Invited Talk @NTOU

Joseph Chuang-Chieh Lin (林莊傑)
- https://josephcclin.github.io

Assistant Professor

Tamkang University
Department of Computer Science & Information Engineering

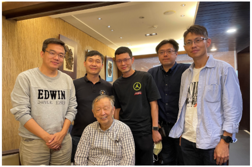
April 6, 2023

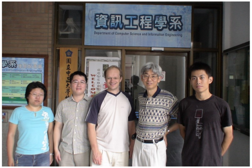
Outline

1. Background
   - Education
   - Postdoctoral Experience (2011–2018)
   - Industrial Experience (2018–2020)
2. Teaching
3. Research Progress & Projects (2021–Present)
4. Services
5. Selected Research Contributions
   - Minimum Quartet Inconsistency
   - Election Game
   - Ongoing Work: Group Formation
6. Conclusion

Education

- BS.: Mathematics (2002), National Cheng Kung University
- MS.: CSIE (2004), National Chi Nan University
  - Supervisor: R. C. T. Lee
    Algorithms
- Ph.D.: CSIE (2011), National Chung Cheng University
  - Supervisors: Maw-Shang Chang & Peter Rossmanith
    FPT + Randomized Algorithms





DAAD-NSC Sandwich Program (2007–2008)

RWTH Aachen University (Funding: DAAD + NSC 96-2911-I-194-008-2.)

Research Progress ($\sim$2011)

*corresponding author

Journal articles:

1. Chang, Lin* & Rossmanith: A property tester for tree-likeness of quartet topologies. *Theory Comput. Syst.*, 2011.
2. Chang, Chung & Lin*: An improved algorithm for the red-blue hitting set problem with the consecutive ones property. *Inform. Process. Lett.*, 2010.
3. Chang, Lin* & Rossmanith: New fixed-parameter algorithms for the minimum quartet inconsistency problem. *Theory Comput. Syst.*, 2010.

Conference articles:

1. Lin*: Testing tree-consistency with k missing quartets. WCMCT 2011.
2. Chang, Chung & Lin*: An improved algorithm for the red-blue hitting set problem with the consecutive ones property. WCMCT 2009, Best Paper Award.
3. Chang, Lin* & Rossmanith: New fixed-parameter algorithms for the minimum quartet inconsistency problem. IWPEC 2008.

Postdoc in Academia Sinica (2011–2018)

研發替代役 (2011–2014)

@Genomics Research Center, Academia Sinica
- Bioinformatics,
- Comparative Genomics

PI: Trees-Juen Chuang

Academia Sinica
Genomics Research Center

@Institute of Information Science, Academia Sinica
- Machine Learning,
- Game Theory

PI: Chi-Jen Lu

Research Progress (2011–2018)

*corresponding author

Journal articles:

1. Chuang*, Yang, Lin, Hsieh & Hung: Comparative genomics of grass EST libraries reveals previously uncharacterized splicing events in crop plants. *BMC Plant Biology*, 2015.
2. Chang, Lin* & Rossmanith: Testing consistency of quartet topologies: a parameterized approach. *Inform. Process. Lett.*, 2013.

Conference articles:

1. Lin & Lu*: Efficient mechanisms for peer grading and dueling bandits. ACML 2018.

Industrial Experience (2018–2020)

- *Quantitative Analyst* (intern) of Point72/Cubist Systematic Strategies (2018–2020).
  - US Hedge Fund; Fintech; Data Science.
  - Taipei Branch (started since in 2019).
  - CEO & Chairman: Steven A. Cohen.
  - AUM: US$27.2 billion (Jan. 2023).

Cubist Systematic Strategies

Point72 Asset Management

Photo: REUTERS/Lucy Nicholson
https://www.calcalistech.com/ctechnews/article/h1tli1t3s

- *Quantitative Analyst* of Seth Technologies Inc. (2020–2021).
  - High-Frequency Trading; Hedge Fund; Fintech; Data Science.
  - Taiwan based.

Image reference: https://www.seth-tech.com/

Outline

Taught & Available Courses

- Adjunct lecturer @CCU (2006, 2010).
  - Discrete Mathematics (資管系; 大學部必修)
  - Introduction to Computers (財金系、通識中心; 計算機概論).
- Assistant professor @Dept. CSIE, Tamkang University (Feb. 2021–Present).
  - Online Learning Algorithms (全英碩)
  - Economics and Computation (全英碩)
  - Randomized Algorithms (全英碩)
  - Research Methodology (全英碩)
  - Algorithmic Game Theory (全英碩)
  - Big Data Analytic Techniques (中文碩)
  - Data Science Theory and Practical Applications (中文碩)
  - Computer Programming in C/C++ (大學部必修)
  - Exploring Sustainability (大學部必修)
  - Linear Algebra (大學部必修)
  - Mathematics for Machine Learning (大學部必修)
- Other available courses.
  - Data structures (大學部必修).
  - Algorithms (大學部必修).

Tricks & Feedback (1/5): e.g., Linear Algebra

- Linear Algebra
  - #students: 54 $\uparrow$ 76 $\uparrow$ 90.
- Concepts of OOP.
- Machine Learning Examples.
- Python vectorization.
- A lot of theorems and proofs.
- Start from the fundamental.
- Mathematics & Engineering?
- Never adjust students' scores.

科目代號：TEIXB2S0439 0A　　科目名稱：線性代數
開課系級：資工二　　開課序號：0849

應填答人數= 76
回　收　數= 27
回　收　率= 35.53%

教學總分：（平均數/標準差）
個人= 5.68 / 0.58
本系= 5.43 / 0.87
本院= 5.58 / 0.72
全校= 5.62 / 0.69

請學生輸入寶貴意見,以供老師教學參考：
1. 請就老師在這門課的教學提供具體有建設性的意見。請注意用字遣詞，勿做人身攻擊和避免不雅語詞。

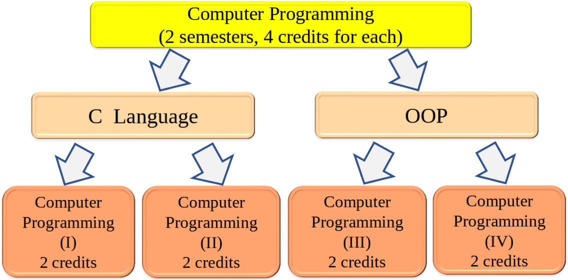
學生對上列各題之意見，內容如下

學生	題號	意　見 (敘述性文字)
1	1	，。
2	1	希望多說一點計算題 證明聽到有點頭熱
3	1	老師教的有點快，筆記有時會來不及抄，還好之後遠距都有錄影
4	1	教授教學非常有熱忱，學習過程輕鬆愉快
5	1	穩扎穩打的教學，能感受到老師真的很想教給我們越多越好，讚
6	1	老師教學良好。
7	1	受益良多
8	1	老師辛苦了
9	1	謝謝老師
10	1	0
11	1	好棒
12	1	老師很認真，與學生的互動也很棒，但可以講慢點然後多點example
13	1	謝謝老師
14	1	大量教學而少有題目，會變成有聽沒有懂
15	1	老師辛苦了
16	1	老師超棒

Date: 2022/6/28 上午 10:26:33

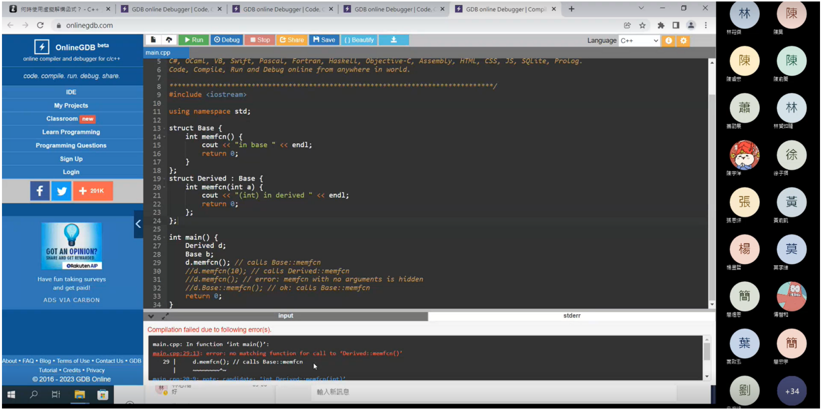
Tricks & Feedback (2/5): e.g., Computer Programming

- 循環式教學 (cycling)
- 聯合會考 (joint-exam or project)
- Quality Control



Tricks & Feedback (2/5): e.g., Computer Programming

- 循環式教學 (cycling)
- 聯合會考 (joint-exam or project)
- Quality Control



Tricks & Feedback (2/5): e.g., Computer Programming

- 循環式教學 (cycling)
- 聯合會考 (joint-exam or project)
- Quality Control

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*** 淡江大學大學部一般課程教學評量結果分析統計資料(供教師參考) ***
                    ( 110 學年第 2 學期 )

發聘單位：TEIX    資訊工程學系
教師姓名：158778 林莊傑
科目代號：TEIXB1E3994 0B      科目名稱：計算機程式語言（三）
開課系級：資工一              開課序號：0791

應填答人數=      61
回  收  數=      10
回  收  率=    16.39%

教學總分：（平均數/標準差）
        個人= 5.64  / 0.52
        本系= 5.43  / 0.87
        本院= 5.58  / 0.72
        全校= 5.62  / 0.69

================================================================
請學生輸入寶貴意見,以供老師教學參考：
 1. 請就老師在這門課的教學提供具體有建設性的意見。請注意用字遣詞，勿做人身攻擊和避免不雅語詞。

### 學生對上列各題之意見，內容如下 ###

學生 題號              意      見 (敘述性文字)
---- ----  ----------------------------------------------------
   1    1  上課進度規劃完整，老師也很樂於解答問題，學習效果良好。

   2    1  我覺得老師上的很好

   3    1  老師認真教學，為學生認真解答

   4    1  很喜歡這門課教學方式，也很喜歡有同學的範例參考，解法多樣

   5    1  很棒。
---- ----  ----------------------------------------------------
                                    Date: 2022/6/28 上午 10:26:33
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*** 淡江大學大學部一般課程教學評量結果分析統計資料(供教師參考) ***
                    ( 110 學年第 2 學期 )

發聘單位：TEIX    資訊工程學系
教師姓名：158778 林莊傑
科目代號：TEIXB1E3995 0B      科目名稱：計算機程式語言（四）
開課系級：資工一              開課序號：0797

應填答人數=      59
回  收  數=      10
回  收  率=    16.95%

教學總分：（平均數/標準差）
        個人= 5.3   / 0.75
        本系= 5.43  / 0.87
        本院= 5.58  / 0.72
        全校= 5.62  / 0.69

================================================================
請學生輸入寶貴意見,以供老師教學參考：
 1. 請就老師在這門課的教學提供具體有建設性的意見。請注意用字遣詞，勿做人身攻擊和避免不雅語詞。

### 學生對上列各題之意見，內容如下 ###

學生 題號              意      見 (敘述性文字)
---- ----  ----------------------------------------------------
   1    1  每次安排針對課堂內容的現時作業有助於提升學習的成效，教學內
           容詳細，上課時會提到一些實用的課外資訊。

   2    1  我覺得老師上的很好

   3    1  老師認真教學，為學生認真解答

   4    1  希望能跟程設3一樣有同學的參考作業，能有更多的解法

   5    1  很棒
---- ----  ----------------------------------------------------
                                    Date: 2022/6/28 上午 10:26:33
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Tricks & Feedback (3/5): e.g., Randomized Algorithms

An Application Recently

各位好友:

我最近在研讀期望值的問題，假設我們有1元硬幣5枚、5元硬幣10枚，10元硬幣20枚，我們從中取1枚，可以算出取出1枚的期望值。我發現取出2枚的期望值是取出1枚的2倍，但我不知道如何證明這個道理。

能不能開我的竅?

李家同

Answering this question can get bonus 2% of this course.

Randomized Algorithms, CSIE, Tamkang University, Taiwan

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Conditional Expectation (contd.)

- Theorem. $\mathbf{E}[Y] = \mathbf{E}[\mathbf{E}[Y \mid Z]]$.
- *Proof.*

$$\mathbf{E}[\mathbf{E}[Y \mid Z]] = \sum_z \mathbf{E}[Y \mid Z = z] \cdot \Pr[Z = z] = \mathbf{E}[Y].$$

Randomized Algorithms, CSIE, Tamkang University, Taiwan

Tricks & Feedback (3/5): e.g., Randomized Algorithms

Coupon Collector's Problem
– An Introduction

Joseph Chuang-Chieh Lin

Dept. CSIE, Tamkang University, Taiwan

Lecture Notes in Randomized Algorithms

Joseph C.-C. Lin CSIE, TKU, TW

Our memories (2005) – Hello Kitty Magnets

https://a.rimg.com.tw/s1/7/f7/89/10061029175177_650.jpg

TKU, TW 2 / 15

- So, you are about to buy $R := n \ln n + \Theta(1) < n \ln n + n$ bags for collecting all **34** types of the coupons.
  - Getting R coupons costs you $\approx$ NT\$ 77 $\times$ $(34 \ln 34 + 34) \approx$ NT\$ 11,850.
  - Getting $2R$ coupons costs you $\approx$ NT\$ 23,700.
- How likely is this to happen?
  - $\Pr[X \geq 2R] \leq \frac{1}{2}$ (Markov Inequality).

- Let X be a random variable that assumes only non-negative values. Then, for all $a > 0$,

$$\Pr[X \geq a] \leq \frac{\mathbf{E}[X]}{a}.$$

Markov Inequality

Andrei Andreyevich Markov (Wikipedia)
1856–1922

Joseph C.-C. Lin CSIE, TKU, TW 10 / 15

Tricks & Feedback (4/5)

Feedback from the other lecturers.

Request for permission

Inbox ×

[redacted]>

to lincc

Mon, Apr 13, 2020, 6:37 PM

Dear Dr. Lin

I am a lecturer at the University of Tehran in the department of Algorithms and Computation. I teach Randomized Algorithms to Msc students. I found your solutions for the problems of MU book very comprehensive, clear and useful. I would like to get your permission to use your pdf files in my class referring to its source and your permission.

Sincerely yours,

[redacted]

Professor, Department of Algorithms and Computation,

School of Engineering Science,

College of Engineering,

Tricks & Feedback (5/5)

Feedback from the other lecturers.

Cornell University

Computer Science > Machine Learning

arXiv:1912.13213 (cs)

[Submitted on 31 Dec 2019 (v1), last revised 21 Mar 2022 (this version, v5)]

A Modern Introduction to Online Learning

Francesco Orabona

Download PDF

In this monograph, I introduce the basic concepts of Online Learning through a modern view of Online Convex Optimization. Here, online learning refers to the framework of regret minimization under worst-case assumptions. I present first-order and second-order algorithms for online learning with convex losses, in Euclidean and non-Euclidean settings. All the algorithms are clearly presented as instantiation of Online Mirror Descent or Follow-The-Regularized-Leader and their variants. Particular attention is given to the issue of tuning the parameters of the algorithms and learning in unbounded domains, through adaptive and parameter-free online learning algorithms. Non-convex losses are dealt through convex surrogate losses and through randomization. The bandit setting is also briefly discussed, touching on the problem of adversarial and stochastic multi-armed bandits. These notes do not require prior knowledge of convex analysis and all the required mathematical tools are rigorously explained. Moreover, all the included proofs have been carefully chosen to be as simple and as short as possible.

Comments:	Added FTRL with group norms, added and refined convex analysis proofs, added more examples, fixed typos, added more history bits
Subjects:	**Machine Learning (cs.LG)**; Optimization and Control (math.OC); Machine Learning (stat.ML)
Cite as:	arXiv:1912.13213 **[cs.LG]**
	(or arXiv:1912.13213v5 **[cs.LG]** for this version)
	https://doi.org/10.48550/arXiv.1912.13213

Abstract

Disclaimer: This is work in progress, I plan to add more material and/or change/reorganize the content.

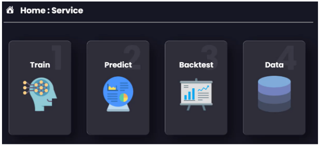
In this monograph, I introduce the basic concepts of Online Learning through a modern view of Online Convex Optimization. Here, online learning refers to the framework of regret minimization under worst-case assumptions. I present first-order and second-order algorithms for online learning with convex losses, in Euclidean and non-Euclidean settings. All the algorithms are clearly presented as instantiation of Online Mirror Descent or Follow-The-Regularized-Leader and their variants. Particular attention is given to the issue of tuning the parameters of the algorithms and learning in unbounded domains, through adaptive and parameter-free online learning algorithms. Non-convex losses are dealt through convex surrogate losses and through randomization. The bandit setting is also briefly discussed, touching on the problem of adversarial and stochastic multi-armed bandits. These notes do not require prior knowledge of convex analysis and all the required mathematical tools are rigorously explained. Moreover, all the included proofs have been carefully chosen to be as simple and as short as possible.

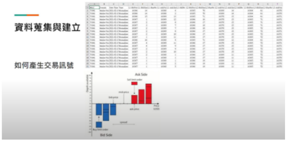
I want to thank all the people that checked the proofs and reasonings in these notes. In particular, the students in my first class that mercilessly pointed out my mistakes, Nicolò Campolongo that found all the typos in my formulas, and Jake Abernethy for the brainstorming on presentation strategies. Other people that helped me with comments, feedback, references, and/or hunting typos (in alphabetical order): Andreas Argyriou, Param Kishor Budhraja, Nicolò Cesa-Bianchi, Keyi Chen, Mingyu Chen, Peiqing Chen, Ryan D'Orazio, Alon Gonen, Daniel Hsu, Gergely Imreh, Christian Kroer, Kwang-Sung Jun, Michał Kempka, Pierre Laforgue, Chuang-Chieh Lin, Shashank Manjunath, Gergely Neu, Ankit Pensia, Daniel Roy, Guanghui Wang, and Jiujia Zhang.

This material is based upon work supported by the National Science Foundation under grant no. 1925930 "Collaborative Research: TRIPODS Institute for Optimization and Learning".

A note on citations: it is customary in the computer science literature to only cite the journal version of a result that first appeared in a conference. The rationale is that the conference version is only a preliminary version, while the journal one is often more complete and sometimes more correct. In these notes, I will not use this custom. Instead, in the presence of the conference and journal version of the same paper, I will cite both. The reason is that I want to clearly delineate the history of the ideas, their first inventors, and the unavoidable rediscoveries. Hence, I need the exact year when some ideas were first proposed. Moreover, in some rare cases the authors changed from the conference to the journal version, so citing only the latter would erase the contribution of some key people from the history of Science.

指導專題競賽得獎


Home : Service
Train
Predict
Backtest
Data


資料蒐集與建立
如何產生交易訊號


2.Long-Short Term Machine
Legend:


2022資訊週競賽得獎公告
A組-系統與軟體組
第1名 A4 Unity 2D遊戲設計與Socket連線
第2名 A1 模仿遊戲-表情相似度挑戰
第3名 A5 手勢操控實作與延伸應用
佳 作 A14 AI史萊姆－在動態環境下學習避障搜尋食物
佳 作 A6 商品重量感測及AI辨識
佳 作 A11 手勢控制電視
B組-資料分析與應用組
第1名 B6 霸凌辨識系統
第2名 B2 人工智慧-網球肢體辨識
第3名 B1 手語辨識
佳 作 B15 利用Azure 口語評分系統輔助改善學生發音與學習動機之成效一以台灣國中生為例
佳 作 B8 音課程查詢系統
佳 作 B9 機器學習於訂單簿投資策略之應用與回測
C組-手機與網頁應用軟體組
第1名 C8 政府施政輿情分析
第2名 C12 基於人工智慧之餐飲選址
第3名 C5 自動家具配置
佳 作 C7 高爾夫球評分系統
佳 作 C3 蜜蜜瓜記帳
佳 作 C14 英語學習評分系統
資訊週

Outline

Research Interests

- ALGORITHMS
- MACHINE LEARNING THEORY
- ALGORITHMIC GAME THEORY
- QUANTITATIVE FINANCE
- DATA SCIENCE

Recent Research Partners

呂及人老師
Chi-Jen Lu

- 中研院資訊所研究員
- 合作方向：機器學習、賽局理論

陳柏安老師
Po-An Chen

- 陽明交通大學資管所副教授
- 合作方向：機器學習、賽局理論

洪智傑老師
Chih-Chieh Hung

- 中興大學資管系副教授
- 合作方向：市場趨勢、資料科學

賀豪 (Ho Ho)

- Chief Risk Officer @Polymer Capital Management
- 合作方向: Data, Talent Recruitment

Projects

- ⋆ Game Theoretical Aspects in Modeling and Analyzing Party Election Campaign (國科會計畫兩年期).
  - NSTC 110-2222-E-032-002-MY2. April 2021–March 2023.
- ⋆ A Study on Group Competition Game of Real-Policy Making Based on Equilibria Existence and Gradient Algorithms (國科會計畫三年期—申請中).

Research Progress (2021–Present)

*corresponding author

Journal articles:

1. Abdoul, Savadogo, Lin, Hung*, Chen, Liu & Liu: A study on constructing an elderly abuse detection system by convolutional neural networks. *J. Chin. Inst. Eng.* 2023.
2. Hung, Lin, Wu* & Lin: A study on reversible data hiding technique based on three-dimensional prediction-error histogram modification and a multilayer perceptron. *Applied Sciences*, 2022.
3. Lin*, Lu & Chen: How good is a two-party election game? *Theoret. Comput. Sci.*, 2021.

Conference articles:

1. Wang, Lu, Ko, Chen*, Lin: Budget-Constrained Cost-Covering Job Assignment for a Total Contribution-Maximizing Platform. IWOCA 2023.
2. Chen*, Lu, Lin* & Fu: Multiagent Learning for Competitive Opinion Optimization. ICS 2022,
3. Lin, Lin, Hung & Chen*: On the Identifiability of Artificial Financial Time Series Data (人造金融時間序列的可檢測性). TAAI 2022.
4. Chen*, Chen, Lu & Lin: Profitable prediction market making. AAAC 2021.

Outline

Professional Services

Academic:

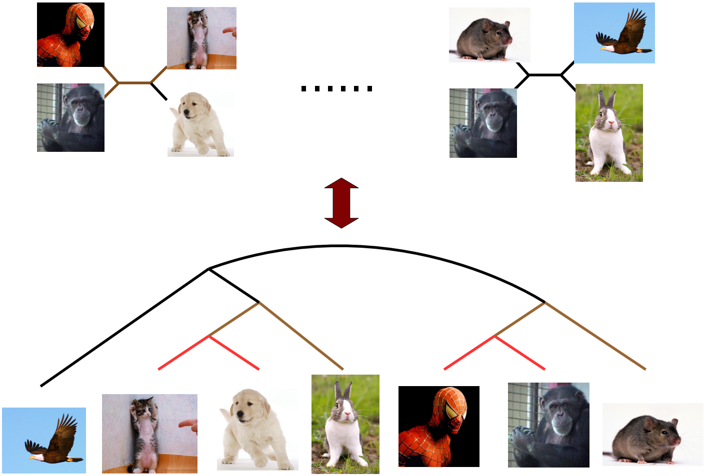
- PC Member of CMCT 2023, ICS 2022, NCS 2021.
- Program Chair (Domestic Track) of TAAI 2022.
- AMS Math Reviews/MathSciNet Reviewer (since Sep. 2021).
- Invited Speaker of 2021 Summer School on Operations Research & Applications.

Others:

- UQ × TKU CSIE Master Dual Degree RPL Administrator.
- 華僑高中、幼華高中模擬面試委員
- 計算機程式語言循環式教學社群主領教師
- 協助系上 IEET 工程教育認證報告書
- 大學與碩士班申請入學書審與面試委員

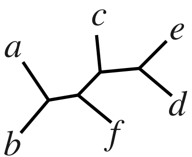
Outline

Evolutionary trees & quartets



A set Q of quartet topologies over $\{a, b, c, d, e, f\}$:

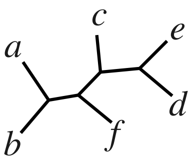
$$
\begin{array}{lll}
[ac \mid bd], & [ab \mid ce], & [ab \mid cf], \\
[ab \mid de], & [ab \mid df], & [ab \mid ef], \\
[ac \mid de], & [af \mid cd], & [af \mid ce], \\
[af \mid de], & [bd \mid ce], & [bf \mid cd], \\
[bf \mid ce], & [bf \mid de], & [cf \mid de].
\end{array}
$$



T

A set Q of quartet topologies over $\{a, b, c, d, e, f\}$:

$$\begin{array}{lll}
{\color{red}[ac \mid bd]}, & [ab \mid ce], & [ab \mid cf], \\
[ab \mid de], & [ab \mid df], & [ab \mid ef], \\
[ac \mid de], & [af \mid cd], & [af \mid ce], \\
[af \mid de], & {\color{red}[bd \mid ce]}, & [bf \mid cd], \\
[bf \mid ce], & [bf \mid de], & [cf \mid de].
\end{array}$$

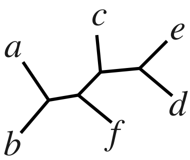


T

Quartet errors w.r.t. T.

A set Q of quartet topologies over $\{a, b, c, d, e, f\}$:

$[ac \mid bd]$, $[ab \mid ce]$, $[ab \mid cf]$,
$[ab \mid de]$, $[ab \mid df]$, $[ab \mid ef]$,
$[ac \mid de]$, $[af \mid cd]$, $[af \mid ce]$,
$[af \mid de]$, $[bd \mid ce]$, $[bf \mid cd]$,
$[bf \mid ce]$, $[bf \mid de]$, $[cf \mid de]$.



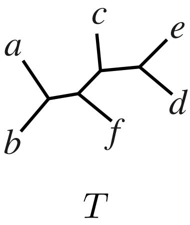
T

Quartet errors w.r.t. T.

- Determine if Q has 0 quartet error: NP-complete [Steel 1992].

A **complete** set Q of quartet topologies over $\{a, b, c, d, e, f\}$:

$$
\begin{array}{lll}
{\color{red}[ac \mid bd]}, & [ab \mid ce], & [ab \mid cf], \\
[ab \mid de], & [ab \mid df], & [ab \mid ef], \\
[ac \mid de], & [af \mid cd], & [af \mid ce], \\
[af \mid de], & {\color{red}[bd \mid ce]}, & [bf \mid cd], \\
[bf \mid ce], & [bf \mid de], & [cf \mid de].
\end{array}
$$

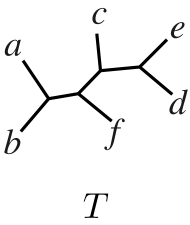


Quartet errors w.r.t. T.

- Determine if Q has 0 quartet error: $O(n^4)$ [Erdős *et al.* 1999].

A **complete** set Q of quartet topologies over $\{a, b, c, d, e, f\}$:

$$
\begin{array}{lll}
[ac \mid bd], & [ab \mid ce], & [ab \mid cf], \\
[ab \mid de], & [ab \mid df], & [ab \mid ef], \\
[ac \mid de], & [af \mid cd], & [af \mid ce], \\
[af \mid de], & [bd \mid ce], & [bf \mid cd], \\
[bf \mid ce], & [bf \mid de], & [cf \mid de].
\end{array}
$$



Quartet errors w.r.t. T.

- Determine if Q has 0 quartet error: $O(n^4)$ [Erdős *et al.* 1999].
- Compute # quartet errors of Q: NP-hard [Berry *et al.* 1999];

Contribution: Fixed-parameter algorithms for MQI

- MQI: minimum quartet inconsistency

The parameterized MQI problem

Input: A complete set Q of quartet topologies, $k \in \mathbb{Z}^+$.

Task: Determine if Q has $\leq k$ quartet errors.

Contribution: Fixed-parameter algorithms for MQI

- MQI: minimum quartet inconsistency

The parameterized MQI problem

Input: A complete set Q of quartet topologies, $k \in \mathbb{Z}^+$.

Task: Determine if Q has $\leq k$ quartet errors.

- Previous results:
  - $\star$ $O(4^k n + n^4)$ [Gramm & Niedermeier 2003].

Contribution: Fixed-parameter algorithms for MQI

- MQI: minimum quartet inconsistency

The parameterized MQI problem

Input: A complete set Q of quartet topologies, $k \in \mathbb{Z}^+$.

Task: Determine if Q has $\leq k$ quartet errors.

- Previous results:
  - ⋆ $O(4^k n + n^4)$ [Gramm & Niedermeier 2003].
- Our results:
  - $O(3.0446^k n + n^4)$, $O(2.0162^k n^3 + n^5)$, $O^*((1+\varepsilon)^k)$.
    - $O^*((1+\varepsilon)^k)$: $\varepsilon \downarrow$, the polynomial factor $\uparrow$.
    - ⋆ Chang, Lin, & Rossmanith: *Theory Comput. Syst.*, 2010.

Contribution: Testing tree-consistency of quartet topologies

The property: tree-consistent

- Q is tree-consistent: 0 quartet errors.

Testing tree-consistency of a complete Q

Input: A **complete** set Q of quartet topologies, $0 < \epsilon < 1$.

Task: Testing if Q is tree-consistent or ϵ-far from this.

- Determine if a complete Q is tree-consistent: $O(n^4)$ [Erdős *et al.* 1999].

Contribution: Testing tree-consistency of quartet topologies

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- Q is tree-consistent: 0 quartet errors.

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Task: Testing if Q is tree-consistent or ϵ-far from this.

- Determine if a complete Q is tree-consistent: $O(n^4)$ [Erdős *et al.* 1999].

Our result:

- An $O(n^3/\epsilon)$ property tester (1-sided error & non-adaptive).
  - ⋆ Chang, Lin, & Rossmanith: *Theory Comput. Syst.*. 2011.

Contribution: Parameterized property testing for tree-consistency

Missing quartets: quartets whose topologies are *missing*.

- T_{miss}: a set of k missing quartets.

Testing tree-consistency with k missing quartets

Input: A set Q of quartet topologies, a set T_{miss} of k missing quartets, $0 < \epsilon < 1$.

Task: Testing if Q is tree-consistent or ϵ-far from this.

- Determine if Q is tree-consistent: NP-complete [Steel 1992].

Contribution: Parameterized property testing for tree-consistency

Missing quartets: quartets whose topologies are *missing*.

- T_{miss}: a set of k missing quartets.

Testing tree-consistency with k missing quartets

Input: A set Q of quartet topologies, a set T_{miss} of k missing quartets, $0 < \epsilon < 1$.

Task: Testing if Q is tree-consistent or ϵ-far from this.

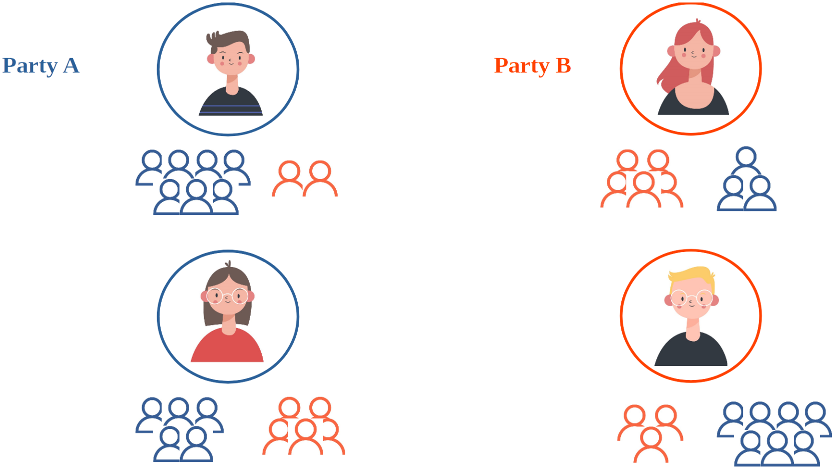
- Determine if Q is tree-consistent: NP-complete [Steel 1992].

  Our results:

  - An $O(1.7321^k kn^3/\epsilon)$ property tester (1-sided error, non-adaptive & uniform) with $O(kn^3/\epsilon)$ queries.
    - ⋆ Chang, Lin, Rossmanith: *Inform. Process. Lett.*, 2013.

Outline

Two-Party Election Game


Party A
Party B

Two-Party Election Game: Formal Setting

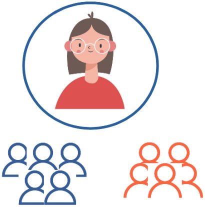
- Party A: m candidates, party B: n candidates.
- Candidate A_i can bring social utility $u(A_i) = u_A(A_i) + u_B(A_i) \in [0, \beta]$ for some real $\beta \geq 1$.
- $p_{i,j}$: $\Pr[A_i \text{ wins over } B_j]$.
  - Linear link: $p_{i,j} := (1 + (u(A_i) - u(B_j))/\beta)/2$
  - Naïve: $p_{i,j} := u(A_i)/(u(A_i) + u(B_j))$
  - Softmax: $p_{i,j} := e^{u(A_i)/\beta}/(e^{u(A_i)/\beta} + e^{u(B_j)/\beta})$
- Reward $r_A = p_{i,j}u_A(A_i) + (1 - p_{i,j})u_A(B_j)$.

Party A

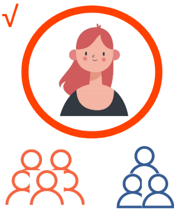
Winning prob.=0.55

Expected utility for A:
0.55*7+0.45*3 = 5.2

$u(A_1) = 7 + 2 = 9$



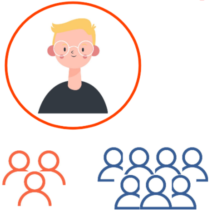
Party B

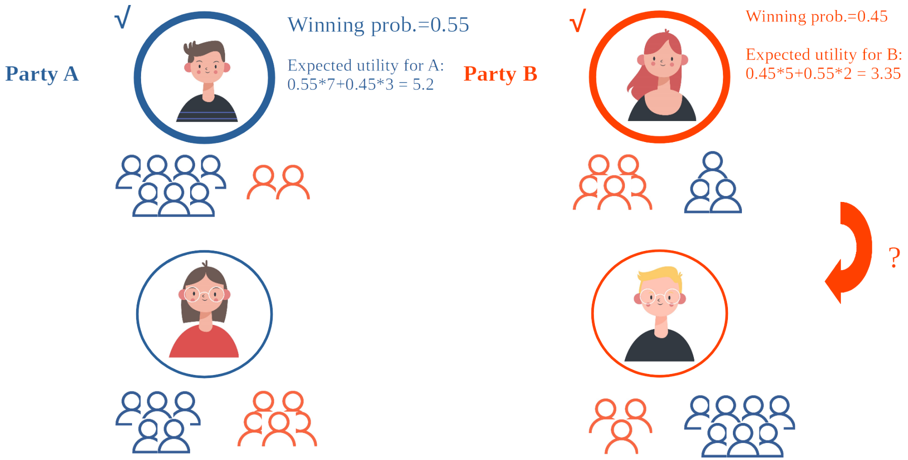


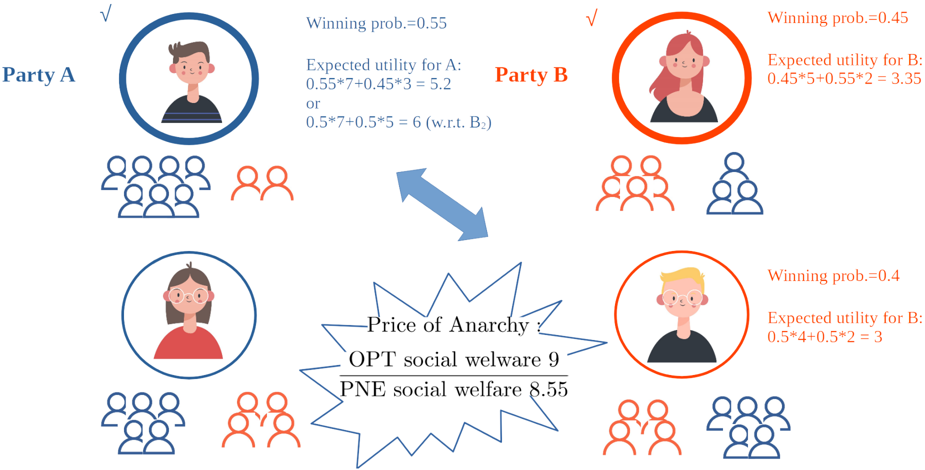
Winning prob.=0.45

Expected utility for B:
0.45*5+0.55*2 = 3.35

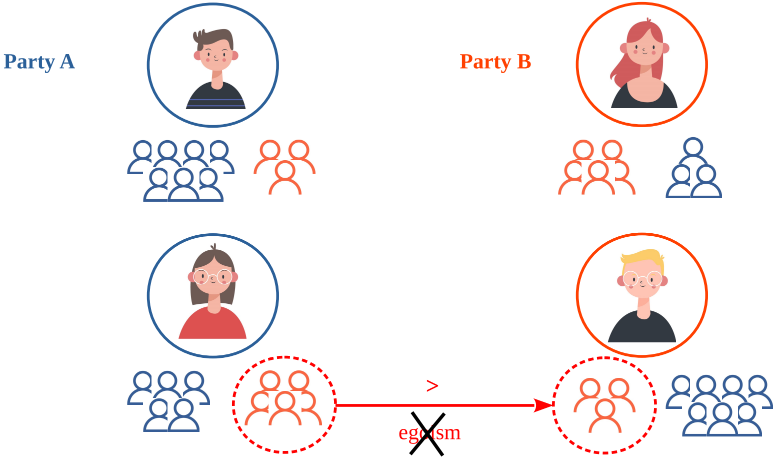
$u(B_1) = 5 + 3 = 8$




√
Party A
Winning prob.=0.55
Expected utility for A:
0.55*7+0.45*3 = 5.2
Party B
√
Winning prob.=0.45
Expected utility for B:
0.45*5+0.55*2 = 3.35
?


√
Party A
Winning prob.=0.55
Expected utility for A:
0.55*7+0.45*3 = 5.2
or
0.5*7+0.5*5 = 6 (w.r.t. B_2)
√
Party B
Winning prob.=0.45
Expected utility for B:
0.45*5+0.55*2 = 3.35
Price of Anarchy : $\frac{\text{OPT social welware 9}}{\text{PNE social welfare 8.55}}$
Winning prob.=0.4
Expected utility for B:
0.5*4+0.5*2 = 3

Egoism (Selfishness)



Results (Two-Party)

	Linear Link	Naïve	Softmax
PNE w/ egoism	$\checkmark$	$\times$	$\checkmark$
PNE w/o egoism	$\times$	$\times$	$?^{\#}$
Worst PoA w/ egoism	$\leq 2^*$	≤ 2	$\leq 1 + e$
Worst PoA w/o egoism	∞	∞	∞

- Lin, Lu, Chen: *Theoret. Comput. Sci.*, 2021.

How about the Game for Two-or-More Parties?

Example: Three-Party Election Game

- Party A, B, C: with m_1, m_2, m_3 candidates, resp.
- E.g., candidate A_i can bring social utility $u(A_i) = u_A(A_i) + u_B(A_i) + u_C(A_i) \in [0, \beta]$ for some real $\beta \geq 1$.
- $p_{i,(j,k)}$: $\Pr[A_i$ wins over B_j and $C_k]$.
  - Naïve: $p^A_{i,(j,k)} := u(A_i)/(u(A_i) + u(B_j) + u(C_k))$
  - Softmax: $p^A_{i,(j,k)} := e^{u(A_i)/\beta}/(e^{u(A_i)/\beta} + e^{u(B_j)/\beta} + e^{u(C_k)/\beta})$
- Reward $r_A = p^A_{i,(j,k)} u_A(A_i) + p^B_{j,(i,k)} u_A(B_j) + p^C_{k,(i,j)} u_A(C_k)$.

k-Party Election Game, $k \geq 2$

- Party $A, B, C, \ldots$: with $m_1, m_2, m_3, \ldots$ candidates, resp.
- E.g., candidate A_i can bring social utility $u(A_i) = u_A(A_i) + u_B(A_i) + u_C(A_i) + \ldots \in [0, \beta]$ for some real $\beta \geq 1$.
- $p^A_{i,(j,k,\ldots)}$: $\Pr[A_i$ wins over the other candidates$]$.
  - Consider all monotone winning probability functions.
    - E.g., $p^A_{i,(-i)} \geq p^A_{i',(-i)}$ whenever $u(A_i) \geq u(A_{i'})$.
- Reward $r_A = p^A_{i,(j,k)} u_A(A_i) + p^B_{j,(i,k)} u_A(B_j) + p^C_{k,(i,j)} u_A(C_k) + \cdots$

Recent Breakthrough (submitted to COMSOC 2023)

https://arxiv.org/abs/2303.14405

Bad News

Three-party election games do not always have a PNE, even it is egoistic.

Theorem

For any k-party election game, $k \geq 2$, we have PoA $\leq k$ if

- The winning probability function is monotone.
- The game is egoistic.

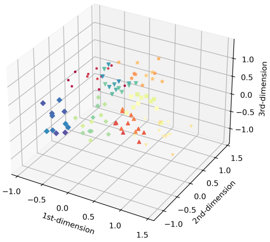
Theorem

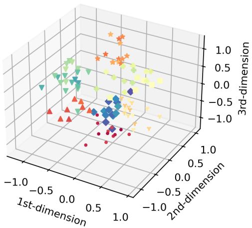
To compute a PNE of the egoistic k-party election game is FPT (+natural parameters).

Outline

Group Formation

- By the group joining strategy:

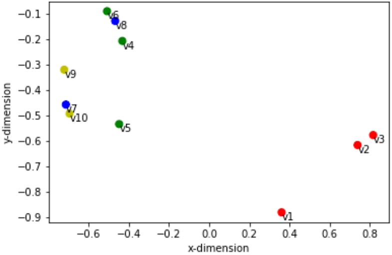


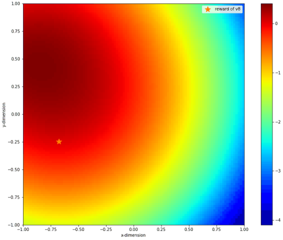


Group Formation

- Multiagent Online Gradient Ascent + Regularization

$$r_i(\tau_t) = \sum_{j=1}^{m} p_j(\tau_t)\langle s_i, \bar{g}_j\rangle - \|z_i - s_i\|_2^2.$$





- τ_t: state at time t; p_j: win. prob. of group j;
- z_i, s_i: opinion and belief of agent i respectively; $\bar{g}_j$: avg. opinion of group j.

Group Formation (IEEE CIM - AI-eXplained (submitted))

Group Formation by Group Joining and Opinion Updates via Multi-Agent Online Gradient Ascent

An interactive article on illustrating group joinging strategies and opinion updates via online gradient ascent to analyze group formation dynamics. Learn how the choices of coaltion of agents lead to a pure-strategy Nash equilibrium and how updating agents' opinions eventually stablizes group formation.

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Published

XXX. X, 2023

Indicates interactive elements

Contents:

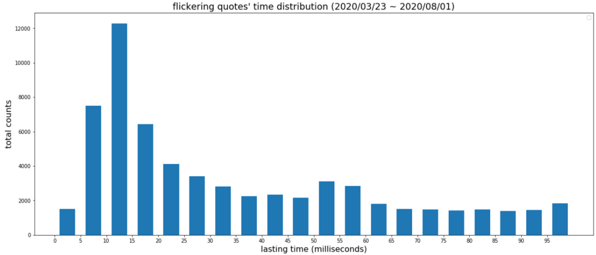
Mottos

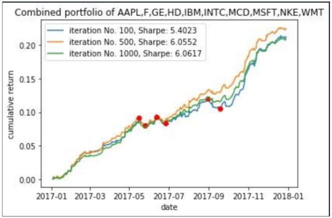
“Think hard, and work smartly.” – R. C. T. Lee & Maw-Shang Chang

“Every job is a self-portrait of the person who did it. Autograph your work with quality.” - Prof. D. T. Lee

Thank you for your time and attention.

Example Projects in HFs





$$\text{Sharpe Ratio} = \frac{\bar{r} - \tilde{r}}{\sigma} \cdot \sqrt{250}$$

$\bar{r}$: average daily return of our strategy

$\tilde{r}$: average daily return of US Treasury

σ : std of daily returns of our strategy