**Women in Theory**

**1. Introduction**

The 3rd Women in Theory (WiT) workshop was held from 22-25 June 2016, at the Simons Institute at the University of California, Berkeley. The workshop brings together women studying theoretical computer science in PhD programs around the world, as well as leading female researchers in the field.

Below is an overview of each day’s proceedings:

* 22nd June
  + Introductions and Icebreakers
* 23rd June
  + Invited Speaker: Anna Karlin (University of Washington)
  + Invited Speaker: Leanne Meyer (CMU Heinz College)
  + Invited Speaker: Elette Boyle (IDC)
  + Invited Speaker: Virginia Vassileyska Williams (Stanford University)
  + Student “rump sessions”
* 24th June
  + Invited Speaker: Edith Cohen (Tel Aviv University/ Google Research)
  + Invited Speaker: Mor Harchol-Balter (Carnegie Mellon University)
  + Invited Speaker: Dahlia Malkhi (VMWare)
  + Invited Speaker: Cynthia Dwork (Microsoft Research)
  + Panel
* 25th June
  + Invited Speaker: Mary Wootters (Carnegie Mellon University)
  + Visit to Google
  + Google Talks:
    - Liadan O’Callaghan
    - Maya Gupta
    - Gagan Aggarwal
    - Anelia Angelova

For the purposes of this conference report, since none of the work done was specific to particular papers, I will briefly overview the content of each talk and it’s exciting results. In the bibliography, I will include links to the various researchers’ webpages, where their work can be found.

Also, as the purpose of this report is much more technical than it is social (i.e. about the state of women representation in Computer Science), the various descriptions of the talks will differ greatly in brevity. I will also dwell longer on talks/ discussions that have relevance to work in DSO, since theoretical computer science is a very broad field, with not all work having salience to cryptography, or military research in general.

**2. Review of Invited Talks**

Below, I present the talks in the order that it was presented at the conference. In particular, I will replicate the abstract that the speaker submitted of their talk, then, as necessary, I will clarify the abstract by giving relevant background, highlighting interesting results, and (if applicable) the relevance of this work to DSO.

2.1 Anna Karlin – “*Two Pricing Problems*”

*Abstract (Written by Speaker)*

In the first part of the talk, I’ll describe work with Chawla, Devanur and Sivan on a pricing problem where a buyer is interested in purchasing/using a good, such as an app or music or software, repeatedly over time. A common assumption in auction theory and mechanism design is that a consumer knows how much he values an item at the moment he is considering a purchase and that he has an accurate prior over how much he will value that item in the future (if not precise knowledge). In this work, we explore scenarios where the consumer discovers his valuation for a good as he uses it, and his value per usage evolves as a martingale. We show how to construct simple pricing mechanisms that yield approximately optimal seller revenue regardless of the buyer’s risk profile. In the second part of the talk, I’ll describe results with Fiat, Goldner and Koutsoupias on how to maximize auctioneer revenue when he is selling a service for which buyers have both a value and a deadline. In this setting, we show how to use linear programming duality to design the optimal auction.

*Discussion*

2.2 Leanne Meyer – “*The Art of Asking for It! Negotiation Strategies for Women*”

*Abstract (Written by Speaker)*

Do you ask for what you want or are you waiting to be offered the opportunity that will advance your career and/or compensation? Learn how to better navigate the barriers we know women face as they negotiate on behalf of their teams, the organization, and themselves. During this presentation, Carnegie Mellon Leadership and Negotiation Academy Program Director, Leanne Meyer, will help participants recognize opportunities to negotiate, eliminate anxiety, feel entitled to get what they want and avoid social consequences that inhibit good outcomes for you and your organization.

*Discussion*

2.3 Elette Boyle – “*Oblivious RAM*”

*Abstract (Written by Speaker)*

An Oblivious RAM (ORAM), introduced by Goldreich and Ostrovsky (JACM 1996), is a (probabilistic) RAM that hides its access pattern: i.e, for every input the memory locations accessed are similarly distributed. Since their inception, ORAMs have become an invaluable tool in designing cryptographic systems, where observable memory access patterns crucially must not leak sensitive information. We present a survey of cryptographic ORAM research, from the original constructions to the most recent discoveries, and the mysteries that lie ahead.

*Discussion*

2.4 Virginia Vassilevska Williams – “*A Fine-Grain Approach to Algorithms and Complexity*”

*Abstract (Written by Speaker)*

A central goal of algorithmic research is to determine how fast computational problems can be solved in the worst case. Theorems from complexity theory state that there are problems that, on inputs of size n, can be solved in *t(n)* time but not in *t(n)*1-ε time for ε>0. The main challenge is to determine where in this hierarchy various natural and important problems lie. Throughout the years, many ingenious algorithmic techniques have been developed and applied to obtain blazingly fast algorithms for many problems. Nevertheless, for many other central problems, the best known running times are essentially those of the classical algorithms devised for them in the 1950s and 1960s.

Unconditional lower bounds seem very difficult to obtain, and so practically all known time lower bounds are conditional. For years, the main tool for proving hardness of computational problems have been NP-hardness reductions, basing hardness on P≠NP. However, when we care about the exact running time (as opposed to merely polynomial vs non-polynomial), NP-hardness is not applicable, especially if the running time is already polynomial. In recent years, a new theory has been developed, based on “fine-grained reductions” that focus on exact running times. The goal of these reductions is as follows. Suppose problem A is solvable in *a(n)* time and problem B in *b(n)* time, and no *a(n)*1-ε and *b(n)*1-ε algorithms are known for A and B respectively (for constant ε>0). Then, if A is fine-grained reducible to problem B (for *a(n)* and *b(n)*), a *b(n)*1-ε time algorithm for B (for any ε>0) implies an *a(n)*1-ε’ algorithm for A (for some ε’>0). Now, mimicking NP-hardness, the approach is to (1) select a key problem X that is conjectured to require *t(n)*1-o(1) time for some t, and (2) reduce X in a fine-grained way to many important problems. This approach has led to the discovery of many meaningful relationships between problems, and even sometimes to equivalence classes. In this talk I will give an overview or the current progress in this area of study, and will highlight some new exciting developments.

*Discussion*

2.5 Edith Cohen – “*Weighted Sampling for Scalable Analytics of Large Data Sets*”

*Abstract (Written by Speaker)*

Random sampling is a classic statistical tool that is used to summarize and perform analytics on data that is too large to store or scalably process. Suppose that our dataset consists of keys (cookies, users, queries) with numeric positive weights. We want to estimate the sum of some function f of the weights over keys in a specified segment; we call such a sum an f-statistic. For example, the number of users from a certain zipcode can be expressed in this way. Weighted sampling can be applied to estimate such f-statistics. Very common statistics are the number of active keys in the segment, the sum of their weights, and capped sums, where weights are capped by a parameter. Classic sampling schemes achieve optimal tradeoffs of sample size and estimation quality for a particular $f$-statistics, roughly, by including keys with probability proportional to $f$ applied to their weight. This talk will focus on extensions of this classic tool to two important regimes. The first, multi-objective sampling schemes, obtain optimal samples that provide estimates with specified statistical guarantees for a set of functions. We will also show that the sample-size overhead (with respect to the optimum sample for a particular f) is surprisingly small for important classes of functions. The second addresses scalability on streamed or distributed data with unaggregated presentation: Each key has multiple elements and its weight is the sum of these element weights, but we are interested in sampling without costly aggregation. We will present a simple sampling framework with novel estimators, which in particular, provided the first solution to capping statistics, used in online advertising.

*Discussion*

2.6 Mor Harchol-Balter – “*Smarter Task Assignment for Server Farms via Replication*”

*Abstract (Written by Speaker)*

Every time you go to the check-out counter in a supermarket, you have a decision to make: which queue do you join? Do you pick the queue with the fewest customers, the one with the least total number of items, pick a random queue, or do something entirely different? This question of picking the right queue so as to minimize mean response time is known as the “task assignment problem” and is a very old and classic problem in the performance modeling community. In this talk we examine task assignment in a new light, where there is server-side variability in addition to job-size variability. We ask how replication of jobs (sending a job to multiple queues) can help reduce response time in light of these two types of variability. We present several new results on the performance analysis of server farms under replication, including power-of-d replication and Join-Idle-Queue replication. Bottom Line: By the end of this talk, you will have a much better sense of what you should do at the supermarket.

*Discussion*

2.7 Dahlia Malkhi – “*Reliable Distributed Systems Foundations in Practice*”

*Abstract (Written by Speaker)*

Distributed systems are difficult to build, algorithms are subtle and bug-prone, and performance is often at odds with consistency. It is therefore crucial to have solid algorithmic foundations that are succinct and simple to follow. This talk examines how some of the most well known foundations in distributed computing evolved through the drive of practical impact. For example, the past decade exposed interesting anomalies in fundamental replication schemes such as Paxos. It saw the emergence of a new algorithm called Vertical Paxos for managing dynamic systems, that bridges between the Paxos theory and engineering practices. Yet, despite increasing insight into distributed systems, there is still a strong deficiency in the set of tools available for building scale-out data platforms. State-of-the-art tools for scaling systems, for example NOSQL systems, typically partition state to achieve scalability. With such systems, obtaining a consistent view of global state often requires complicated and expensive distributed protocols. This led a team of researchers at Microsoft to design a new method, called Corfu, that provides high-throughput scale-out replication with strong consistency guarantees. Corfu spreads updates over a large cluster, each replicated over a small group of nodes. All groups are “stitched” into a global log using a soft-state sequencer, which is neither an IO bottleneck, nor a single point of failures. Fast forward to today, we describe how Corfu is being used by a team of researchers at VMware Research to build a distributed control plane for VMware’s software defined networking (SDN) technology.

*Discussion*

2.8 Cynthia Dwork – “*Theory for Society*”

*Abstract (Written by Speaker)*

As technology reaches increasingly deeply into our everyday lives, changing the fabric of society woven by our interactions – with one another, with government, with the corporate world – design decisions have increasing impact on basic social values such as privacy, fairness, and protection from physical and emotional harm. Complexity of this type requires mathematically rigorous notions that allow us to quantify these goods and their loss, to explore fundamental tradeoffs and limitations, and to lay the theoretical groundwork for what can be achieved. This talk describes efforts of this type in two areas: privacy-preserving data analysis and fairness in classification, and touches on an agenda for future directions.

*Discussion*

2.9 Mary Wootters – “*Locality in Error Correcting Codes*”

*Abstract (Written by Speaker)*

In the traditional set-up for error-correcting codes, a sender (Alice) wants to send a message to a receiver (Bob); the catch is that some errors may get introduced along the way. One solution to their problem is an error-correcting code. Alice will encode her message, introducing some redundancy, and send the resulting codeword to Bob; even if errors are introduced, the extra redundancy will allow Bob to recover the original message. While originally introduced for the purpose of communication, error-correcting codes have found many uses beyond Alice and Bob. One feature of an error-correcting code which has been especially useful is that of \*locality:\* If Bob only wants part of Alice’s message, must he look at the entire codeword? It turns out that, no, he needn’t, and moreover, this fact has been very useful in many application domains, including complexity theory, cryptography, and storage. In this talk, I’ll discuss different notions of locality in coding theory, and their many applications. I’ll also talk about some recent work on one notion of locality—repair bandwidth—which is useful for distributed storage.

*Discussion*

**3. Review of Other Segments of WiT**

3.1 “Rump sessions”

“Rump sessions” were a series of 3-minute presentations by attendees (mostly PhD students) introducing their work. This was for the purpose of networking, so that attendees could both understand the breadth of work being done by the community, and also find likeminded women who work on similar problems. Therefore, my review of this segment encompasses conversations I had with presenters whose work was relevant to work being done in IS.

3.2 Google Talks

While interesting, the Google talks were not extremely relevant in any specific way to work done in IS. This is because the speakers spoke quite directly about their work at Google. Below are the list of topics discussed and a short summary of the talk.

Liadan O’Callaghan – “*Challenges in Search Ad Auctions*”

This work studies algorithms for fair auctions where the auctioned items are tiered in value. Specifically for Google, they want to incentivize advertisers to bid for advertisement slots in a way that truly represents the worth of the slots to them, and stays relevant to the activity of the user (i.e. the advertisement must be somehow related to the user’s search queries, or browser history).

Maya Gupta – “*GlassBox Machine Learning*”

This presentation was about the machine learning techniques used when YouTube “suggests” videos that a user might be interested in, given videos he has watched, or is watching. It models the problem as a multidimensional simplex, and shows that doing this in real-time requires a combination of pre-computation and real-time computation, based on common variables and individual activity, respectively.

Gagan Aggarwal – “*Optimization in Resource Planning*”

This presentation was about how to distribute Google’s computational and other resources among different offices. In one dimension, there are algorithms that can easily optimize this, but the problem becomes NP-complete when resources take on multiple constraints (e.g. requesting a certain number of computing nodes, for a certain number of days, at a particular location). The solution presented involved showing how disallowing certain extreme combinations of resources (e.g. using many resources for a very short amount of time) will simplify the distribution to one that is computationally feasible, while achieving near-optimal resource usage.

Anelia Angelova – “*Applied Deep Learning for Computer Vision*”

This presentation concerns the Machine Learning required to allow the Google Car to avoid pedestrians in real-time. By using a tiered approach to the problem, the researchers are able to allow the car to quickly the location of pedestrians in its cameras, and avoid them, with much higher accuracy than other work. This involves layering progressively more computationally intensive tiers of machine learning upon each other, with each layer evaluating only what the previous layers have not ruled out. In another way, this allows upper layers to perform a more crude analysis and immediately dismiss objects that clearly are not pedestrains (e.g. street lamps), but for the lower layers to study more complex objects with higher computing power (e.g. a person that is in a wheelchair).

*Discussion*

Reflecting on this, we can consider the relevance of Machine Learning in general towards IS and DSO.

**Visit Days at UCSD**

**1. Introduction**

In conjunction with my going to the WiT conference, as well as my graduate school term starting in the fall, HISL approved a trip to the University of California, San Diego (UCSD), where I will be doing my PhD studies in Computer Science, starting in September.

The purpose of this trip was to make up for the fact that I could not leave work to go to the original visit days (planned by UCSD) in March. In addition, I hoped to get a better understanding of the work being done at UCSD before starting my studies there, so that I can reflect upon its relevance to DSO. This also gives me a chance to share this with the lab while I am still in DSO. With this, we can identify if there are opportunities for collaboration, or specific things that I can get informed on while I am there, and bring those capabilities back to IS, after my PhD studies.

**2. Overview of Visit**

Since I organized this visit on my own, I set up meetings with various Professors, post-doctorial students and current graduate students myself. These are the people I was able to meet:

* Assistant Professor Hovav Shaham??
* Professor Daniele Micciancio
* Kirill Levenchenko?? (Post-doctorial scholar)
* Professor Ranjit Jhala
* Professor Mihir Bellare
* Joseph ??, Michael ?? and Igors Stepanovs (Current graduate students)

Therefore, in this report, I will briefly describe my discussions with these people and the applications to DSO, if any.