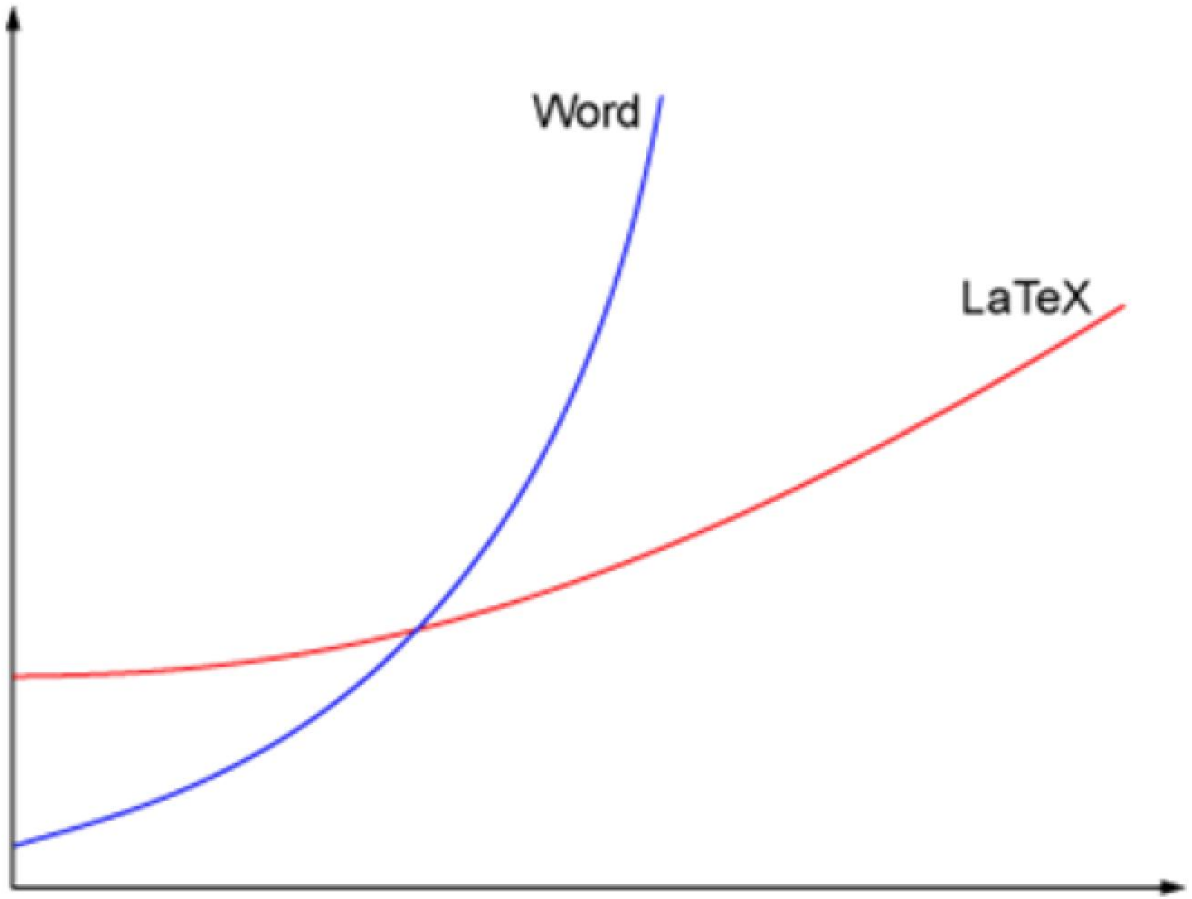
Latex文档格式均匀，黑白和行距均匀，数学格式排版美观

Slides from Prof. Yao Wang

LaTeX vs. Word



Slides from Prof. Yao Wang

LaTeX vs. Word

- 如果只是排版一些简单的公文, word就够用了
- 如果需要排版高质量的包含大量数学公式的科技文档，那就需要用LaTex
- 用LaTeX时间越长，就越会发现word的不足，从而更爱LaTeX
- LaTeX开源，可免费获得(这一条理由就足够)

Slides from Prof. Yao Wang

LaTeX: Install

LaTeX: Suggested IDE

TeXstudio
LaTeX made comfortable

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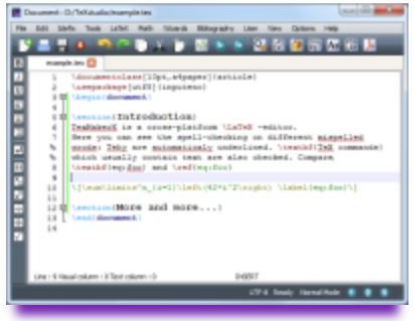
Welcome to TeXstudio

TeXstudio is an integrated writing environment for creating LaTeX documents. Our goal is to make writing LaTeX as easy and comfortable as possible. Therefore TeXstudio has numerous features like syntax-highlighting, integrated viewer, reference checking, and various assistants. For more details see the features.



TeXstudio is open-source and is available for all major operating systems.

Download now
TeXstudio 3.1.1 (OSX dmg)
for macOS 10.14 or higher

News

2021-02-22 A new bugfix release **TeXstudio 3.1.1** is available.Mainly it fixes crashes loading included files.
see changelog

2021-02-17 A new bugfix release **TeXstudio 3.1.0** is available.Mainly changing the GUI language has been fixed. Furthermore a global TOC is available besides the structure view. It is work in progress and not (yet) automatically updated. Please give feedback.
see changelog

LaTeX: How to Learn

Learn LaTeX in 30 minutes

In this guide, we hope to give you your first introduction to LaTeX. The guide does not require you to have any prior knowledge of LaTeX, but by the time you are finished, you will have written your first LaTeX document, and hopefully will have a good knowledge of some of the basic functions provided by LaTeX.

Contents

1. What is LaTeX?
2. Why learn LaTeX?
3. Writing your first piece of LaTeX
4. The preamble of a document
5. Adding a title, author and date
6. Adding comments
7. Bold, italics and underlining
8. Adding images
    - 8.1. Captions, labels and references
9. Creating lists in LaTeX
    - 9.1. Unordered lists
    - 9.2. Ordered lists

Use Overleaf!!!

Overleaf

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LaTeX, Evolved

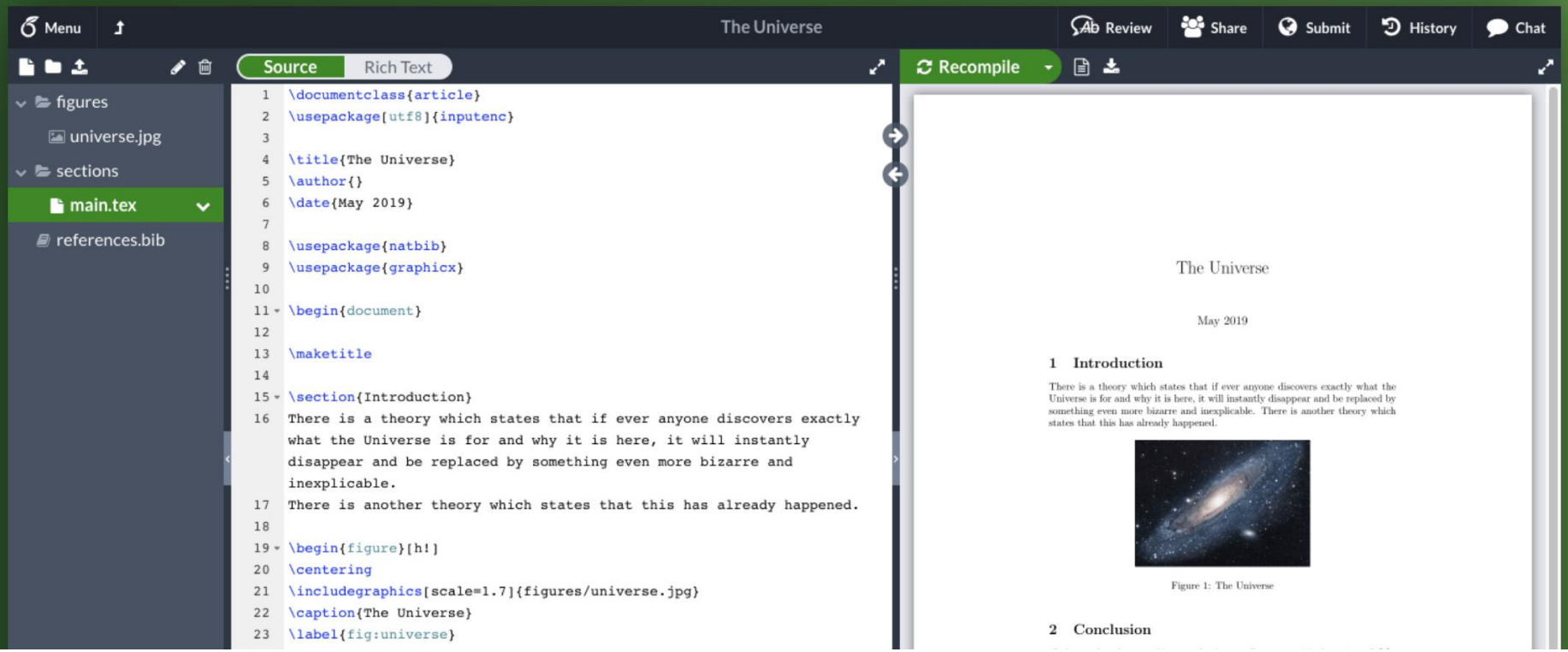
The easy to use, online, collaborative LaTeX editor

Menu | The Universe | Review | Share | Submit | History | Chat

Source | Rich Text | Recompile

figures
universe.jpg
sections
main.tex
references.bib

```
\documentclass{article}
\usepackage[utf8]{inputenc}

\title{The Universe}
\author{}
\date{May 2019}

\usepackage{natbib}
\usepackage{graphicx}

\begin{document}

\maketitle

\section{Introduction}
There is a theory which states that if ever anyone discovers exactly
what the Universe is for and why it is here, it will instantly
disappear and be replaced by something even more bizarre and
inexplicable.
There is another theory which states that this has already happened.

\begin{figure}[h!]
\centering
\includegraphics[scale=1.7]{figures/universe.jpg}
\caption{The Universe}
\label{fig:universe}
```



Materials

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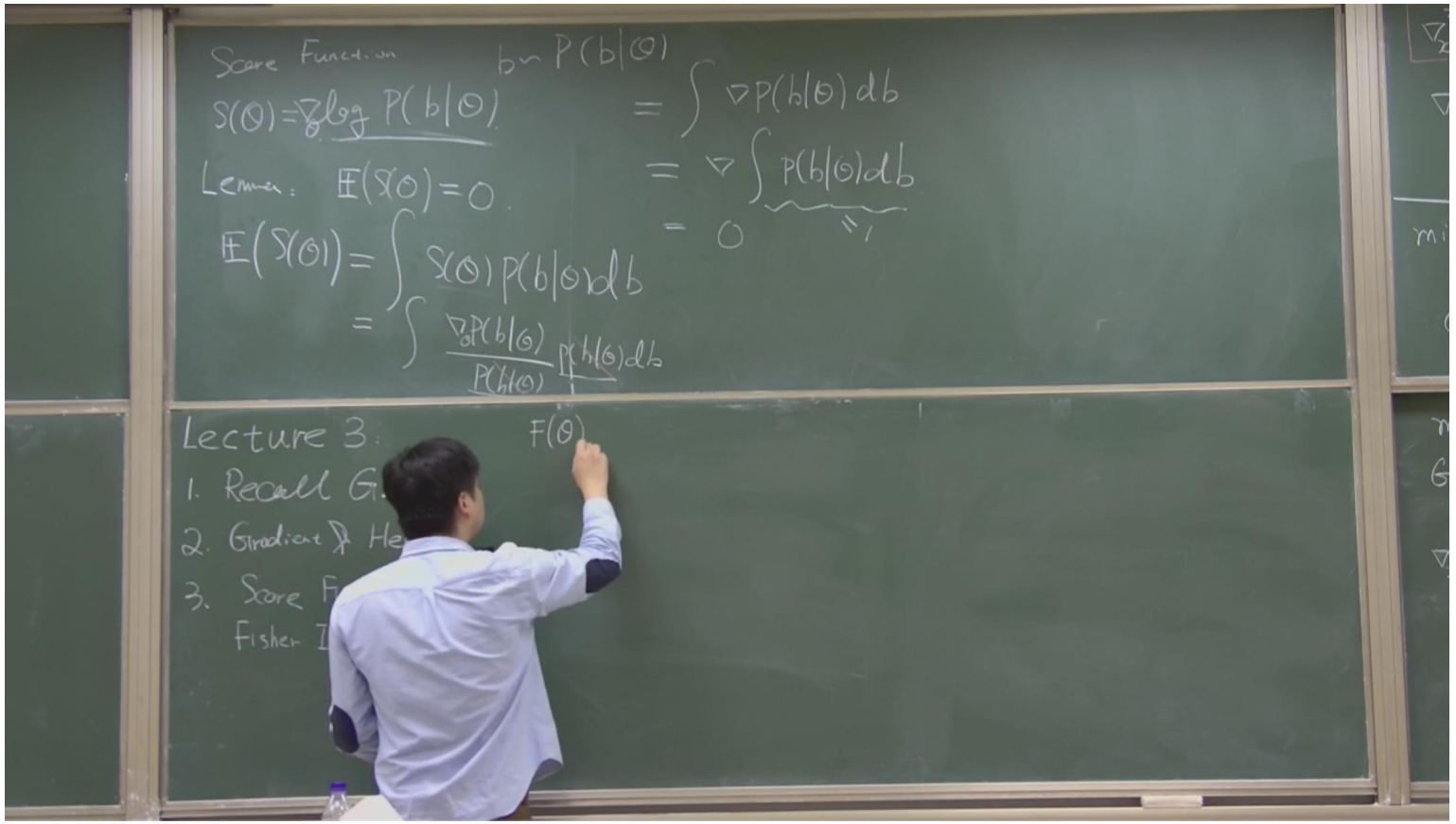
- SciPy Tutorial
- NumPy Quickstart Tutorial

LaTeX

- MacTeX
- CTeX
- Learn LaTeX in 30 minutes
- Use Overleaf
- TeXStudio: Suggested IDE

https://som-course.github.io/opt-spring-2021/materials/

Teaching Style



- Writing on the blackboard in English for main lectures, Speaking in Chinese

- Demostraing codes or visual examples by sildes

Why?

手机人民网 m.people.cn | 观点 > 人民网评

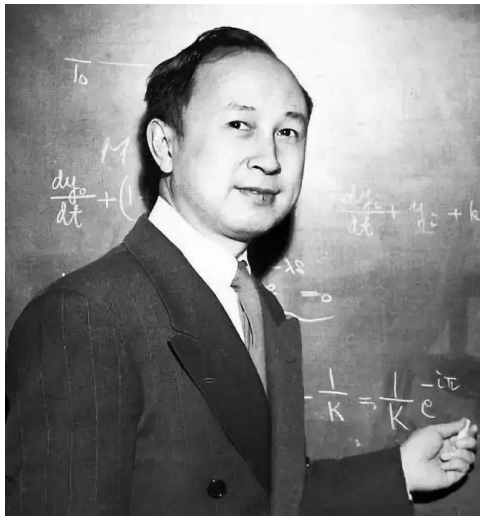
人民网评：一流大学建设要坚持社会主义办学方向

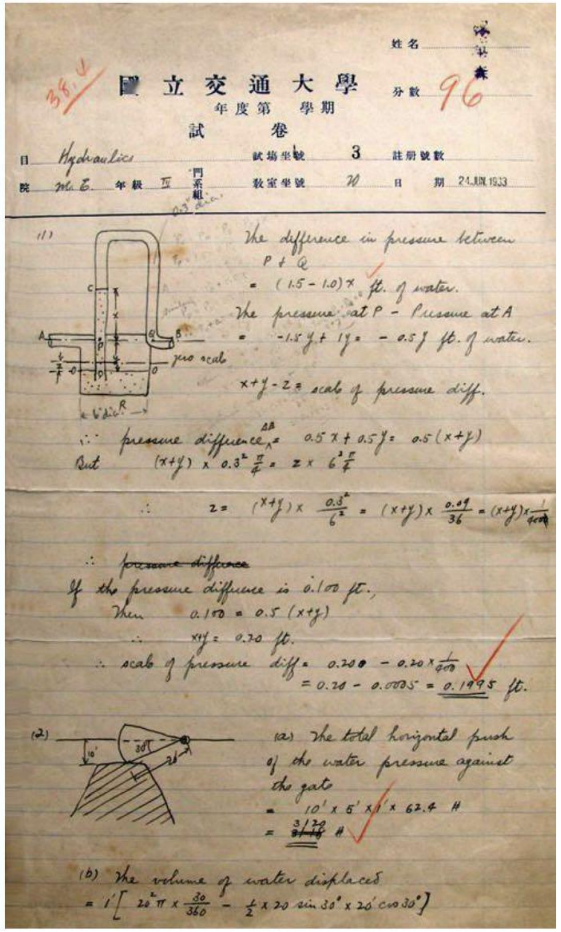
2021-04-22 08:07 人民网-观点频道 作者：岚山

文章指出，教育兴则国家兴，教育强则国家强。在国家发展进程中**办好高等教育，办出世界一流大学，首先要在体现中国特色上下功夫。**

交通大学上海徐家汇校区老校门（1920年代）

1956年交通大学主体西迁西安兴庆宫





姓名

國立交通大學

年度第 學期

分數 96

試卷

Hydraulics 試場座號 3 註冊號數

教室座號 N 日期 24.JUN.1933

The difference in pressure between P & Q

= (1.5 - 1.0) × ft. of water.

The pressure at P - Pressure at A

= -1.5 y + 1 y = - 0.5 y ft. of water.

x + y - z = scale of pressure diff.

∴ pressure difference = 0.5 x + 0.5 y = 0.5 (x + y)

But (x+y) × 0.3² π/4 = z × 6² π/4

∴ z = (x+y) × 0.3²/6² = (x+y) × 0.09/36 = (x+y) × 1/400

∴ pressure difference

If the pressure difference is 0.100 ft.,

Then 0.100 = 0.5 (x+y)

∴ x+y = 0.20 ft.

∴ scale of pressure diff. = 0.200 - 0.20 × 1/400

= 0.20 - 0.0005 = 0.1995 ft.

(a) The total horizontal push of the water pressure against the gate

= 10' × 5' × 1 × 62.4 #

= 3120 #

(b) The volume of water displaced

= 1' [20² π × 30/360 - 1/2 × 20 sin 30° × 20 cos 30°]

Questions

RUSSIAN

SPANISH

FRENCH

VIETNAMESE

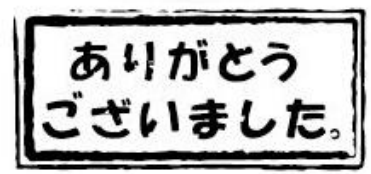
CHINESE

ENGLISH

GREEK

ARABIC

KOREAN



JAPANESE