

**REPORT ON THE ACTIVITIES OF WG5:
FOUNDATIONAL ASPECTS, ALGEBRAIC METHODS IN RANDOM NETWORK
CODING, DISTRIBUTED STORAGE
(PARTLY OVERLAPPING WITH OTHER WGs)**

Camilla Hollanti, Chair of WG5, March-October 2015

The group has been working on lattice codes, algebraic codes, and designs with applications to network coding and distributed storage systems, both on the network layer and physical layer. Motivated by the future 5G networks, the group has also worked on the complexity reduction on space-time codes, especially multiple-access and distributed codes. Locally repairable codes have been of particular interest.

Papers and preprints (some have been reported earlier as submitted or arxiv preprints, but are now given the proper journal reference)

1) Preprint, Cristina Martinez: "Topological network coding, t-designs and set partitions" joint with Alberto Besana

We study t–designs over finite fields relating the problem to the representation theory of the general linear group $GL(n, F_q)$ and the constructions of algebraic codes over finite fields. In particular we construct families of cyclic codes by considering sets of roots of the polynomial $x^n - 1$ over its splitting field.

2) N. Silberstein, A. S. Rawat, and S. Vishwanath, "Error-Correcting Regenerating and Locally Repairable Codes via Rank-Metric Codes", IEEE Transactions on Information Theory, Vol. 61, No. 11, pp. 5765 - 5778, November 2015.

3) N. Silberstein and T. Etzion, "Optimal Fractional Repetition Codes based on Graphs and Designs", IEEE Transactions on Information Theory, Vol. 61, No. 8, pp. 4164 - 4180, August 2015.

4) N. Silberstein and T. Etzion, "Optimal Fractional Repetition Codes and Fractional Repetition Batch Codes", in proc. IEEE International Symposium on Information Theory (ISIT 2015), pp.2046--2050, Hong-Kong, Jun. 2015.

5) N. Silberstein and A. Zeh, "Optimal Binary Locally Repairable Codes via Anticodes", in proc. IEEE International Symposium on Information Theory (ISIT 2015), pp.1247--1251, Hong-Kong, Jun. 2015.

6) N. Raviv, N. Silberstein, and T. Etzion, "Access-optimal MSR Codes with Optimal Sub-packetization over Small Fields", Recent results session, ISIT 2015.

7) submitted, Relinde Jurrius and Ruud Pellikaan, "On defining generalized rank weights" (<http://arxiv.org/abs/1506.02865>). Ruud presented this work at ACA2015 (see link on arXiv page) and Relinde presented it in the Zürich-Neuchâtel coding & crypto seminar.

8) @ inproceedings{manini2015ceph,
title={Modeling replication and erasure coding in large scale distributed storage systems based on CEPH},
author={Marco Gribaudo, Mauro Iacono and Daniele Manini},

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booktitle={XII edition of the itAIS conference on},
year={2015},
organization={Italian Chapter of AIS}
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9) @article{anglano2015exploiting,
title={Exploiting Rateless Codes in Cloud Storage Systems},
author={Anglano, Cosimo and Gaeta, Rossano and Grangetto, Marco},
journal={Parallel and Distributed Systems, IEEE Transactions on},
volume={26},
number={5},
pages={1313--1322},
year={2015},
publisher={IEEE}
}
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10) @article{fiandrotti2015simple,
title={Simple Countermeasures to Mitigate the Effect of Pollution Attack in Network Coding-
Based Peer-to-Peer Live Streaming},
author={Fiandrotti, Attilio and Gaeta, Rossano and Grangetto, Marco},
journal={Multimedia, IEEE Transactions on},
volume={17},
number={4},
pages={562--573},
year={2015},
publisher={IEEE}
}
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11) @inproceedings{fiandrotti2015pollution,
title={Pollution-resilient peer-to-peer video streaming with Band Codes},
author={Fiandrotti, Attilio and Gaeta, Rossano and Grangetto, Marco},
booktitle={Multimedia and Expo (ICME), 2015 IEEE International Conference on},
pages={1--6},
year={2015},
organization={IEEE}
}
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12) Wolfgam Willems:

Relevant visits (visiting Prof. G. Nebe): RTWH Aachen 30.3. - 2.4. and 4.5.- 8.5.

We concentrated on the problem of finding self-dual MRD codes. Especially we proved together with Gabrielle Nebe the following.

“A Gabidulin code in $(\mathbb{F}_q)^{n \times n}$ (which is MRD) is equivalent to a self-dual code if and only if $n \equiv 2 \pmod{4}$ and $q \equiv 3 \pmod{4}$. Moreover in characteristic 2 there are no self-dual MRD codes in $(\mathbb{F}_q)^{m \times n}$.”

You can find the full paper under: Nr 78 at

<http://fma2.math.uni-magdeburg.de/~willems/wwpubl.html>

13) Ivo Kubjas, Vitaly Skachek, "Data Dissemination Problem in Wireless Networks", 53rd Annual Allerton Conference on Communication, Control, and Computing, Allerton, IL, USA.

14) Thomas Westerbäck, Ragnar Freij-Hollanti, Toni Ernvall, and Camilla Hollanti, "On the combinatorics of locally repairable codes via matroid theory", arXiv:1501.00153, revision submitted to IEEE Transactions on Information Theory, Oct. 2015.

15) Toni Ernvall, Thomas Westerbäck, Camilla Hollanti, Ragnar Freij-Hollanti, "Constructions and properties of linear locally repairable codes", arXiv:1410.6339, revision submitted to IEEE Transactions on Information Theory, 2015.

16) Amaro Barreal, Camilla Hollanti, and Nadya Markin, "Fast-decodable space-time codes for the N-relay and multiple-access MIMO channel", IEEE Transactions on Wireless Communications, to appear, 2015 (or 2016?).

17) Joonas Pääkkönen, Camilla Hollanti, and Olav Tirkkonen, "Device-to-device data storage with regenerating codes", Springer Lecture Notes in Computer Science: Multiple Access Communications, no. 9305, pp. 57-69, Sep. 2015.

18) Thomas Westerbäck, Ragnar Freij-Hollanti, and Camilla Hollanti, "Applications of Polymatroid Theory to Distributed Storage Systems", 53rd Annual Allerton Conference on Communication, Control, and Computing, University of Illinois at Urbana-Champaign, Sep. 2015.

19) Amaro Barreal, Joonas Pääkkönen, David Karpuk, Camilla Hollanti, and Olav Tirkkonen, "A low-complexity message recovery method for compute-and-forward relaying", 2015 IEEE Information Theory Workshop (ITW), Jeju, South Korea, Oct. 2015.

20) Ivan Blanco-Chacon, Camilla Hollanti, Montserrat Alsina, and Dionis Remon Adell, "Fuchsian codes with arbitrary rates", Journal of Pure and Applied Algebra, vol. 220, pp. 180-196, June 2015, arXiv:1410.6094.

21) Camilla Hollanti, Ragnar Freij-Hollanti, and Thomas Westerbäck visited Prof Salim El Rouayheb at IIT Chicago, and worked on Private Information Retrieval. While the topic falls under WG3, the visit was not part of COST activities.