Additional Information

Zhenghong Lieu

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Zhenghong Lieu
(lieuzhenghong@gmail.com)

Education

Oct 2017 – present

University of Oxford

BA in Philosophy, Politics and Economics (PPE)

Jun 2017 – present

Massive Open Online Courses (MOOCs) completed

Computer Science

- Algorithms and Data Structures (Stanford)
- Databases (Stanford)
- Machine Learning (Stanford)
- From NAND to Tetris I & II (computer architecture) (IDC Herzilya)
- Competitive Programmer's Core Skills (SPSU)

Data Science

- Functional Programming Principles in Scala (EPFL)
- Parallel Programming in Scala (EPFL)
- Big Data Analysis in Scala and Spark (EPFL)

Mathematics

- Linear Algebra (Imperial College London)
- Multivariate Calculus (Imperial College London)

Experience

Jun 2019 – Sep 2019

Data Scientist (Intern)

Inzura AI

Increased monthly active users by $> 20\%$ by building a Bayesian SMS sender in Python and SQL, meeting a KPI which secured an important client contract

Built deep learning model with Keras that reduces trip processing time from 7s to 0.05s, which made possible a new revenue vertical for the company

Deployed distributed Apache Spark infrastructure and performed Big Data analysis with Scala on ~85 million data points used to assign users more accurate risk ratings

Jun 2018 – Aug 2019

Blockchain Developer (Intern)

Infocomm Media Development Authority of Singapore (IMDA)

Wrote a research paper on blockchain interop protocols and presented it to senior management

Created a fully-automated blockchain demonstration of supply chain management:

- Real-time blockchain visualisation using JavaScript and Canvas
- IoT sensor integration to update asset location data on Hyperledger blockchain
- QR-code based asset tracking with Node.js

Jun 2017 – Aug 2017

Software Engineer

Imcomp International

Greatly increased firm efficiency (75% less time taken to generate reports, 300 engineer hours saved per month) by developing bespoke building inspection software (Electron, Vue.js, JavaScript)

Jan 2017 – May 2017	**Venture Capital Analyst (Intern)**
	iGlobe Partners
	Co-wrote 2 papers recommending investment; senior management accepted both recommendations and made Stage B investments
	Developed more powerful version of Microsoft Mail Merge in Python that automates away 90% of human errors and saves 50% time when sending mass mailers
May 2016 – Sep 2017	**Python Programming Tutor (Volunteer)**
	Ulu Pandan Stars
	Taught a team of underprivileged children Python and led them to win 3rd (amongst ~100 participating teams) in national hackathon CodeXtreme
Feb 2015 – Dec 2016	**Soldier (Conscript)**
	Singapore Armed Forces (SAF), HQ Army Medical Service
	Developed the Army's first item tracker and SMS reminder service with React and Node.js:
	• Won second prize in the Army Annual Innovation Competition • Won Best Soldier of the Month out of ~3000 soldiers

Working Papers

2019	"Accounting for Travel Times in Estimating Political Dislocation"
	with Nicholas Eubank and Jonathan Rodden
2019	"Using human geography to build a more meaningful compactness measure for automated districting algorithms"
2019	"Can freeform communication increase the rate of Pareto-efficient outcomes in repeated games?"

Honors and Fellowships

Oct 2019	Postmaster
	Major college scholarship awarded for sustained academic excellence
Aug 2019	Raff Prize
	Awarded for best second-year Economics performance in my college
Oct 2018	Exhbitioner
	Minor college scholarship awarded for good performance in the first year
Aug 2018	Sam McNaughton Prize
	Awarded for top score in Philosophy in the PPE first-year exams
June 2018	Quantitative Political Essay Prize
	Awarded to the best quantitative essay of my Oxford politics cohort (~300 students)
Dec 2017 – present	Fowler Prize(s)
	Awarded for First-class performance in termly exams, awarded 7/7 terms
Sep 2017	National Infocomm Scholarship
	Full-ride undergraduate scholarship awarded to promising Singaporean students by the Infocomm Media and Development Authority (IMDA), a Singaporean statutory board. Awarded on the basis of academic excellence, demonstrated interest in tech, and a will to serve the nation.

Accounting for Travel Times in Estimating Political Dislocation

Nicholas Eubank*, Zhenghong Lieu†, Jonathan Rodden‡

November 20, 2019

Preliminary Draft
PLEASE DO NOT CITE
[Please click here for most recent version.](#)

Abstract

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*Assistant Research Professor, Social Science Research Institute, Duke University `nick@nickeubank.com`

†Oxford University

‡Professor, Department of Political Science and Senior Fellow, Hoover Institution, Stanford University `jrodden@stanford.edu`

Fundamental to a political of single member districts is the idea that there is value in voters who live in the same area being represented by a single politician. Arguments for this are multifaceted — voters in the same area are likely to share political interests; voters in the same area are better able to communicate and coordinate with one another; politicians can better maintain connections with voters in the same area; voters in the same area are especially likely to belong to the same social communities — but all suggest the importance of voters being located in districts with their geographic peers. [need cites]

The idea that there is value in the constituents of a district being physically proximate to one another is present not only in political theory texts, but also in law. Many states, for example, explicitly state that geometric compactness is one of the desired attributes of electoral districts, and indeed compactness is often a metric used to evaluate the reasonableness of districts in legal cases around districting.

Yet historically, when evaluating whether districts accomplish their goal of creating districts composed of constituents who are "close" to one another, proximity is almost always evaluated on the basis of geographic district. But geographic distance often does not correspond to the human experience of proximity, as anyone who has tried to travel even a few miles across downtown at rush hour can attest. This reliance on purely geometric metrics is understandable given its tractability, but with the rise of ubiquitous data on travel patterns and the amount of time it actually takes for citizens to drive from one location to another, it is now possible to measure the distances between citizens not in feet or miles, but in actual travel times, reflecting for the first time the actual human geography of distance.

In this paper, we build on the work of Lieu (2019) – who develops a measure of district compactness built on a travel-time metric rather than a geographic-distance metric – to create a revised version of the *Political Dislocation* from Eubank and Rodden (2019) that takes into account travel times to more accurately estimate the characteristics of voters' local neighborhoods.

Political Dislocation measures the degree to which a voter's district is aligned with their immediate geographic neighbors. In particular, we examine the degree to which the *partisan composition* of a voter's actual electoral district differs from the partisan composition of their local neighborhood. Where these measures differ dramatically — where, for example, a voter whose k nearest neighbors (where k is the number of people in the voter's actual legislative district) are mostly Democrats, but despite this their district is mostly Republican — we term that voter *politically dislocated*. As shown in Eubank and Rodden (2019), not only is this measure of direct normative importance, it is also a very good measure of the degree to which an individual voter is the victim of packing or cracking, making it a valuable individual-level metric of abusive districting and gerrymandering.

In this paper, we take the *Political Dislocation* measure from Eubank and Rodden

(2019) and update it by identifying each voter's k nearest neighbors not on the basis of geographic proximity, but on the basis of shortest travel times. As we will show, this not only provides an objective basis for identifying and guarding against abusive districting practices (like drawing districts that cross large impassable bodies of water), but it also offers a consistently different picture of the social context of suburban voters. As shown below, we find that our measure generally shows that suburban voters' nearest neighbors tend to be more conservative when one uses travel times as a distance metric, likely because more geographically distant exurban (generally more conservative) voters are often closer on human-scales than voters on the other side of the city (who tend to be more liberal).

1 Data & Methodology

Following Eubank and Rodden (2018), estimation of the partisan composition of each voter's neighborhood is accomplished through a three-step process. First, precinct-level election returns from the 2008 Presidential election are used to estimate the spatial distribution of voters in each state.[1] This is done by creating a number of representative voter points within each precinct, where points are positioned uniformly at random within each precinct's catchment area, and the number of points in each precinct's catchment area is proportional to the number of votes cast for each party.[2] While this down-sampling and placements of points randomly within precincts does introduce some noise, as discussed in Appendix A, the variability contributed to our dislocation measure is empirically very small. This analysis generates an estimate *for each representative-voter point* of the share of neighbors who are co-partisans.

Estimation of the partisan composition of the neighborhood around each of these representative-voter points is then calculated. In our naive nearest neighbor analysis (following Eubank and Rodden (2019)), for each representative-voter point v of a given party $p \in \{D, R\}$, the partisanship of the neighborhood around v is equal to the share of the k nearest points (as measured by geographic distance) who are democrats. The number of nearest neighbors considered – k – is set to ensure the included points

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[1]Before calculating these intervals, we apply a uniform swing to account for McCain / Obama vote shares in our 2008 Presidential two-party vote share data. In particular, as McCain's two-party vote share was 46.31%, we apply a 3.69 percentage point uniform swing to all data, so that a Republican voter whose voter neighborhood is 46.31% co-partisan would be said to be in a perfect 50% co-partisan neighborhood. In Congressional races, Democratic victories have been quite rare in districts where McCain's 2008 vote share was higher than 46.31 percent, and Republican victories have been quite rare in districts where Obama's vote share was higher than 53.69 percent.

[2]In particular, the number of points we generate in each precinct for each party is determined by taking a binomial draw from the total number of actual voters. The binomial probability varies by state-chamber, but is equal to $prob_k = \frac{number of districts}{number of voters in state} * k$, where k=1,000 for state legislative districts and 5,000 for US Congressional districts. This probability generates k voters per district in expectation. A larger number of points are used for US Congressional districts to adjust for the fact that the relatively small size of precincts with respect to US Congressional districts reduces the sampling probabilities in each precinct, increasing sampling variance for a given k.

Using human geography to build a more meaningful compactness measure for districting algorithms

Zhenghong Lieu

14 November 2019

Abstract

[This is a working title, and everything about this is very much a work-in-progress.]

Most existing districting approaches aim to optimise over geographical compactness measures like Polsby-Popper and Convex Hull. Compactness is important because compact districts better represent communities of interest and have been shown to improve democratic effectiveness. However, compactness measures are imperfect proxies for human interaction as they cannot account for human geography. For instance, a typical compactness measure would put two villages separated by a big mountain together, even if these villages have near-to-zero interaction. While the shortcomings of compactness measures are well-known in the literature, existing approaches to improve it have failed due to lack of data and computational intractability (NP-hardness). I develop a new metric ("human compactness") based on travel times that is computationally feasible—yet still captures human geography—and calculate it for many US Congressional districts. Finally, I augment several districting algorithms with the metric, including the Metric Geometry and Gerrymandering Group (MGGG's) Monte Carlo Markov Chain (MCMC) districting algorithm, and show that the plans drawn with my metric are superior in electoral competitiveness and media congruence, which directly translates to increased federal funding.

Zheng Lieu (mert3946), Merton	XRNLI-2017-1323740
Bachelor of Arts in Philosophy, Politics, and Economics	Organising Tutor: Simon Saunders , Emin Baysan , Karina Cendon boveda , Alistair Macaulay , Patricia Thornton , Bassel Tarbush
Logic	Personal Tutor: None
Taught by **Simon Saunders** (lina0174)	Michaelmas 2017

Total hours by Group Size

Size	Hours
1	0.0
2	0.0
3	0.0
11	12.0
6	8.0
0	0.0

Lieu Zheng had a good presence in the class, a personality, with some interesting attitudes to philosophy. He is also extremely quick and able. He worked well and is on course to do very well in the subject. He has occasionally made poor choices in how to go about answering questions, and may yet mess up, but I predict a clear distinction.

of which

Hours missed	*Hours to come*
0.0	0.0

Number of collections marked: 1.0

Number of pieces of work set:	9.0
Work satisfactorily completed:	9.0
Work handed in late:	0.0

		Comments:
Effort:	Excellent	
Achievement:	Excellent	
Estimate of Term's work:	1	

Collection marks: 66
Vacation essay marks:

Submitted on 10/01/2018	*Approved by Sergi Pardos-Prado on 04/03/2018*

Zheng Lieu (mert3946), Merton	XRNLI-2018-1402855
Bachelor of Arts in Philosophy, Politics, and Economics	Organising Tutor: Simon Saunders , Emin Baysan , Karina Cendon boveda , Alistair Macaulay , Patricia Thornton , Bassel Tarbush
Macroeconomics	Personal Tutor: None
Taught by **Matthias Qian** (shug3997)	Trinity 2018

Total hours by Group Size

Size	Hours
1	0.0
2	0.0
3	7.0
0	0.0
0	0.0
0	0.0

Zhenghong shows a great motivation to develop a deep and thorough understanding of Economics. Nearly all of his problem sets are written very beautifully and this answers show attention to detail. He is very proactive in the tutorials and is very energetic. He also has strong economic intuition - he already thinks like an Economist. I see great potential Zhenghong to obtain a First in the exams.

of which

Hours missed	Hours to come
0.0	0.0

Number of collections marked: 0.0

Number of pieces of work set: 0.0
Work satisfactorily completed: 0.0
Work handed in late: 0.0

Effort: Excellent
Achievement: Excellent
Estimate of Term's work: 1

Comments:

Collection marks:
Vacation essay marks:

Submitted on 11/06/2018   *Approved by Sergi Pardos-Prado on 27/06/2018*

Zheng Lieu (mert3946), Merton

Bachelor of Arts in Philosophy, Politics, and Economics

Politics Prelims: Theory of Democracy
Taught by **Patricia Thornton** (polf0211)

XRNLI-2018-1368547

Organising Tutor: Simon Saunders , Emin Baysan , Karina Cendon boveda , Alistair Macaulay , Patricia Thornton , Bassel Tarbush
Personal Tutor: None
Trinity 2018

Total hours by Group Size	
Size	Hours
1	0.0
2	0.0
3	0.0
4	10.0
0	0.0
0	0.0

of which

Hours missed	*Hours to come*
0.0	0.0

Number of collections marked: 0.0

Number of pieces of work set:	5.0
Work satisfactorily completed:	5.0
Work handed in late:	0.0

Effort:	Excellent
Achievement:	Excellent
Estimate of Term's work:	1

Collection marks:
Vacation essay marks:

Zheng Hong is an extremely talented student who is driven to perform at a very high level. Several of his essays were very clear firsts-- he has an unusual ability to address directly and very clearly the key issues at hand, and demonstrates an unusual flair for political philosophy. He certainly turned in one of the best essays on civil society that I've seen. I very much enjoyed tutoring him, and I am very hopeful that he will continue on with Politics!

Comments:

Submitted on 17/07/2018   *Approved by Ralf Bader on 30/07/2018*

Zheng Lieu (mert3946), Merton

Bachelor of Arts in Philosophy, Politics, and Economics

Analysis

Taught by **Alexander Scott** (mert1909)

XRNLI-2019-1546252

Organising Tutor: Simon Saunders , Emin Baysan , Karina Cendon boveda , Alistair Macaulay , Patricia Thornton , Bassel Tarbush

Personal Tutor: None

Trinity 2019

	Total hours by Group Size	
Size	Hours	
1	0.0	
2	0.0	
3	11.0	
0	0.0	
0	0.0	
0	0.0	

of which

Hours missed	Hours to come
0.0	0.0

Number of collections marked: 0.0

Number of pieces of work set:	0.0
Work satisfactorily completed:	0.0
Work handed in late:	0.0

Effort:	Not specified
Achievement:	Not specified
Estimate of Term's work:	Not specified

Collection marks:

Vacation essay marks:

This term we went through a significant part of the Prelims Analysis sequence. Zhenghong contributed well in tutorials, and produced some good written work. This was a very enjoyable group to teach!

Comments:

Submitted on 01/07/2019 *Approved by Patricia Thornton on 01/07/2019*

Zheng Lieu (mert3946), Merton Bachelor of Arts in Philosophy, Politics, and Economics Core Macroeconomics Taught by **Michael Rousakis** (econ0431)	XRNLI-2019-1502598 Organising Tutor: Simon Saunders , Emin Baysan , Karina Cendon boveda , Alistair Macaulay , Patricia Thornton , Bassel Tarbush Personal Tutor: None Hilary 2019

Total hours by Group Size

Size	Hours
1	0.0
2	0.0
3	0.0
4	12.5
0	0.0
0	0.0

Zheng Hong had a really good term. His essays were first class and his participation during the tutorials was extremely constructive. I have been very happy with Zheng Hong, and I expect him to get a first.

of which

Hours missed	Hours to come
0.0	0.0

Number of collections marked: 0.0

Number of pieces of work set: 7.0
Work satisfactorily completed: 7.0
Work handed in late: 0.0

Effort: Excellent
Achievement: Excellent
Estimate of Term's work: 1

Comments:

Collection marks:
Vacation essay marks:

Submitted on 19/03/2019	*Approved by Charlotte Pawley on 21/03/2019*

Zheng Lieu (mert3946), Merton

Bachelor of Arts in Philosophy, Politics, and Economics

Core Microeconomics

Taught by **Bassel Tarbush** (scat3580)

Total hours by Group Size	
Size	Hours
1	0.0
2	2.0
3	3.75
4	10.75
0	0.0
0	0.0

of which

Hours missed	Hours to come
0.0	1.5

Number of collections marked: 1.0

Number of pieces of work set: 0.0
Work satisfactorily completed: 0.0
Work handed in late: 0.0

Effort: Not specified
Achievement: Not specified
Estimate of Term's work: Not specified

Collection marks:
Vacation essay marks:

Zheng Hong had a decent term. He was understandably very busy (preparing for his thesis in Pol. Soc.) and did not spend as much time on micro as I would have liked him to.

That said, it was apparent in the tutes that he has a good grasp of most of the material. If he gives himself enough time to revise, he should do well. Just remember one thing: understanding the material is one thing. Knowing what is being asked and knowing how to respond to (exam) questions well is another. Please look at past exams and specimen papers. Practice on those. Get feedback from grad mentors.

He is very creative on the essay writing front. That sometimes works really well, but it can also sometimes work against him if his approach happens to be too complicated (or possibly wrong). E.g. I'm thinking of the insurance market essay in which he attempted an analytical solution to the problem -- but it would have been much easier to approach it graphically.

Comments:

Submitted on 13/12/2018

Approved by Sergi Pardos-Prado on 18/12/2018

Zheng Lieu (mert3946), Merton	XRNLI-2018-1457065	
Bachelor of Arts in Philosophy, Politics, and Economics	Organising Tutor: Simon Saunders , Emin Baysan , Karina Cendon boveda , Alistair Macaulay , Patricia Thornton , Bassel Tarbush	
Political Sociology	Personal Tutor: None	
Taught by **Sergi Pardos-Prado** (nuff0797)	Michaelmas 2018	

Total hours by Group Size

Size	Hours
1	0.0
2	14.0
3	0.0
0	0.0
0	0.0
0	0.0

ZhengHong has performed at the highest possible level in this module. His coverage and understanding of the materials, his committed attitude, his constant improvement on the econometric side of the paper, and the quality of his written work were First class. ZhengHong is planning to write a thesis on quantitative political science topic, so the effort he made in Pol Soc will be very helpful later on. Two things concern me, though, at this point. First, the level of nuance and sophistication that ZhengHong is able to show in his tutorial essays will be difficult to replicate in an exam setting. He will need to practice exam writing under timed conditions (at home and in Collections), and learn how to be more selective in his arguments and critical engagement with the literature. Second, I hear from Economics that the extra effort he put in Pol Soc came at the cost of investing in Microeconomics. Zhenghong should remember that all papers need to be mastered in order to get a First, and that, as he very well knows, technical papers are not necessarily always the most straightforward.

of which

Hours missed	*Hours to come*
0.0	0.0

Number of collections marked: 1.0

Number of pieces of work set:	7.0
Work satisfactorily completed:	7.0
Work handed in late:	0.0

Comments:

Effort:	Excellent
Achievement:	Excellent
Estimate of Term's work:	1

Collection marks:

Vacation essay marks:

Submitted on 18/12/2018	*Approved by Bassel Tarbush on 18/12/2018*

Zheng Lieu (mert3946), Merton

Bachelor of Arts in Philosophy, Politics, and Economics

Quantitative Economics

Taught by **Bassel Tarbush** (scat3580)

Zheng Hong clearly enjoyed QE. He should spend some time solidifying his grasp of the material -- but he is on track to do very well in this paper. He submitted written work of high quality and he was an active participant in tutorials.

Total hours by Group Size

Size	Hours
1	2.0
2	2.5
3	9.0
4	6.0
8	2.0
0	0.0

of which

Hours missed	Hours to come
0.0	0.0

Number of collections marked: 1.0

Number of pieces of work set:	0.0
Work satisfactorily completed:	0.0
Work handed in late:	0.0

Effort:	Not specified
Achievement:	Not specified
Estimate of Term's work:	Not specified

Comments:

Collection marks:

Vacation essay marks:

Submitted on 01/07/2019	*Approved by Michael Rousakis on 01/07/2019*

Zheng Lieu (mert3946), Merton

Bachelor of Arts in Philosophy, Politics, and Economics

Theory of Politics
Taught by **Collis Tahzib** (linc3311)

XRNLI-2019-1485729

Organising Tutor: Simon Saunders , Emin Baysan , Karina Cendon boveda , Alistair Macaulay , Patricia Thornton , Bassel Tarbush
Personal Tutor: None
Hilary 2019

Zhenghong has had a very good term. He is active in tutorial discussions and makes bright and thoughtful contributions. A few of his essays have been handed in late, but they are always well written and well argued.

Total hours by Group Size

Size	Hours
1	0.0
2	0.0
3	12.0
0	0.0
0	0.0
0	0.0

of which

Hours missed	Hours to come
0.0	0.0

Number of collections marked: 0.0

Number of pieces of work set: 0.0
Work satisfactorily completed: 0.0
Work handed in late: 0.0

Effort: Not specified
Achievement: Not specified
Estimate of Term's work: Not specified

Comments:

Collection marks:
Vacation essay marks:

Submitted on 01/03/2019

Approved by Sergi Pardos-Prado on 14/03/2019

Stanford | ONLINE
STATEMENT OF ACCOMPLISHMENT

September 23, 2017

Lieu Zheng Hong

has successfully completed a free online offering of

Algorithms: Design and Analysis

This is an undergraduate level course on the design and analysis of algorithms. The main topics are: asymptotic analysis, divide and conquer algorithms, sorting and searching, basic randomized algorithms, graph search, shortest paths, heaps, search trees, and hash tables. In order to earn a Statement of Accomplishment, participants were required to score at least 70% on 6 problem sets, 6 programming assignments, and 1 final exam.

Tim Roughgarden
Associate Professor of Computer Science
Stanford University

Authenticity can be verified at **https://verify.lagunita.stanford.edu/SOA/f06d4d781ad5466c85d65b279e2e2e63**

EPFL

11/13/2019

Zheng Hong Lieu

has successfully completed

Big Data Analysis with Scala and Spark

an online non-credit course authorized by École Polytechnique Fédérale de Lausanne and offered through Coursera

EDUCATION FOR EVERYONE · coursera · COURSE CERTIFICATE

Heather Miller
École Polytechnique Fédérale de Lausanne

Verify at coursera.org/verify/CSFJQZEQFBHD

Coursera has confirmed the identity of this individual and their participation in the course.

09/10/2018

Zheng Hong Lieu

has successfully completed

Competitive Programmer's Core Skills

an online non-credit course authorized by Saint Petersburg State University and offered through Coursera

EDUCATION FOR EVERYONE

coursera

COURSE CERTIFICATE

Alexander S. Kulikov, Alexander Logunov, Kirill Simonov

K Simonov

Stanford | ONLINE
STATEMENT OF ACCOMPLISHMENT

June 26, 2019

Lieu Zheng Hong

has successfully completed a free online offering of

Relational Algebra

with **Statement of Accomplishment**.

Jennifer Widom, Ph.D
Professor in Computer Science
Stanford University

Authenticity can be verified at **https://verify.lagunita.stanford.edu/SOA/129872c52c734402a73bfd3098992146**

Lieu Zheng Hong

has successfully completed a free online offering of

Relational Design Theory

with **Statement of Accomplishment**.

Jennifer Widom

Jennifer Widom, Ph.D
Professor in Computer Science
Stanford University

Stanford | ONLINE
STATEMENT OF ACCOMPLISHMENT

July 23, 2019

Lieu Zheng Hong

has successfully completed a free online offering of

SQL

with **Statement of Accomplishment**.

Jennifer Widom, Ph.D
Professor in Computer Science
Stanford University

EPFL

11/13/2019

Zheng Hong Lieu

has successfully completed

Functional Programming Principles in Scala

an online non-credit course authorized by École Polytechnique Fédérale de Lausanne and offered through Coursera

MARTIN ODERSKY
PROFESSOR OF COMPUTER SCIENCE
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

EDUCATION FOR EVERYONE · COURSE CERTIFICATE · coursera

Verify at coursera.org/verify/M9QXY6C62MKX

Coursera has confirmed the identity of this individual and their participation in the course.

Imperial College London

COURSE CERTIFICATE

07/25/2019

Zheng Hong Lieu

has successfully completed

Mathematics for Machine Learning: Linear Algebra

an online non-credit course authorized by Imperial College London and offered through Coursera

David Dye and Samuel J. Cooper

Verify at coursera.org/verify/R5MYEWD9MU2J

Coursera has confirmed the identity of this individual and their participation in the course.

Stanford | ONLINE

COURSE CERTIFICATE

04/30/2017

Zheng Hong Lieu

has successfully completed

Machine Learning

an online non-credit course authorized by Stanford University and offered through Coursera

Andrew Ng

Associate Professor Andrew Ng
Computer Science Department
Stanford University

EDUCATION FOR EVERYONE · COURSE CERTIFICATE ·
coursera

Verify at coursera.org/verify/GA6ZJZ5PMK3P

Coursera has confirmed the identity of this individual and their participation in the course.

Imperial College London

COURSE CERTIFICATE

11/18/2019

Zheng Hong Lieu

has successfully completed

Mathematics for Machine Learning: Multivariate Calculus

an online non-credit course authorized by Imperial College London and offered through Coursera

David Dye and Samuel J. Cooper

EDUCATION FOR EVERYONE · coursera · COURSE CERTIFICATE

האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM
الجامعة العبرية في اورشليم القدس

COURSE CERTIFICATE

08/28/2017

Zheng Hong Lieu

has successfully completed

Build a Modern Computer from First Principles: From Nand to Tetris (Project-Centered Course)

an online non-credit course authorized by Hebrew University of Jerusalem and offered through Coursera

Shimon Schocken
Associate Professor
Computer Science

Professor Noam Nisan
School of Computer Science and Engineering
The Hebrew University of Jerusalem

האוניברסיטה העברית בירושלים
THE HEBREW UNIVERSITY OF JERUSALEM
الجامعة العبرية في اورشليم القدس

COURSE CERTIFICATE

12/24/2017

Zheng Hong Lieu

has successfully completed

Build a Modern Computer from First Principles: Nand to Tetris Part II (project-centered course)

an online non-credit course authorized by Hebrew University of Jerusalem and offered through Coursera

Shimon Schocken
Associate Professor
Computer Science