Report on SIROCCO 2017

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The 24th International Colloquium on Structural Information and Communication Complexity[1] (SIROCCO 2017) took place from the 19th - 22nd June 2017 on the beautiful island of Porquerolles, which is located 20 minutes by boat off the coast of Hyères in the French Mediterranean Sea. SIROCCO has a tradition of being located in fantastic locations, and this year's edition was no exception. Porquerolles is a small island (roughly 7 x 3 km) with beautiful beaches, impressive cliffs, and a village large enough to host a resort facility (IGESA[2] resort) that offers plenty of accomodation and a small conference venue. This year's edition had 56 participants, which is similar to previous years. I attended the SIROCCO conference for the first time this year. I had heard that the atmosphere at SIROCCO conferences is usually rather colloquial, and I can confirm that this is indeed the case, which is most likely due to the great location, the limited number of participants, and the fantastic organization. The conference received 41 submissions, which is 9 submissions less than last year, and accepted 21 papers. As pointed out in the conference business meeting, the lower number of submissions is most likely due to the fact that the conference deadline was a month earlier than last year and preceeded the notification date of other conferences. The 21 paper presentations were scheduled over three days, together with three keynote talks, a SIROCCO award lecture, the business meeting, and the celebration of Andrzej Pelc's 60th birthday. This left enough room for a boat excursion, the conference banquet dinner, and short refreshing dips in the sea to cool down and enjoy the Mediterranean sun for a while.

The scope of SIROCCO is decentralized systems of communicating entities. The focus lies on the interplay of structural knowledge, communication, and computational complexity in such systems. The conference thus encompasses research areas such as distributed and parallel computing, communication complexity, mobile computing, peer to peer networks, social networks and many others. For example, in this year's edition, four papers addressed mobile agents that collectively need to solve a common problem (e.g., exploring the underlying graph or gathering at the same point), three papers considered labelling schemes, two papers dealt with the

[1] https://sirocco2017.lif.univ-mrs.fr

[2] https://www.igesa.fr/vos-vacances/recherche-sejour/reserver-mes-vacances/etablissement/porquerolles/

Fig. 1. Lovely view of Porquerolles Island. Credit for all photos in this article goes to Sebastien Tixeuil (LIP 6, University Pierre et Marie Curie, Paris).

SINR model for wireless networks, and another two papers addressed the $\mathcal{LOCAL}$ model for distributed computation.

The main purpose of this report is to summarize the technical contributions of the conference. I will also write briefly about the social activities that took place, and hopefully convince the reader that participating in this conference is a very enjoyable experience.

1 Technical Contributions

1.1 Keynote and Award Lectures

Three keynote lectures were given at this years edition of SIROCCO. On the first day, Faith Ellen (University of Toronto) opened the technical part of the programme with her keynote lecture entitled "Ignorance is Bliss (for Proving Impossibility)". She demonstrated that impossibility results in distributed systems are often obtained by exploiting the lack of knowledge of one entity about the state or input values of others. This talk discussed classic impossibility results for problems such as leader election (á la Angluin), consensus (Fischer, Lynch, Paterson), and coloring the ring (Linial). She also discussed a recent result by Frischknecht, Holzer and Wattenhofer, who proved that if message sizes in a distributed system are bounded by a parameter B, then $\Omega(n/B)$ rounds are necessary for network nodes to determine the diameter of the input graph, even if the diameter is either 2 or 3. This result is obtained by a reduction to the Set-Disjointness problem in the two-party communication complexity framework.

The second keynote lecture opened the afternoon session of the first day. It was given by Christian Scheideler (University of Paderborn) and concerned programmable matter. Programmable matter is an interdisciplinary research area involving physics, chemistry, bioengeneering, robotics, and, as Christian Scheideler made clear during the presentation, distributed algorithms. It is conceivable that nano-scale programmable devices will be built in the foreseeable future. These devices will require appropriate programming in order to solve specific tasks. Useful applications of programmable matter include shape formation and coating problems (e.g., small particles that coat buildings or bridges in order to monitor their structural integrity). Christian Scheideler presented the "Amoebot model", where the movements of individual particles share similarities to the movement of amoebas. Leader election is a critical building block for algorithms in this model. He discussed a solution to the leader election problem and how this problem can be used to solve other problems. Finally, extensions of the Amoebot model as well as preliminary results obtained for these extended models were discussed.

No keynote lecture was scheduled on the second day in order to leave time for the SIROCCO 2017 award lecture. Schmuel Zaks (Technion) received the "Prize for Innovation in Distributed Computing 2017". This prize is awarded to outstanding researchers who identified new problems or research areas that were unorthodox at the time of their introduction, but later attracted the interest of the SIROCCO community. Shmuel Zaks received this award for the entirety of his achievements, but especially for his pioneering work on algorithmic aspects of optical networks. He introduced the rigorous study of algorithmic problems related to ATMs and optical networks, which have previously only been tackled by heuristics. His contributions lie in the areas of approximation and online algorithms, complexity, parameterized complexity, and inapproximability. He is the 9th recipient of this award and joins the group of previous recipients consisting of Nicola Santoro, Jean-Claude Bermond, David Peleg, Roger Wattenhofer, Andrzej Pelc, Pierre Fraigniaud, Michel Raynal, and Masafumi Yamashita. His lively lecture was much appreciated and provided a very clear overview of his contributions.

Fig. 2. Conference participants before the banquet dinner

The third and final keynote lecture was given by Christoph Lenzen (Max Planck Institut Saarbrücken) on the morning of the third and final day of the conference. It concerned clock synchronization problems: Even if multiple computational entities start their calculations with synchronized clocks, their clocks will differ from each other after some amount of time, since they usually tick at slightly different rates. The objective is to keep them synchronized. Christoph Lenzen first argued that clock synchronization problems occur not only in distributed systems but also in hardware chip design, i.e., he justified that chips should in fact be regarded as distributed systems. In his presentation, he addressed various practical and theoretical issues,

for example, the presence of uncertainty and faults, and pointed out open problems that are of interest to the distributed computing community.

1.2 Regular Papers

Two of the 21 accepted papers addressed the SINR (Signal-to-interference-plus-noise ratio) model for wireless networks. In this model, wireless network nodes are located on the plane and can transmit with different power levels. A node only receives a transmitted message if the often dreaded SINR condition is fulfilled: a formula that relates the different power levels and distances from the receiver of simultaneously transmitting senders to the power level and distance from the receiver of the sender of interest. This condition ensures that the interference from other senders compared to the signal strength received from the sender of interest is small enough to guarantee error-free reception. Magnús Halldórsson, Stephan Holzer and Evangelia Anna Markatou received the best paper award for their work on the leader election problem in the SINR model. They show that if network nodes can select arbitrarily large transmission powers (at least exponential in the number of network nodes), then the leader election problem can be solved in two rounds. The presentation was given by Magnús Halldórsson, who made the audience illustrate the core of the problem (i.e., interference) by having members of the audience shout out their names simultaneously, which caused reception problems for the listening audience members. The authors' algorithm randomly splits the network nodes into two halves, makes one half transmit their IDs at randomly chosen power levels, and makes the other half listen. If power levels are chosen from a sufficiently large domain, all listeners can distinguish the network node that transmitted with the highest power. This node is chosen to be the leader of the network. In the second round, the listeners of the first round transmit the leader's ID, and transmitting nodes of the first round remain silent and learn the leader's name in this way. Jurdzinski, Różański and Stachowiak presented new results on the token traversal problem in the SINR model. They give a $O(n \log n)$ rounds deterministic algorithm, which is shown to be optimal and improves on previous $O(n \log^2 n)$ rounds algorithms. An interesting aspect of their work is that their result holds in weakly connected SINR networks, while most previous works consider strongly connected networks.

Four papers addressed problems related to the coordination of mobile agents. Disser et al. presented new results on the collaborative tree exploration problem: Initially, k deterministic agents are located at the same node in a tree. Their common goal is to explore the entire tree. To this end, in each round, they have to choose an incident edge and move along this edge to a different node. They can make use of communication to coordinate their strategies. In other words, the decision as to which edge an agent visits next may depend on the previous actions of all other agents. Their results include a new lower bound that renders the O(1)-competitive algorithm of Dereniowski et al., which works for the $k = n^{1+\epsilon}$ case, in a sense optimal. Brandt et al. study the problem of evacuating k agents that are initially located at the same point on one of m rays. These rays meet at a single junction point. Again, agents can communicate freely with each other. The objective is to evacuate the k agents through a single exit point. Various competitive algorithms are obtained, such as a 4-approximation if $k = m$, and a $2+\sqrt{3}$-competitive algorithm for the case $k = m = 3$. Czyzowicz et al. study how to evacuate three robots, which can communicate through a wireless network, from a circle through an exit that is located at an unknown position on the perimeter of the circle. The difficulty stems from the fact that at most one of these robots is faulty. They give algorithms for two different fault models that show that competitive ratios of at most 7 can be achieved, while lower bounds rule out competitive ratios below 5. Di Luna et al. consider the problem of gathering agents that live on an anonymous dynamic ring in a single vertex. In each round, at most one edge of the ring is missing, which keeps the underlying graph structure constantly connected. They

consider agents that cannot communicate with each other. Their paper studies the impact of chirality (agents have a common sense of orientation) and cross detection (when traversing an edge, agents can detect whether other agents are crossing the edge in the other direction at the same time) on the feasibility of the gathering problem.

Fig. 3. Porquerolles Island at sunset

Dynamic or evolving graphs are graphs that change over time such as the constantly connected dynamic ring mentioned above. These graphs have received substantial attention in recent years, and various models for evolving graphs exist today. One such model is characterized by the T-interval connectivity property, which states that, at any moment, there exists a spanning tree in the evolving graph that remains unchanged for at least T iterations. In a previous work, Casteigts et al. gave an algorithm that acts on a dynamic graph and determines the minimal parameter T for which the graph is T-interval connected. In the work that they presented at this conference, they reuse ideas from their previous algorithm and obtain new testing algorithms for other properties, such as the Round-Trip-Temporal-Diameter at a given moment t, i.e., the minimum time d it takes to commute at time t from any node u to any other node v and return back to u.

Feuilloley considered the $\mathcal{LOCAL}$ model of distributed computation and studied average case running times of distributed algorithms. It is known that leader election on a ring requires $\Omega(n)$ rounds (i.e., at least one node runs the algorithm for $\Omega(n)$ rounds). However, if we are interested in the average time required for the nodes to output their results instead of the worst case time, then an algorithm can be designed where the average node requires only $\mathrm{O}(\log n)$ rounds. Halldórsson and Konrad studied the minimum vertex coloring problem on interval graphs in the $\mathcal{LOCAL}$ model. In a recent work, they showed that a constant factor approximation can be computed in $\mathrm{O}(\log^* n)$ rounds. In their new work, they improved the approximation factor and gave a $(1+\epsilon)$-approximation algorithm that runs in $\mathrm{O}(\frac{1}{\epsilon}\log^* n)$ rounds. Linial's ring coloring lower bound shows that the dependency on $\log^* n$ is optimal. They further prove that the dependency on $\frac{1}{\epsilon}$ is optimal as well.

Three papers addressed labelling schemes. A labelling scheme is an assignment of labels to the vertices of the network graph so that network nodes can make use of these labels and solve a certain problem much faster (i.e., using fewer communication rounds) than without labels. The focus usually lies on the maximum length of a label. Gorain and Pelc studied the topology recognition problem in tree radio networks, where every node is required to learn an

isomorphic copy of the input graph and identify its position within the copy. They show that there is a labelling scheme of length $O(\log \log \Delta)$ and a distributed algorithm that makes use of these labels and runs in $O(D\Delta)$ rounds, where D is the diameter of the input graph and Δ the maximum degree. They prove that this is essentially best possible. Ostrovsky, Perry and Rosenbaum addressed proof labelling schemes. In a proof labelling scheme, the distributed algorithm uses the initially assigned labels and usually runs in a constant number of rounds in order to verify a certain property of the input graph. In their paper, the authors give trade-offs between the length of the labels and the number of rounds required by the distributed verification algorithm. They particularly focus on the situation where the verification algorithm runs in $\omega(1)$ rounds. Censor-Hillel, Paz and Perry introduce a new notion for approximate proof labelling schemes, and show that label lengths can be much shorter than for ordinary proof labelling schemes.

The accepted papers covered a wide range of other topics (and I apologize to the authors of these papers for the brevity of my summaries). Spiegelman and Keidar make progress on a dynamic storage problem. Rodeh and Korman consider a parallel search problem that does not allow for coordination. It has been known since the eighties that symmetry breaking is only possible if network nodes are aware of at least "something" about the problem instance (e.g., non-symmetrical topology, random bits, etc.). Peva and Guerraoui focus on identifying the smallest "something" necessary to achieve this. Narayanan and Wu make progress on a problem in viral marketing. Bonnet et al. show how to kill some network nodes in order to avoid virus expansion. A group of twelve Masters students from the University of Paderborn supervised by Meyer auf der Heide give solutions to an interesting monitoring problem in distributed data streams. Biló et al. discuss a way to fix a single-source spanner by swapping edges. The objective of Gotfryd, Klonowski, and Pajak is to hide agents on a graph so that the mutual information between their current and initial positions is minimized. Rabie studies what can be computed in few rounds by probabilistic encounters of agents.

Fig. 4. Another lovely view of Porquerolles Island

2 Social Activities

The very enjoyable technical programme of the conference was accompanied by great social activities. We celebrated Andrzej Pelc's 60th birthday between the last conference talk of the first day and the business meeting. Members of the audience had the opportunity to congratulate

Andrzej, and many of Andrzej's colleagues that could not attend the conference had recorded their birthday wishes on video.

The technical programme on the second day ended before lunch, and we started the afternoon with a boat ride around the island. The views of the island were spectacular, and I refer the reader to the figures placed in this article.

After the boat ride, we were treated to delicious French cuisine and wine at the conference dinner banquet in a restaurant near the harbour. The restaurant provided an excellent atmosphere for congratulating Shmuel Zaks on the SIROCCO 2017 award, Magnus Halldórsson and his co-authors on the best paper award, and Andrzej Pelc on his 60th birthday again.

3 Conclusion

SIROCCO 2017 was a fantastic event. The organizational team chaired by Shantanu Das (LIF, University of Aix-Marseille) did a great job and made themselves available throughout the conference. I particularly appreciated that the organizers scheduled transport (bus and boat ride) to and from the conference venue and sorted out accommodation for all participants, which simplified the travel arrangements. Next year's edition of the SIROCCO conference will take place in Israel and will be organized by Boaz Patt-Shamir.