Distributed Computing Column 52
Annual Review 2013

Jennifer L. Welch
Department of Computer Science and Engineering
Texas A&M University, College Station, TX 77843-3112, USA
welch@cse.tamu.edu

This is my inaugural issue as editor of the SIGACT News Distributed Computing Column. I am honored to be asked to take over from Idit Keidar, who has done a wonderful job with the column for the last seven years, obtaining a wide variety of articles that have provided the community with informative news, and leavening it with her sense of humor. I hope to continue to rely on the efforts of the community to share information about our field.

As with prior December issues, this issue is devoted to a review of notable events related to distributed computing that occurred during the year.

First, congratulations to Nati Linial who received the 2013 Dijkstra Prize for his paper "Locality in Distributed Graph Algorithms"! I have reproduced the citation for his award, which was presented at the International Symposium on Distributed Computing (DISC), illustrated with a photo. Congratulations as well to Shiri Chechik and Danupon Nanongkai, who were awarded the Principles of Distributed Computing Doctoral Dissertation Award! Shiri's dissertation was entitled "Fault-Tolerant Structures in Graphs", while Danupon's was "Graphs and Geometric Algorithms on Distributed Networks and Databases". I have also reproduced their citations; the awards were also given at DISC. Graphs rule!

The first invited article is a review of the 2013 ACM Symposium on Principles of Distributed Computing (PODC) by Nicolas Braud-Santoni. Nicolas is the student author of the paper "Fast Byzantine Agreement", which received a Best Student Paper Award; the other authors are Rachid Guerraoui and Florian Huc. Ami Paz is the student author of the paper "Upper Bound on the Complexity of Solving Hard Renaming", which also received a Best Student Paper Award; his coauthors are Hagit Attiya, Armando Castañeda, and Maurice Herlihy. Shiri Chechik received the Best Paper award for her paper "Compact Routing Schemes with Improved Stretch". Congratulations to Nicolas, Ami, and Shiri! Additional notable happenings at PODC are reported by Nicolas.

The second invited article is a review of DISC 2013 by Shahar Timnat. Shahar won the Best Student Paper award for "Lock-Free Iterators", coauthored with Erez Petrank. Mohsen Ghaffari and Fabian Kuhn received the Best Paper Award for "Distributed Minimum Cut Approximations." Congratulations to Shahar, Mohsen and Fabian! See Shahar's article for more inside information about DISC.

To close, Ami Paz has provided us with a lively review of the Mathematical Methods in Theoretical Distributed Computing workshop, which occurred August 26–30 in Bremen, Germany.

Many thanks to Nicolas, Shahar, and Ami for their contributions! For those of us who were unable to attend these events, we can get the flavor of them and be inspired not to miss them next year.

Call for contributions: I welcome suggestions for material to include in this column, including news, reviews, open problems, tutorials and surveys, either exposing the community to new and interesting topics, or providing new insight on well-studied topics by organizing them in new ways.

2013 Dijkstra Prize in Distributed Computing

Nati Linial accepting Dijkstra Prize. Photo by Jukka Suomela.

The Dijkstra Prize Committee has selected Nati Linial as the recipient of this year's Edsger W. Dijkstra Prize in Distributed Computing. The prize is given to him for his outstanding paper

Nati Linial. Locality in Distributed Graph Algorithms. *SIAM Journal on Computing*, 21(1), pages 193–201, 1992.

This paper has had a major impact on distributed message-passing algorithms. It focused a spotlight on the notion of locality in distributed computation and raised interesting questions concerning the locality level of various distributed problems, in terms of their time complexity on different classes of networks. Towards that goal, in this paper, Linial developed a model particularly suitable for studying locality, which ignores message sizes, asynchrony and failures. This clean model allowed researchers to isolate the effects of locality and study the roles of distances and neighborhoods, as graph theoretic notions, and their interrelations with algorithmic and complexity-theoretic problems in distributed computing.

In addition to this major conceptual contribution, Linial's paper presents an $O(\Delta^2)$-coloring algorithm for graphs with maximum degree at most Δ that runs in $O(\log^* n)$ time. It is based on a new connection between extremal set theory and distributed computing. This result serves as a cornerstone for many other distributed coloring algorithms, including the current best algorithm. Whether one can get an $O(\Delta^2 - \epsilon)$-coloring within the same time bound remains a major open problem.

His paper also proves that, for any function f, any $f(\Delta)$-coloring algorithm requires $\Omega(\log^* n)$ time. Moreover, the same bound is shown for 3-coloring an oriented path or cycle. To obtain these lower bounds, Linial introduced the concept of the neighborhood graph of a distributed network and analyzed it. An enhanced form of his technique was recently used for establishing the best known lower bounds for Maximal Independent Set and Maximal Matching.

In summary, Linial's paper opened new approaches to distributed symmetry breaking and remains one of the most important papers in this area.

The Edsger W. Dijkstra Prize in Distributed Computing is awarded for an outstanding paper on the principles of distributed computing, whose significance and impact on the theory and/or practice of distributed computing has been evident for at least a decade. The Prize is sponsored jointly by

the ACM Symposium on Principles of Distributed Computing (PODC) and the EATCS Symposium on Distributed Computing (DISC). This prize is presented annually, with the presentation taking place alternately at ACM PODC and EATCS DISC. This year it was presented at DISC 2013.

The Prize Committee for 2013 consisted of Yehuda Afek, Tel-Aviv University, Israel; Faith Ellen, University of Toronto, Canada; Boaz Patt-Shamir, Tel-Aviv University, Israel; Sergio Rajsbaum, Universidad Nacional Autónoma de México, Mexico; Alexander Shvartsman, University of Connecticut, USA; and Gadi Taubenfeld, The Interdisciplinary Center, Israel (chair).

2013 Principles of Distributed Computing Doctoral Dissertation Award

The Doctoral Dissertation Award Committee has awarded the Principles of Distributed Computing Doctoral Dissertation Award to Dr. Shiri Chechik and Dr. Danupon Nanongkai.

The abundance of excellent candidates made the choice very difficult. Even after narrowing the list down, the committee still decided to split the award between two winners, listed next alphabetically by last name. Dr. Shiri Chechik completed her thesis "Fault-tolerant structures in graphs" in 2012 under the supervision of Prof. David Peleg at the Weizmann Institute of Science. Dr. Danupon Nanongkai completed his thesis "Graphs and geometric algorithms on distributed networks and databases" in 2011 under the supervision of Prof. Richard J. Lipton at the Georgia Institute of Technology.

The thesis of Dr. Chechik includes a comprehensive and deep body of work on fault-tolerant graph spanners and related structures. It contains many strong results, one of which received a best student paper award, and one solved a long-standing open problem. In one of these results, Dr. Chechik shows that it is possible to compute, ahead of time, a compact routing table that provides good routes even if several edges fail. The thesis targets an area of research that has been well studied, but Dr. Chechik's contributions advance the area significantly and promise to have a deep and long-lasting impact.

The thesis of Dr. Nanongkai shows a useful approach to make communication complexity a powerful tool for establishing lower bounds bounds for distributed computing. It also contains several sophisticated almost matching upper bounds. The thesis shows that this tool is applicable in diverse contexts, such as random walks, graph problems, and more. Besides being technically deep, the thesis combines distributed computing, communication complexity, and theory of random walks, in natural and novel ways. These results suggest and open the path for much exciting follow-up work on distributed communication complexity and distributed random walks.

The award is sponsored jointly by the ACM Symposium on Principles of Distributed Computing (PODC) and the EATCS Symposium on Distributed Computing (DISC). This award is presented annually, with the presentation taking place alternately at PODC and DISC. This year it was presented at DISC.

The Principles of Distributed Computing Doctoral Dissertation Award Committee for 2013 consisted of Marcos K. Aguilera, Microsoft Research; Rachid Guerraoui, EPFL; Shay Kutten (Chair), Technion; Michael Mitzenmacher, Harvard; and Alessandro Panconesi, Sapienza.

PODC 2013 Review

Nicolas Braud-Santoni
ENS Rennes
Bruz, France
nicolas.braud-santoni@ens-rennes.fr

The 32nd[1] Symposium on the Principles of Distributed Computing (PODC 2013) was held on July 22-24, in Montréal, Canada. PODC was co-located with the 25th[2] Symposium on Parallelism in Algorithms and Architectures (SPAA'2013), at the *Mont Royal* conference center. Moreover, two workshop were hosted on July 21 by Concordia University:

- the PODC Social Network Workshop; and
- WRAWN'13, the fourth Workshop on Realistic models for Algorithms in Wireless Networks.

This report focuses on PODC itself.

Program

Keynotes

This year featured 3 keynote talks in the mornings:

1. Michael Merritt's *Distributed Computing: An Empirical Approach*
2. Nancy Lynch's Athena lecture: *Distributed Computing Theory for Wireless Networks and Mobile Systems*
3. Marc Snir's *Programming Models for Extreme-Scale Computing*

All three denoted a will to *bridge the gap* between theory and practice.

[1] 2^5 sounded auspicious from the beginning, especially as it is the ninth happy number.
[2] $25 = 5^2$ sounds related to 32.

Distributed Computing: An Empirical Approach Michael MERRITT is Executive Director of a research department at AT&T, concerned with network and infrastructure design and performance. His talk mainly revolved around anecdotes about AT&T's network, and how they illustrate the need, sometimes, to shed abstraction layers. For instance, he mentioned how they improved network capacity by removing old, unused allocation.

Distributed Computing Theory for Wireless Networks and Mobile Systems Professor LYNCH is the head of MIT's *Theory of Distributed Systems* group, currently on sabbatical at Harvard University. The ACM Athena lecturer award is attributed yearly to a preeminent woman computer scientist, and is tied to a one-hour lecture during an ACM conference. The award includes travel expenses to the meeting and a $10,000 honorarium. Nancy LYNCH talked about the limitation of current models for wireless and mobile systems, and shared her views about what future works should bring to this field.

Programming Models for Extreme-Scale Computing Professor SNIR is the director of the Mathematics and Computer Science Division at Argonne National Laboratory. The slides of the presentation are available on his homepage. After a brief overview of the evolution of technologies and programming languages, Marc asked several questions:

1. Why is message-passing said to be difficult, yet is the most-used paradigm?
2. What does a programming system need to succeed?
3. What does a *good, high performance computing* programming system need?

He then proceeded to answer these questions in the context of MPI, a widely successful message-passing programming model, to share some hindsight about the factors that contributed to its success, and what it tells us regarding the design of novel solutions.

Regular program

PODC 2013 featured 39 regular papers, and 17 brief announcements. Compared with the two previous years, we notice a skew towards regular papers. The papers were grouped in 13 sessions (by chronological order):

1. Concurrent Data Structures and Objects
2. Routing and Distributed Algorithms
3. Byzantine Agreement
4. Distributed Algorithms and Their Complexity
5. Brief Announcements
6. Distributed Algorithms and Their Complexity (again)
7. Fault Tolerance in Distributed Systems
8. Renaming and Mutual Exclusion
9. Social and Peer-to-peer Networks and Mobile Robots
10. Byzantine Agreement and Self-Stabilization
11. Shared and Transactional Memory

12. Radio and Wireless Networks
13. Sensor Network, Graph Algorithms and System Security

It could be said that the sheer number of sessions (and sometimes *odd* pairings) illustrate the breadth and diversity of distributed systems.

Social

Montréal was a very pleasant venue, combining features (both architectural and cultural) from both its French and Anglo-Saxon roots. Moreover, in the middle of Montréal lies *Mont Royal*, a 230m high hill, covered by a park spanning over 280ha[3].

The social event, this year, was two-fold: a tour of Montréal, in small groups, led us to the conference dinner, held at Montréal's Science Center, in the old harbour.

At the banquet, several awards were attributed:

- Shiri Chechik won the *Best Paper award* for *Compact Routing Schemes with improved stretch* [3].
- The *Best Student Paper award* was jointly awarded to:
  - Ami Paz[4], for *Upper Bound on the Complexity of Solving Hard Renaming* [1];
  - myself, for *Fast Byzantine Agreement* [2].

[3] 280ha is almost 700 acres.
[4] Represented by his co-author, Armando Castañeda

Business meeting

In this year's business meeting, two main topic were broached:

- the locations for PODC 2014 and 2015;
- the possibility of co-locating with other conferences.

Indeed, it was officially announced that:

- PODC 2014 will be hosted in Paris, on June 15-19;
- PODC 2015 will take place in Portugal.

This announcement was met by some with discontent, as it breaks with the current trend, which had PODC alternating between Europe and the American continent since 2008.

The conference committee took advantage of the business meeting to ask the community about co-locating, in the future, with other conferences, in particular, co-locating with *Computer Aid Verification* (CAV), the premier conference on automated *formal analysis*. While the conference committee saw clear potential for synergy between distributed systems and automated verification, few met this proposal with enthusiasm; some even voiced their preference for co-locating with a chocolate-making conference. Despite the nay-saying, no other serious proposal was made regarding co-location, and the stance the conference committee will take is still unclear.

Acknowledgments

I would like to thank warmly, in no particular order:

- Swan Dubois, for the pictures illustrating this report;
- the local organisers, Jarda Opatrny and Lata Narayanan from Concordia University;
- both the conference committee and the program committee;
- the editor of SIGACT News' quarterly Distributed Computing column, Jennifer L. Welch.

References

[1] Hagit Attiya, Armando Castañeda, Maurice Herlihy, and Ami Paz. Upper bound on the complexity of solving hard renaming. In *Proceedings of the 2013 ACM Symposium on Principles of Distributed Computing*, PODC '13, pages 190–199, New York, NY, USA, 2013. ACM.

[2] Nicolas Braud-Santoni, Rachid Guerraoui, and Florian Huc. Fast byzantine agreement. In *Proceedings of the 2013 ACM Symposium on Principles of Distributed Computing*, PODC '13, pages 57–64, New York, NY, USA, 2013. ACM.

[3] Shiri Chechik. Compact routing schemes with improved stretch. In *Proceedings of the 2013 ACM Symposium on Principles of Distributed Computing*, PODC '13, pages 33–41, New York, NY, USA, 2013. ACM.

DISC 2013 Review

Shahar Timnat
Department of Computer Science
Technion, Israel
stimnat@cs.technion.ac.il

The 27th International Symposium on Distributed Computing, DISC 2013, was held this year in Begin Center, Jerusalem, Israel. The event included two workshops days and three days of the main conference, from October 14th to the 18th. Naturally, this review cannot cover all the works that has been presented, but I will try to give you a glimpse of the event.

As one might expect from a symposium on distributed computing, the first workshop day included several workshops, which were executed concurrently. At the end of the day, all of the participants synced in a joint session named: "Love and Fear in the Lab", which was the highlight of the day. Uri Alon and his guitar led the session. Uri talked about how important it is to enjoy the research, and how advisors should encourage their students to do so. The session included some hit songs, most notably: "Sunday at the Lab". If you look it up on youtube, you can find Uri performing it (but not in DISC).

The next day was the first day of the main conference. The session started with an invited talk, given by Ravi Rajwar from Intel. The talk's main subject was the concept of lock-elision. Lock-elision is a hardware mechanism that enables avoiding locks when different threads do not actually collide in their execution. This effect is achieved using hardware transactional memory: threads attempt to execute a transaction instead of acquiring a lock, and only revert and acquire a lock when necessary. Ravi emphasized the greater benefit of lock-elision is that it comes free: no change is required in the programming model. Programmers *think* with locks. Lock-elision enables them to continue to program this way, and yet achieve more parallelism. The new Intel Haswell processor supports lock-elision, and thus, as Yehuda Afek (the session chair) said, it is likely to live forever.

This talk was followed by the presentation of the paper "Distributed Minimum Cut Approximation" [4], which was the winner of the best paper award. The paper was presented by Mohsen Ghaffari, and it is a joint work by him and Fabian Kuhn. While the minimum cut is a central problem in graph theory, it was not yet studied thoroughly in the context of distributed computing. The authors presented two new probabilistic approximation algorithms for the problem, and a lower bound.


Figure 1: Left: the view from Begin Center. In the distance you could see (part of) the old city walls and the tower of David. Right: Uri gets the guitar, while Begin observes (disapprovingly?) from the portrait on the wall.

In the next session, we saw interesting works regarding leader election. As it turned out in a rather lively discussion, there is more than one definition to the problem of leader election. In [5], the authors discussed a problem variant in which at the end of the protocol each process has to decide either *win* or *lose*, such that exactly one process wins. This work gives a deterministic obstruction-free algorithm, and also a general transformation of any deterministic obstruction-free algorithm into a randomized wait-free algorithm for this problem.

Danny Dolev presented [1], which discussed what I believe is the better known variant of the leader election problem: the output of the protocol is a process id, and all processes must choose the same id (leader). This work considered aspects of game theory in the leader election problem. Mainly, it assumes each process *wants* to be the leader. This work did not focus on complexity, but on algorithms that satisfies the Nash-Equilibrium, and allows each process an equal chance to be elected. It is necessary to assume that all processes prefer *some* leader to no leader at all, otherwise the Nash-Equilibrium will always result in no leader. I found this lecture to be quite unusual in our field, and very interesting.

The next session was on the subject of transactional memory. Jens Palsberg presented: Proving Non-opacity [6]. Opacity is a safety criteria for transactional memory, and this work presents a tool that automatically identifies two types of bugs that lead to non-opacity. Li Lu (probably the shortest name I've heard) presented "Generic Multiversion STM" [7], a generic way to implement a multiversion STM on top of existing STM systems. Multiversion STM allows readers to view old values of the data and "commit in the past" (personally, I've been a fan of time traveling ever since "Back to the Future"). Allowing readers to commit in the past enables them to avoid unnecessary aborts, and reduce the danger of being starved by frequent writes.

The second day was opened with an invited lecture by Nati Linial. Nati discussed simplicial complexes. Simplicial complexes are widely used in the area of distributed computing. Nati showed that with some inspiration, they can also be useful for other fields, such as for proofs in the field of combinatorics.

My field of concurrent data structures was a big part of the second day. I presented: Lock-Free Data-Structure Iterators [8], which was awarded the best student paper award. Yujie Liu presented: Practical Non-blocking Unordered Lists [9]. In this work the authors describe new lock-free and wait-free algorithms for linked-lists.

Keren Censor-Hillel presented an atomic snapshot object with time complexity of $O(\log^3 n)$ steps [2]. The thing I found interesting about this work is that there is actually a lower bound of $\Omega(n)$. Keren argued with a smile that lower bounds are only there to make us think harder. It turns out that even though deterministic atomic snapshot algorithms require $\Omega(n)$ in the worst case scenario, randomized algorithms can beat this lower bound with very high probability. A key novel technique used in this work is *randomized helping*: a thread asks a randomly chosen other thread for help.

DISC also features short announcements. Such announcements receive a few minutes' presentation during the relevant session. I found the short announcements of the data structure session particularly interesting. They concerned the constructions of lock-free trees. Lock-free trees, and balanced trees in particular, are especially hard to design. Aravind Natarajan presented: A Concurrent Lock-Free Red-Block Tree. Trevor Brown presented: A General Technique for Non-blocking trees. This technique relies on the LLX and SCX primitives. Those are extended version of the LL and SC primitives, implemented using regular CAS. Unfortunately I couldn't find an official reference to cite, but I could easily find full versions of these papers on the web.

At the end of the second day we went for an excursion in Jerusalem. There were two alternatives: the old city and sight seeing for Jerusalem "first-timers", and a tour to the western wall tunnel and the church of the holy sepulchre for "veteran" tourists of Jerusalem. The excursion was followed by a banquet at the Eucalyptus restaurant. The restaurant served traditional Jerusalem dishes. At the end of the banquet there was a small ceremony of welcoming the new DISC committee, and thanking the previous one.

Figure 2: The Excursion

The third day also contained many interesting talks, but one very unusual presentation was both entertaining and special. Barbara Keller's talk about Convergence in (Social) Influence Networks

[3] was, beyond a doubt, my favorite talk in the conference. The talk was funny and yet informative and clear. The slides were quite entertaining as well.

The problem discussed is quite simple: we assume a world with two opinions, and each node changes its opinion every round to reflect the opinion the majority of its friends held in the previous round. It can fairly easily be seen that eventually, a node must either converge to a single opinion it will never change again, or reach a steady state of changing its opinion every round. The question is: how long can it take for the graph to converge to this final state?

In the presentation we saw an easy lower bound of $\Omega(n)$, and an upper bound of $O(n^2)$ (n is the number of nodes in the graph). Then, unexpectedly, Barbara asked us to vote (she comes from Switzerland, where apparently they vote on everything). What do we think? which bound is tight? after voting, she asked us: "So now, after you saw what your friends think, how many of you want to change your opinion?" I thought it was very clever :)

Unfortunately, the talk took an unexpected turn to the downside, when I found out I voted for the wrong answer. The authors couldn't quite prove any of the bounds were tight, but they could prove a lower bound of $\Omega(n^2/\log^2(n))$, pretty close to $O(n^2)$. They put together a surprisingly complicated graph for showing it, and presented an animation of it in the talk. I imagine putting the animation together took as much time as coming up with the graph example.

This was the first time I attended the DISC conference. I really enjoyed it, and the consensus among the participants was that it was very well planned and organized. I hope next year's DISC will be just as successful.

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[2] James Aspnes and Keren Censor-Hillel. Atomic snapshots in $O(\log^3 n)$ steps using randomized helping. In *DISC*, pages 254–268, 2013.

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[5] George Giakkoupis, Maryam Helmi, Lisa Higham, and Philipp Woelfel. An $O(\sqrt{n})$ space bound for obstruction-free leader election. In *DISC*, pages 46–60, 2013.

[6] Mohsen Lesani and Jens Palsberg. Proving non-opacity. In *DISC*, pages 106–120, 2013.

[7] Li Lu and Michael L. Scott. Generic multiversion STM. In *DISC*, pages 134–148, 2013.

[8] Erez Petrank and Shahar Timnat. Lock-free data-structure iterators. In *DISC*, pages 224–238, 2013.

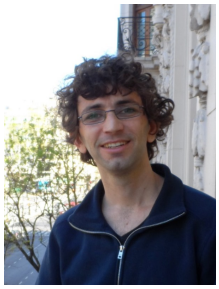
[9] Kunlong Zhang, Yujiao Zhao, Yajun Yang, Yujie Liu, and Michael F. Spear. Practical non-blocking unordered lists. In *DISC*, pages 239–253, 2013.

Bremen city hall

Windmill at Bremen

Bremen Workshop Review

Ami Paz
Department of Computer Science
Technion, Israel
amipaz@tx.technion.ac.il



The Mathematical Methods in Theoretical Distributed Computing workshop took place on August 26 to August 30, 2013 in Bremen, Germany. The workshop was organized by the Institute for Algebra, Geometry, Topology and their applications (ALTA) at the University of Bremen, headed by Prof. Dr. Dmitry Feichtner-Kozlov.

The workshop consisted of 15 talks and an open problems session; long time slots were allocated for the talks, allowing comprehensive presentations and thorough discussions. The main topic discussed was distributed algorithms in shared memory systems. Some participants presented works regarding the topological approach; others presented innovative ways to bridge the gap in the theoretical study of shared memory and message passing systems; a third subject discussed was Byzantine faults.

Talks

Day I

The first day was devoted to talks presenting topological methods and their applications. Maurice Herlihy (Brown University, USA) gave the first talk, which consisted of a colorful introduction to the connection between colorless distributed algorithms and combinatorial topology. Maurice then discussed his work with Mendes and Tasson [15], proving a new characterization of distributed tasks solvability in the presence of Byzantine failures, using some techniques including a variation of the *stable vectors* algorithm [2].

The talk gave the basics for the future talks regarding topological methods, and triggered many discussions and comments. At the end of the talk, Maurice presented the new book *Distributed Computing Through Combinatorial Topology*, written by Maurice, Dmitry Feichtner-Kozlov and Sergio Rajsbaum, soon to be published [12].

Eli Gafni (UCLA, USA) delivered the second talk (which continued in the open problems session), presenting a way to represent a shared memory system prone to t crash failures as a collection of open sets, corresponding to a subdivided simplex with its $(t-1)$-dimensional boundary removed. This work, done with Kuznetsov and Manolescu [10], is different from previous works regarding t-resilient algorithms in the direct use of topology, instead of using the wait-free model and deriving the results using simulations.

Yehuda Afek (Tel Aviv University, Israel), in a joint work with Gafni [1], presented the Iterated Pairs model. The general idea is to consider many different omission failure models in a message passing systems, each defined by the sets of messages the adversary is allowed to omit. In the Iterated Pairs model, the adversary is allowed to leave only a single message in each round, as long as a message between each pair of processes is eventually delivered. Yehuda showed that in spite of its simplicity, this model is equivalent to the shared memory wait-free model, allowing to derive the topological representation of a wait-free protocol in a simpler way.

The open problems session was lively and interesting. Among the questions discussed was finding an "explicit" algorithm for the *weak symmetry breaking (WSB)* task, when possible; although there exists an algorithm for this task in many cases [8], it is based on topological notions and on subdivision procedures of simplicial complexes, producing a very non-intuitive code which is hard to analyze and verify. This raises the question of what is considered an "explicit" algorithm, and leads to the conjecture that such an algorithm for WSB might not exist. Another subject discussed was the possible relevance of the works and tools developed in the shared memory context to research regarding message passing systems, and vice versa; specifically, Michel Raynel proposed the idea of extending the concept of locality from message passing systems to shared memory, and Maurice Herlihy suggested problems on large scale graphs should also be discussed in the shared memory community. Will the Blue-Red dichotomy, between message passing and shared memory, be finally broken?

Day II

Michel Raynal (IRISA, France) opened the second day of the workshop, presenting an attempt to find a unifying model for distributed computing. Michel discussed a joint work with Stainer [18], following the work presented by Afek. He showed some relations between models of synchrony weakened by message suppressing adversaries and models of asynchrony restricted by failure detectors, and examined the hierarchy and equivalence between these models.

Eli Gafni in the open problems session

At the excursion

Julien Stainer (IRISA, France) presented a new and interesting model of computation, in an attempt to unify shared memory and message passing, developed with Rajsbaum and Raynal [17]. The main idea in this model is that in a wait-free shared memory system, at most one process may run without seeing any other process, i.e. solo, while in asynchronous message passing, it might be the case that all processes run without seeing each other. Julien presented the k-solo model, where at most k processes may run without seeing any other process, discussed the solvability of colorless tasks in that model, and showed a task separating the k-solo model and the $(k+1)$-solo model.

Armando Castañeda (Technion, Israel) discussed uniform set consensus in synchronous message passing systems with crash failures. While for some problems there are optimal early deciding protocols, it is known that there cannot be such a protocol for uniform set consensus. Hence, Armando, Gonczarowski and Moses [7] propose to consider the game theoretic notion of Pareto optimal solution. A protocol P is *Pareto optimal* if there is no other protocol Q which strictly exceeds P, i.e., Q is as good as P in all executions, and better than P at least in one execution. For uniform set consensus and for set consensus, Armando presented protocols which are Pareto optimal in the stopping time parameter.

Thomas Nowak (Ecole Polytechnique, France) introduced us to the topic of long walks in weighted digraphs with constant messages delays on the links. After a transient phase, such a walk becomes periodic; the length of the transient phase was the main topic of the talk. By using *max-plus* recursion, Thomas, Charron-Bost and Függer [9] were able to study the length of this transient phase, and to give asymptotically tight bounds on it. Additionally, he presented some interesting applications of walks on weighted digraphs.

Zohir Bouzid (ENST, France) concluded the second day of the workshop, continuing Herlihy's talk about the treatment of Byzantine failures using topological tools. Zohir considered a specific task, *weak agreement*, which is a variation of set agreement. In k-weak agreement, processes have to decide on sets, such that the total number of values in all sets together is at most k, and each set contains at least one input value of a non-faulty process; specifically, the inputs of the Byzantine processes are ignored. In their ongoing research, Zohir and Kuznetsov study the solvability of k-weak agreement in the presence of f Byzantine failures, and give explicit solvability conditions, which are both necessary and sufficient. For this specific case, this improves upon the necessary conditions derived from the theorems presented earlier by Herlihy.

The third day of the workshop was dedicated to an excursion, which is discussed later.


Bicycles: the workshop's unofficial mode of transportation

Day IV

The last day of the conference opened with an interesting talk by Stefan Schmid (TU Berlin, Germany), who discussed synchronous distributed data structures in message passing systems. One of the problems presented was topological self stabilization: a message passing system starting in some network topology, and the common goal is to achieve a different topology, and specifically, an unsorted lacing which has to be sorted. Later on, a distributed data structure called *splay networks* was introduced, inspired by the sequential splay tree data structure. The talk was based on works done with Avin, Gall, Haeupler, Jacob, Lotker, Richa, Scheideler and Täubig [5, 11, 13].

Eric Goubault (CEA Saclay, France) delivered the next talk, starting with the notion of progress graph. A *progress graph* represents the possible states of a system through time, marking the allowed and forbidden states. In addition to 2D examples (e.g., the Swiss flag example), Eric demonstrated this concept in a 3D animation of the forbidden space. He then pointed out a possible connection between these progress graphs and directed algebraic topology, and specifically, a way to represent progress graphs in tools of directed algebraic topology.

Achour Mostéfaoui (University Nantes, France) considered a more practical problem, relevant to many of us: *Distributed collaborative editing* of a text document. In this problem, multiple editors want to edit a document simultaneously, with minimal mutual interference and conflicts and maximal update. For different editing behaviors, Achour, with Desmontils, Molli and Nédele [16], proposed a technique to store the edited document, and showed statistical comparison to other techniques.

My talk continued the discussion from the first day regarding an explicit weak symmetry breaking (WSB) algorithm. It is known that if n, the number of processes in a system, is a power of a prime number, then WSB is not solvable; for all other cases, it was proved using topological methods that there exists an algorithm. With Attiya, Castañeda and Herlihy [3], we give a new, simpler topological construction, which also yields a bound on the step complexity of solving WSB. The question if this algorithm can be called "explicit" remains undecided.

Srivatsan Ravi (TU Berlin, Germany) gave a survey talk about safety in distributed computing. The talk started with two definitions of safety: one based on Alpern-Schneider topology, and the other, more operational definition, by Lynch. Ravi discussed a way to prove a property is a safety property, using König's *path lemma* [14], and then applied it to show linearizability is a safety property. Some parts of the talk where based on Srivatsan's work with Attiya, Hans and



At the Wadden sea (pictures by Stefan Schmid)

Kuznetsov [4].

Nicolas Braud-Santoni (ENS Chachan — Antenne de Bretagne, France) concluded the workshop with a talk regarding Byzantine adversaries, this time in a synchronous message passing system and using randomized algorithms. Nicolas considered the consensus task, as well as the almost-everywhere agreement task, in which an unbiased agreement should be achieved among most nodes; almost-everywhere agreement is used together with almost-everywhere reduction to construct randomized consensus algorithms. By improving the reduction, Nicolas, Guerraoui and Huc [6] showed how to construct a poly-log time Byzantine agreement protocol, with poly-log communication.

Social Program

The workshop's dinner, on the first night, was held in the *Bremer Ratskeller* restaurant. This gourmet restaurant and wine cellar, one of the oldest wine cellars in Germany, is located under the Bremen town hall. The whole building is a magnificent piece of brick Gothic architecture, and is listed in UNESCO's world heritage list. The restaurant itself was nice and old fashioned, giving good atmosphere and fine foods and beverages for the opening night.

The third day of the workshop was fully dedicated to an excursion. After changing two trains and a bus to the beach of the Wadden sea (I almost got lost on the way), we started to walk to the Neuwerk island. In spite of some preliminary discussions, it appears no Divine Providence was involved here: In times of low tide, the seabed reveals, and so we had the opportunity to walk and wade the big mud flat between the mainland and the island. The Wadden sea is also listed in UNESCO's world heritage list, and as such, in addition to this interesting low-tide phenomenon it also has rich flora and fauna; while walking through the sea, we saw a diversity of birds, seashells, shrimp-like Corophiums and mussels. After the long and exciting walk to the island, we had a decent lunch. Then, going back to the seashore, we saw the ocean covering the way we walked just a few hours ago—an extraordinary view. Walking back was no longer possible, and so we took a ferryboat back to the mainland, and a train to Bremen, where we had a good rest after a long day.

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At Neuwerk island
(picture by Stefan Schmid)

The Wadden sea

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