

Xingran Chen

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Research Fields

Research Interests: My research interests are in the modeling, analysis, and decision making of networked systems, with focus on the intersection of Information Theory and Networking (e.g., the Internet of Things, information networks, communication networks).

Methodologies: Information and Coding Theory, Learning Theory, Optimization, Game Theory, and Control Theory.

Education

Ph.D. in Information and Decision Systems	2018 - present
University of Pennsylvania	Philadelphia, PA
Department of Electrical and Systems Engineering	GPA: 3.94/4.0
<i>Advisor: Shirin Saeedi Bidokhti</i>	

M.A. in Applied Mathematics and Computational Science	2016 - 2018
University of Pennsylvania	Philadelphia, PA
Applied Mathematics and Computational Science Program	GPA: 4.0/4.0
<i>Master Thesis Advisor: Saswati Sarkar</i>	

M.S. in Operations Research	2015 - 2016
Central South University	Changsha, China
School of Mathematics and Statistics	Transfer to Upenn
<i>Advisor: Zhong Wan</i>	

B.S. in Statistics	2011 - 2015
Central South University	Changsha, China
School of Mathematics and Statistics	90.41/100

Research Experience

Tradeoffs between Information Freshness and Rate.....

University of Pennsylvania	Philadelphia, PA, USA
Graduate Researcher	07/2020 - 02/2021

Advisor: Shirin Saeedi Bidokhti

- The interplay between timeliness and rate efficiency was investigated in packet erasure broadcast channels with feedback.
- A scheduling framework was proposed in which coding actions, as opposed to users, are scheduled to attain desired tradeoffs between rate and age of information. This tradeoff was formalized by an upper bound on AoI as a function of the target rate constraints and two lower bounds.
- Simulations results showed that (i) coding can be beneficial in reducing age of information in the regime of moderate arrival rates even without rate constraints and the benefits increases with the number of users, and (ii) age of information increases with both the target rate constraint and the

arrival rate when either is kept fixed, but decreases with them when they are set to be equal.

- One paper has been submitted in 2021 *IEEE ISIT*, the journal version is ready to submit.

Multi-hop Contact Tracing Policies for COVID-19.....

University of Pennsylvania

Philadelphia, PA, USA

Graduate Researcher

07/2020 - 12/2020

Advisor: Saswati Sarkar, Shirin Saeedi Bidokhti

- Our findings obtained through extensive simulations over a diverse set of four contact networks, starting from those obtained from real-world data to synthetic networks show that multi-hop contact tracing has the potential to substantially reduce total number of infections and reduce overall testing load.
- The paper is submitted to *Nature Communications*.

Remote Estimation in Decentralized Random Access Channels.....

University of Pennsylvania

Philadelphia, PA, USA

Graduate Researcher

03/2020 - 07/2020

Advisor: Shirin Saeedi Bidokhti

- Sampling and remote estimation of M independent autoregressive Markov processes over a wireless collision channel. Oblivious and non-oblivious policies were considered.
- Proved that minimizing the expected time-average estimation error, in the class of oblivious policies, is equivalent to minimizing the age of information. The lower and upper bounds on the minimum achievable estimation error were obtained.
- Proposed a (non-oblivious) threshold policy based on the collision feedback and the local information of each node. An accurate approximation was obtained.
- The conference version has been published in 2020 *IEEE ISIT*, the journal version has been accepted by 2021 *IEEE INFOCOM*, the journal version is ready to submit.

Information Freshness in Decentralized Random Access Channels.....

University of Pennsylvania

Philadelphia, PA, USA

Graduate Researcher

05/2019 - 03/2020

Advisor: Shirin Saeedi Bidokhti, Hamed Hassani

- An analytic expression for AoI under stationary randomized policies was provided.
- Proved that the age performance of a (stabilized) slotted ALOHA algorithm is approximately optimal in large number of sources when the sum arrival rate θ is below the infamous critical point $\frac{1}{e}$.
- Proposed two age-based thinning methods (adaptive and stationary) in which transmitters discard packets in order to reach an effective (sum) arrival rate. Proved that our proposed thinning mechanism can reduce age to $1/2C$ for any random access technologies which can achieve the throughput C .
- The conference version has been published in 2020 *IEEE ISIT*, the journal version has been submitted to *IEEE Transactions on Information Theory (TIT)*.

Information Freshness in Broadcast Channels.....

University of Pennsylvania

Philadelphia, PA, USA

Graduate Researcher

09/2018 - 04/2019

Advisor: Shirin Saeedi Bidokhti

- Randomized policies were devised, and explicit conditions were found for symmetric dependent channels under which coded randomized policies strictly outperform the corresponding uncoded policies.
- Deterministic policies with or without other constraints (throughput, transmitting cost and sampling cost) were devised. Coded deterministic policies strictly outperforms uncoded ones when

channel erasure is larger than a threshold, otherwise coded and uncoded deterministic policies reach the same EWSAoI.

- One paper has been published in 2019 *IEEE ITW*.

Non-asymptotic Coded Slotted Aloha.....

University of Pennsylvania

Philadelphia, PA, USA

Graduate Researcher

02/2018 - 06/2018

Advisor: Hamed Hassani, Shirin Saeedi Bidokhti

- Coded Slotted Aloha (CSA) was considered and its performance was analyzed in the non-asymptotic regime where the frame length and the number of users are finite.
- A density evolution framework was provided to describe the dynamics of decoding, and fundamentally limits were found on the maximum channel load (the number of active users per time slot) that allows reliable communication.
- Scaling laws were established, describing the non-asymptotic relation between the probability error, number of users, and the channel load.
- One paper has been published in 2019 *IEEE International Symposium on Information Theory (ISIT)*, the journal version is ready to submit.

Resource Allocation in Wireless Networks.....

University of Pennsylvania

Philadelphia, PA, USA

Graduate Researcher

04/2017 - 05/2018

Advisor: Saswati Sarkar

- Investigated the incentives of mobile networks (MNOs) for acquiring additional spectrum to offer mobile virtual network operators (MVNOs) and thereby inviting competition for a common pool of end users (EUs).
- Considered a sequential framework and a hybrid of a sequential and a bargaining frameworks in a base case (one MNO and one MVNO) and two generalizations ((i) one MNO, one MVNO and an outside option, (ii) two MNOs and one MVNO).
- The optimal strategies were characterized analytically and numerically: (i) cooperation between MNO and MVNO can enhance the payoffs of both, while increased competition due to the presence of additional MNOs is beneficial to EUs but reduces the payoffs of the service providers; (ii) whether and by how much the different entities benefit due to the cooperation in spectrum acquisition decision is evaluated.
- Two papers have been published in *IEEE Transactions on Network Science and Engineering (TNSE)*.

Online-Offline Supply Chain Management.....

Central South University

Changsha, China

Graduate Researcher

09/2015 - 02/2016

Advisor: Zhong Wan

- Optimal strategies for Online-Offline retailing under BOPS (buy-on-line, pick-up-in-store) mode were proposed by constructing a *Stochastic* Nash equilibrium model.
- One paper has been published in *ANZIAM Journal*.

Teaching Experience

- **Stochastic Systems Analysis and Simulation**, teaching assistant, undergraduate graduate course, University of Pennsylvania, Electrical and Systems Engineering Department, 2020 Fall.
- **Information Theory**, teaching assistant, graduate course, University of Pennsylvania, Electrical and Systems Engineering Department, 2020 Spring.

Publications

corresponding author: *

contributed equally: †

Preprints

- [P6] **X. Chen***, R. Liu[†], S. Wang[†], and S. Saeedi-Bidokhti, "Timely Broadcasting in Erasure Networks: Age-Rate Tradeoffs," IEEE ISIT, 2021, under review.
- [P5] **X. Chen***, R. Liu[†], S. Wang[†], and S. Saeedi-Bidokhti, "Timely Broadcasting in Erasure Networks: Age-Rate Tradeoffs (Journal Version)," Available Online.
- [P4] J. Kim*, **X. Chen**, S. Saeedi-Bidokhti and S. Sarkar, "Tracing and Testing the COVID-19 Contact Chain: Cost-Benefit Tradeoffs," Available Online. <https://doi.org/10.1101/2020.10.01.20205047>
- [P3] **X. Chen***, X. Liao and S. Saeedi-Bidokhti, "Real-time Sampling and Estimation on Random Access Channels: Age of Information and Beyond (Journal Version)," Available Online. [arXiv: 2007.03652]
- [P2] **X. Chen***, K. Gatsis, H. Hassani, and S. Saeedi-Bidokhti. Age of Information in Random Access Channels (Journal Version). *IEEE Transactions on Information Theory (TIT)*, under review. [arXiv: 1912.01473]
- [P1] M. Fereydounian*, **X. Chen**, H. Hassani, and S. Saeedi-Bidokhti. Non-asymptotic coded slotted ALOHA (Journal Version). Available Online, www.seas.upenn.edu/mferey/ms.pdf

Journal Articles

- [J3] **X. Chen***, S. Sarkar, M. H. Lotfi. The Interplay of Competition and Cooperation among Service Providers (Part II). *IEEE Transactions on Network Science and Engineering (TNSE)*, In Press.
- [J2] **X. Chen***, S. Sarkar, and M. H. Lotfi. The Interplay of Competition and Cooperation among Service Providers (Part I). *IEEE Transactions on Network Science and Engineering (TNSE)*, In Press.
- [J1] **X. Chen**, Y. Liu, and Z. Wan*. Optimal Decision Making for Online and Offline Retailers under BPOS Mode. *ANZIAM Journal*, 58:187-208,2016

Conference Papers

- [C4] **X. Chen**, X. Liao and S. Saeedi-Bidokhti, "Real-time Sampling and Estimation on Random Access Channels: Age of Information and Beyond," IEEE INFOCOM, May, 2021. [Acceptance rate 19.9%].
- [C3] **X. Chen**, K. Gatsis, H. Hassani, and S. Saeedi-Bidokhti. Age of Information in Random Access Channels. *2020 IEEE International Symposium on Information Theory (ISIT)*, June, 2020
- [C2] **X. Chen** and S. Saeedi-Bidokhti. Benefits of Coding on Age of Information in Broadcast Networks. *2019 IEEE Information Theory Workshop (ITW)*, August, 2019
- [C1] M. Fereydounian, **X. Chen**, H. Hassani, and S. Saeedi-Bidokhti. Non-asymptotic coded slotted ALOHA. *2019 IEEE International Symposium on Information Theory (ISIT)*, July, 2019

Technical Report

- [TR1] **X. Chen**, S. Sarkar, and M. H. Lotfi. Supplementary Material for the Paper "The Interplay of Competition and Cooperation among Service Providers (Part I)". *Technical Report*, [arXiv: 1905.13423]

Thesis

- [Th1] **X. Chen**. Competition and Cooperation between Service Providers. *Master's Thesis*, University of Pennsylvania, 2018.

Talks & Posters

Talks.....

- [06/2020]: "Age of Information in Random Access Channels", 2020 IEEE International Symposium on Information Theory (ISIT), virtual conference (due to COVID-19).
- [07/2019]: "Non-asymptotic coded slotted aloha", 2019 IEEE International Symposium on Information Theory (ISIT), Paris, France.
- [08/2019]: "Benefits of coding on age of information in broadcast networks", Southwest University, Chongqing, China.
- [12/2015]: "Optimal Decision Making for Online and Offline Retailers under BOPS Mode", The 6th International Conference on Optimization and Control with Applications, Changsha, China.

Posters.....

- [08/2019]: "Benefits of coding on age of information in broadcast networks", 2019 IEEE Information Theory Workshop, Visby, Sweden.
- [07/2019]: "Benefits of coding on age of information in broadcast networks", 2019 IEEE International Symposium on Information Theory (ISIT), Paris, France.
- [07/2019]: "Benefits of coding on age of information in broadcast networks", 2019 North American School of Information Theory (NASIT), Boston, USA.

Awards and Achievements

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|--------------------------------------------------------------------------------------|----------------|
| o IEEE INFOCOM Student Conference Award | 2021 |
| o IEEE ISIT Student Travel Grant | 2019 |
| o The Dean's Fellowship (University of Pennsylvania) | 2018 - present |
| o Ganster Engineering Fellowship (University of Pennsylvania) | 2018 |
| o National Scholarship of China (Graduate Student) | 2016 |
| o First Prize of the 12th Graduate Students' Mathematical Modeling Contest in China | 2015 |
| o Student Representative at the 2015 Graduation Ceremony of Central South University | 2015 |
| o Outstanding Graduates of Hu'nan Province (Top 1% in Hu'nan Province) | 2015 |
| o Meritorious Winner of Mathematical Contest In Modeling (MCM) | 2015 |
| o National Scholarship of China (Undergraduate Student) | 2014 |

Paper Review

Reviewer for Journals.....

- o IEEE/ACM Transactions on Networking (ToN)
- o IEEE Journal on Selected Areas in Communications (JSAC)
- o IEEE Transactions on Wireless Communications (TWC)
- o IEEE Internet of Things Journal (IoT-J)
- o IEEE Wireless Communications Letters
- o ANZIAM Journal
- o Journal of Industrial and Management Optimization (JIMO)

Reviewer for Conferences.....

- o 2021 IEEE ICC
- o 2020 IEEE GLOBECOM Workshop
- o 2020 IEEE ISIT
- o The 3rd Age of Information Workshop (AoI'20)
- o The Joint Optimization Conferences 2017 (JOC 2017)

Selected Courses

- **Mathematics:** Complex Analysis, Real Analysis, Functional Analysis, Topology, Advanced Algebra, Advanced Probability, Stochastic Process.
- **Engineering Mathematics:** Machine Learning, Convex Optimization, Linear Systems, Information Theory, Finite Element Analysis.
- **Statistics:** Mathematical Statistics, Regression Analysis, Multivariable Statistical Analysis, Time Series Analysis, Sampling Survey.
- **Economics & Finance:** Macro Micro Economics, Econometrics, Monetary Finance, Financial Management.