

Discrete Algorithms Seminar

List of Presentations

Spring 2012

January 27, 2012

Title: “The Complexity of Flood Filling Games”

Authors: Raphael Clifford, Markus Asplenium, Ashley Montanaro, and Benjamin Sach

Journal or Conference: FUN 2010: 307–318

Abstract: We study the complexity of the popular one player combinatorial game known as Flood-It. In this game the player is given an $n \times n$ board of tiles where each tile is allocated one of c colours. The goal is to make the colours of all tiles equal via the shortest possible sequence of flooding operations. In the standard version, a flooding operation consists of the player choosing a colour k , which then changes the colour of all the tiles in the monochromatic region connected to the top left tile to k . After this operation has been performed, neighbouring regions which are already of the chosen colour k will then also become connected, thereby extending the monochromatic region of the board. We show that finding the minimum number of flooding operations is NP-hard for $c \geq 3$ and that this even holds when the player can perform flooding operations from any position on the board. However, we show that this “free” variant is in P for $c = 2$. We also prove that for an unbounded number of colours, Flood-It remains NP-hard for boards of height at least 3, but is in P for boards of height 2. Next we show how a $c - 1$ approximation and a randomised $2c/3$ approximation algorithm can be derived, and that no polynomial time constant factor, independent of c , approximation algorithm exists unless P=NP. We then investigate how many moves are required for the “most demanding” $n \times n$ boards (those requiring the most moves) and show that the number grows as fast as $\Theta(\sqrt{cn})$. Finally, we consider boards where the colours of the tiles are chosen at random and show that for $c \geq 2$, the number of moves required to flood the whole board is $\Omega(n)$ with high probability.

Internet:

<http://arxiv.org/pdf/1001.4420v3.pdf>

Speaker: Valia Mitsou

February 3, 2012

Title: “Mapping an Unfriendly Subway System”

Authors: Paola Flocchini, Matthew Kellett, Peter Mason, and Nicola Santoro

Journal or Conference: FUN 2010: 190–201

Abstract: We consider a class of highly dynamic networks modelled on an urban subway system. We examine the problem of creating a map of such a subway in less than ideal conditions, where the local residents are not enthusiastic about the process and there is a limited ability to communicate amongst the mappers. More precisely, we study the problem of a team of asynchronous computational entities (the mapping agents) determining the location of black holes in a highly dynamic graph, whose edges are defined by the asynchronous movements of mobile entities (the subway carriers). We present and analyze a solution protocol. The algorithm solves the problem with the minimum number of agents possible. We also establish lower bounds on the number of carrier moves in the worst case, showing that our protocol is also move-optimal.

Internet:

<http://people.scs.carleton.ca/~santoro/Reports/Subway.pdf>

Speaker: Feng Yu

Mar 2, 2012

Title: “UNO is Hard, Even for a Single Player”

Authors: Erik D. Demaine, Martin L. Demaine, Ryuhei Uehara, Takeaki Uno, and Yushi Uno

Journal or Conference: FUN 2010: 133–144

Abstract: UNO[®] is one of the world-wide well-known and popular card games. We investigate UNO from the viewpoint of combinatorial algorithmic game theory by giving some simple and concise mathematical models for it. They include cooperative and uncooperative versions of UNO, for example. As a result of analyzing their computational complexities, we prove that even a single-player version of UNO is NP-complete, while it becomes in P in some restricted cases. We also show that uncooperative two-player’s version is PSPACE-complete.

Internet:

http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&ved=OCCMQFjAA&url=http%3A%2F%2Ferikdemaine.org%2Fpapers%2FUno_FUN2010%2Fpaper.ps&ei=C-1JT8fRjtTL8Q075P20Dg&usg=AFQjCNE_Ld9nJIT27bN5wn33CjTKvwRa9A

Speaker: Yosef Alayev

Mar 9, 2012

Title: “Christmas Gift Exchange Games”

Authors: Arpita Ghosh and Mohammad Mahdian

Journal or Conference: FUN 2010: 228–236

Abstract: The Christmas gift exchange is a popular party game played around Christmas. Each participant brings a Christmas present to the party, and a random ordering of the participants, according to which they will choose gifts, is announced. When a participant’s turn comes, she can either open a new gift with unknown value, or steal an already opened gift with known value from someone before her in the ordering; in the second case, the person whose gift was stolen gets to make the same choice. We model the gift exchange as a sequential game of perfect information and characterize its equilibria, showing that each player plays a threshold strategy in the subgame perfect equilibrium of the game. We compute the expected utility of players as a function of the position in the random ordering; the first player’s utility is vanishingly small relative to every other player. We then analyze a different version of the game, also played in practice, where the first player is allowed an extra turn after all presents have been opened – we show that all players have equal utility in the equilibrium of this game.

Internet:

<http://www.mahdian.org/giftexchange.pdf>

Speaker: Peter Terlecky

Mar 16, 2012

Title: “Cracking Bank PINs by Playing Mastermind”

Authors: Riccardo Focardi and Flaminia L. Luccio

Journal or Conference: FUN 2010: 202–213

Abstract: The bank director was pretty upset noticing Joe, the system administrator, spending his spare time playing Mastermind, an old useless game of the 70ies. He had fought the instinct of telling him how to better spend his life, just limiting to look at him in disgust long enough to be certain to be noticed. No wonder when the next day the director fell on his chair astonished while reading, on the newspaper, about a huge digital fraud on the ATMs of his bank, with millions of Euros stolen by a team of hackers all around the world. The article mentioned how the hackers had played with the bank computers just like playing Mastermind, being able to disclose thousands of user PINs during the one-hour lunch break. That precise moment, a second before falling senseless, he understood the subtle smile on Joes face the day before, while training at his preferred game, Mastermind.

Internet:

http://www.dsi.unive.it/~focardi/MM_PIN/FUN10corrected.pdf

Speaker: Ben Baumer

March 23, 2012

Title: “Scheduling with Bully Selfish Jobs”

Authors: Tami Tamir

Journal or Conference: FUN 2010: 355–367

Abstract: In job scheduling with precedence constraints, $i \prec j$ means that job j cannot start being processed before job i is completed. In this paper we consider selfish bully jobs who do not let other jobs start their processing if they are around. Formally, we define the selfish precedence-constraint where $i \prec_s j$ means that j cannot start being processed if i has not started its processing yet. Interestingly, as was detected by a devoted kindergarten teacher whose story is told below, this type of precedence constraints is very different from the traditional one, in a sense that problems that are known to be solvable efficiently become NP-hard and vice-versa. The work of our hero teacher, Ms. Schedule, was initiated due to an arrival of bully jobs to her kindergarten. Bully jobs bypass all other nice jobs, but respect each other. This natural environment corresponds to the case where the selfish precedence-constraints graph is a complete bipartite graph. Ms. Schedule analyzed the minimum makespan and the minimum total flow-time problems for this setting. She then extended her interest to other topologies of the precedence constraints graph and other special instances with uniform length jobs and/or release times.

Internet:

<http://www.faculty.idc.ac.il/tami/papers/fun10.pdf>

Speaker: George Rabanca

March 30, 2012

Title: “Fighting Censorship with Algorithms”

Authors: Mohammad Mahdian

Journal or Conference: FUN 2010: 296–306

Abstract: In countries such as China or Iran where Internet censorship is prevalent, users usually rely on proxies or anonymizers to freely access the web. The obvious difficulty with this approach is that once the address of a proxy or an anonymizer is announced for use to the public, the authorities can easily filter all traffic to that address. This poses a challenge as to how proxy addresses can be announced to users without leaking too much information to the censorship authorities. In this paper, we formulate this question as an interesting algorithmic problem. We study this problem in a static and a dynamic model, and give almost tight bounds on the number of proxy servers required to give access to n people k of whom are adversaries. We will also discuss how trust networks can be used in this context.

Internet:

<http://mahdian.org/censorship.pdf>

Speaker: Kenneth Ezirim

Apr 6, 2012

Title: “Return of the Boss Problem: Competing Online against a Non-adaptive Adversary”

Authors: Magns M. Haldrsson and Hadas Shachnai

Journal or Conference: FUN 2010: 237–248

Abstract: We follow the travails of Enzo the baker, Orsino the oven man, and Beppe the planner. Their situation have a common theme: They know the input, in the form of a sequence of items, and they are not computationally constrained. Their issue is that they dont know in advance the time of reckoning, i.e. when their boss might show up, when they will be measured in terms of their progress on the prefix of the input sequence seen so far. Their goal is therefore to find a particular solution whose size on any prefix of the known input sequence is within best possible performance guarantees.

Internet:

<http://www.cs.technion.ac.il/~hadas/PUB/prefix.pdf>

Speaker: Ou Liu

April 20, 2012

Title: “Die Another Day”

Authors: Rudolf Fleischer

Journal or Conference: FUN 2007: 146–155

Abstract: The Hydra was a many-headed monster from Greek mythology that would immediately replace a head that was cut off by one or two new heads. It was the second task of Hercules to kill this monster. In an abstract sense, a Hydra can be modeled as a tree where the leaves are the heads, and when a head is cut off some subtrees get duplicated. Different Hydra species differ by which subtrees can be duplicated in which multiplicity. Using some deep mathematics, it had been shown that two classes of Hydra species must always die, independent of the order in which heads are cut off. In this paper we identify three properties for a Hydra that are necessary and sufficient to make it immortal or force it to die. We also give a simple combinatorial proof for this classification. Now, if Hercules had known this...

Internet:

http://www.tcs.fudan.edu.cn/rudolf/Paper/hydra_tocs.pdf

Speaker: Simin You

April 27, 2012

Title: “Fun-Sort – or the Chaos of Unordered Binary Search”

Authors: Therese C. Biedl, Timothy M. Chan, Erik D. Demaine, Rudolf Fleischer, Mordecai J. Golin, James A. King, and J. Ian Munro

Journal or Conference: FUN 2004: Discrete Applied Mathematics (DAM) 144(3):231-236 (2004)

Abstract: Usually, binary search only makes sense in sorted arrays. We show that insertion sort based on repeated binary searches in an initially unsorted array also sorts n elements in time $\Theta(n^2 \log n)$. If n is a power of two, then the expected termination point of a binary search in a random permutation of n elements is exactly the cell where the element should be if the array was sorted. We further show that we can sort in expected time $\Theta(n^2 \log n)$ by always picking two random cells and swapping their contents if they are not ordered correctly.

Internet:

<http://www.sciencedirect.com/science/article/pii/S0166218X04001131>

Speaker: Raymond Law

May 4, 2012

Title: “Fun with Sub-linear Time Algorithms”

Authors: Luca Trevisan

Journal or Conference: FUN 2007

Abstract: Provided that one is willing to use randomness and to tolerate an approximate answer, many computational problems admit ultra-fast algorithms that run in less than linear time in the length of the input. In many interesting cases, even algorithms that run in constant time are known, whose efficiency depends only on the accuracy of the approximation and not on the length of the inputs. Algorithms for graph problems on dense graphs are especially efficient and simple. I will describe an algorithm that estimates the size of the maximum cut in a dense graph, and its specialization to the task of distinguishing bipartite dense graphs from dense graphs that are far from bipartite. Results explaining the simplicity of such algorithms will also be discussed. Some sublinear-time algorithms are also known for graph problems in sparse graphs, but they are typically more elaborate. I will describe a simple but very clever algorithm that approximates the number of connected components of a given graph, and its generalization to the problem of approximating the weight of the minimum spanning tree of a given weighted graph. The algorithm runs in time dependent only on the maximum degree, the required quality of approximation, and the range of weights, but the running time is independent of the number of vertices.

Internet:

Speaker: Ivo Vigan

May 11, 2012

Title: “A Hat Trick”

Authors: Oren Ben-Zwi and Guy Wolfovitz

Journal or Conference: FUN 2010: 37–40

Abstract: Consider the following game. There are n players, each wearing a hat colored red or blue. Each player does not see the color of her own hat but does see the colors of all other hats. Simultaneously, each player has to guess the color of her own hat, without communicating with the other players. The players are allowed to meet beforehand, hats-off, in order to coordinate a strategy. We give an explicit polynomial time deterministic strategy which guarantees that the number of correct guesses is at least $\max\{n_r, n_b\} - O(n^{1/2})$, where n_r is the number of players with a red hat and $n_b = n - n_r$. This answers a question of Feige.

Internet:

<http://cs.haifa.ac.il/~nbenzv03/hatters.pdf>

Speaker: Ali Assarpour

May 18, 2012

Title: “The Magic of a Number System”

Authors: Amr Elmasry, Claus Jensen, and Jyrki Katajainen

Journal or Conference: FUN 2010: 156–165

Abstract: We introduce a new number system that supports increments with a constant number of digit changes. We also give a simple method that extends any number system supporting increments to support decrements using the same number of digit changes. In the new number system the weight of the i th digit is $2^i - 1$, and hence we can implement a priority queue as a forest of heap-ordered complete binary trees. The resulting data structure guarantees $O(1)$ worst-case cost per *insert* and $O(\log n)$ worst-case cost per *delete*, where n is the number of elements stored.

Internet:

<http://www.cphstl.dk/Paper/Magic/magic.pdf>

Speaker: Xing Su