# Final Report on IAPR TC16

## (September 2018 – December 2020)

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# 1. TC Background Information

## 1.1. TC Aim and Scope

The TC16 on “Algebraic and Discrete Mathematical Techniques in Pattern Recognition and Image Analysis” has the main aim to identify, discuss and promote emerging research trends in mathematical methods for pattern recognition, including algebraic, geometrical, topological and discrete mathematical methodologies.

The main goals of TC16 are a discussion of actual and prospective lines of research and exchange of the results in Algebraic and Discrete Mathematical Problems and Techniques inspired by Pattern Recognition and Image Analysis.

TC16 achieves its goals by organizing several dissemination, communication and clustering actions, including the organization of workshops and conferences, the preparation of publications (survey articles, tutorials, etc.), the design of bibliographical databases and benchmarking datasets, the provision of support for results exchange between members.

We also consider it very important to allow the Algebraic and Discrete Mathematical community involved in Pattern Recognition and Image Analysis to know each other better and have a discussion forum.

The main lines of scientific interests of TC 16 are:

- image algebras, image superalgebras, graded image algebras;
- image mining;
- image models of non-statistical nature;
- algebraic models of pattern recognition and image analysis algorithms;
- pattern recognition algorithms based on algebras and discrete mathematics;
- image metrics;
- image equivalence;
- algebraic approach to the knowledge representation and processing in pattern recognition and image analysis problems;

- algebraic and logical techniques application in image databases and knowledge bases;
- algebraic topology in data analysis and learning.

## 1.2 TC Structure and Organization

**Chair:**

- Dr. Davide Moroni, Institute of Information Science and Technologies (ISTI), National Research Council, Pisa, Italy

**Vice-Chairs:**

- Prof. Dietrich Paulus, Institute for Computational Visualistics, University of Koblenz-Landau, Koblenz, Germany
- Dr. Vera Yashina, Federal Research Center "Computer Sciences and Control", Russian Academy of Sciences, Moscow, Russian Federation

**Honorary Chair**:

-Dr.-Eng. Igor Gurevich, Federal Research Center "Computer Sciences and Control", Russian Academy of Sciences, Moscow, Russian Federation

**Scientific Secretary:**

- Dr. Maria Antonietta Pascali, Institute of Information Science and Technologies (ISTI) National Research Council, Pisa, Italy

**Bureau members:**

- Prof. Dr. Heinrich Niemann, Friedrich-Alexander-University of Erlangen-Nuremberg Erlangen, Germany
- Prof. Dr. Bernd Radig, Munich Technical University, Munich, Germany
- Prof. Dr. Gerhard Ritter, University of Florida, Gainesville, USA
- Prof. Dr. Ovidio Salvetti, Institute of Information Science and Technologies (ISTI) National Research Council, Pisa, Italy

## 1.3 TC website URL

http://iapr-tc16.isti.cnr.it/

## 1.4 Number of members (people on the mailing list)

The mailing list, based on the previous activity of the TC16, has now 1550 members.

## 1.5. Communication means (e.g. newsletters, social media) and frequency

The main communication means are represented by the issue of the newsletter, by the news section on the website and by contribution to the IAPR newsletter. Two issues were released after the restart of the activities, starting with the fall of 2019.

## 1.6. Listing of key event(s) typically organized by the TC

The brand name of the main event organized by TC16 is "Image Mining: Theory and Applications" (IMTA), which has reached the seventh edition this year named IMTA-VII-2020, (as described below). The IMTA-VII-2020 continues the successful series of workshops devoted to modern mathematical techniques of image mining and to corresponding applications:

- IMTA-I-2008, Funchal, Madeira, Portugal, in conjunction with the 3rd International Conference on Computer Vision Theory and Applications (VISAPP 2008);
- IMTA-II-2009, Lisboa, Portugal, in conjunction with the 4th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2009);
- IMTA-III-2010, Angers, France, in conjunction with the 5th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2010);
- IMTA-IV-2013, Barcelona, Spain, in conjunction with the 8th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2013);

- IMTA-V-2015, Berlin, Germany, in conjunction with the 10th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications (VISIGRAPP 2015);
- IMTA-VI-2018, Montreal, Canada, in conjunction with the 1st International Conference on Pattern Recognition and Artificial Intelligence (ICPRAI 2018).

The workshops were organized jointly by the Technical Committee No. 16 "Algebraic and Discrete Mathematical Techniques in Pattern Recognition and Image Analysis" of the International Association for Pattern Recognition and by the National Committee for Pattern Recognition and Image Analysis of the Russian Academy of Sciences until 2015. The 2018 edition was organized in a period during which TC16 was not active and was managed by the National Committee for Pattern Recognition and Image Analysis of the Russian Academy of Sciences.

The workshops are usually enriched by a relevant publication activity:

A. Proceedings of IMTA, including all accepted papers (before or during the workshop); the Proceedings were published as a separate book or included in the Proceedings of the corresponding conference;

B. Extended texts of selected papers in the Special Issues of the international journal of the Russian Academy of Sciences "Pattern Recognition and Image Analysis. Advances in Mathematical Theory and Applications". ISSN PRINT: 1054-6618, ISSN ONLINE: 1555-6212 (see PRIA – http://pleiades.online and http://link.springer.com).

## 2. Activities in the last two years (since ICPR 2018)

Restart and preliminary activities. The TC16 was proposed by the Russian Federation "Association for Pattern Recognition and Image Analysis" and created in 1996 (at the meeting of the IAPR Governing Board in Vienna, 13th ICPR). The "Association" represented in the IAPR the Russian Academy of Sciences till 2006, then the representative of the RAS in the IAPR become the "National Committee of the Russian Academy of Sciences for Pattern Recognition and Image Analysis". TC16 successfully worked till 2012, when the activities were paused. In 2018 an activity towards TC16 renewal was carried out, which eventually

resulted in the approval of the restart of the activities during IAPR meeting at ICPR 2018. This was formally communicated to the appointed chair in March 2019. Preliminary activities soon started with the creation of a brand new website (http://iapr-tc16.isti.cnr.it/). Teleconferences were organized among the chair, the vice-chairs and the honorary chairs for defining and forming the board, also by selecting a scientific secretary (Maria Antonietta Pascali, CNR-ISTI) and newsletter editors (Vera Yashina and Igor Gurevich, RAS). A bureau was also proposed to serve as an advisory board to support the chair and vice-chairs in selecting scientific themes and presenting new activities.

Creation of mailing list and newsletter. A mailing list was created also based on the former data collected by the TC during the years and launching a new campaign to enrol interested researchers. The campaign, following the suggestion of IAPR ExCo, was based via networking with interested people (i.e. a grassroots approach, from the grounds up). To this end, the activities of TC16 have been briefly presented at conferences.

Organization of IMTA-VII-2020 at ICPR 2020. The activities were soon oriented to the organization of a large scale event for the TC16 under the brand name of IMTA. It was quickly apparent that it was impossible to organize IMTA during the year 2019 and, therefore, plans were made for the next year 2020. ICPR, to be held in Italy, was selected as a convenient and highly relevant event for hosting IMTA workshop. The workshop proposal was approved by ICPR workshop chair. As it is well known, during the COVID19 outbreak, several changes were made to the initial plans for ICPR; consequently, also IMTA has moved to an entirely virtual event that will be held on January 11th, 2021. The workshop consists of invited talks, contributed talks, informal discussions and a wrap-up session (see http://imta.isti.cnr.it/index.php/program). The workshop received 34 submissions for reviews from authors belonging to 11 different countries. After the review process, 31 papers were accepted and, eventually, 27 regular papers were included in the workshop program for oral presentation. The review process, based on a minimum of two reviews for each paper, focused both on paper quality and prospective interest in the themes of IMTA workshop. A number of invited talks further enriched the program. Notably, the lecture titled "Basic Models of Descriptive Image Analysis" has been delivered by Dr.-Eng. I. Gurevich

and Dr. V. Yashina (Federal Research Center "Computer Sciences and Control" of the Russian Academy of Sciences, Moscow, the Russian Federation) while "Learning topology: bridging computational topology and machine learning" has been presented by Dr. M.A. Pascali and Dr. D. Moroni (ISTI-CNR, Italy).

Organization of the extended OGRW. During the first actions of the TC16, it has been planned to have a larger event besides the one-day workshop IMTA at ICPR. Indeed, a 3-day event was scheduled to be held in Italy during spring 2021 in the form of an eXtended Open German Russian Worskhop (X-OGRW). Its main goal was an engagement of the local communities and TC16 community. Unfortunately, the initiative was aborted due to the unclear situation connected to COVID19 and the postponement of ICPR 2020 to the beginning of 2021.

Promotion at conferences. The purposes of the TC16 were disseminated at several conferences including the 41st DAGM German Conference, DAGM GCPR 2019 held in Dortmund and the 15th International Conference on Signal-Image Technology & Internet-Based Systems (SITIS 2019) held in Sorrento.

# 3. Future plans (timeline until ICPR 2022 and beyond):

## 3.1. Planned activities

TC16 Leadership meeting. A TC16 core meeting will be scheduled as soon as the general situation makes it possible to travel again. The selected venue will be Munich, Germany. The meeting will serve to better shape the objectives and emerging research lines relevant to TC16 and will include an in-depth thematic workshop.

Exchange, visits and students. We are looking for opportunities of exchange and visit among the TC16 core members. Funding for this initiative will depend on the specific funding program of the institutions to which the members are affiliated. In Pisa, a PhD program on

the themes of TC16 has been started and a grant was offered to a student. It is expected that student mobility will be fostered to activate collaboration and joint publications among the TC16 community.

IMTA-VIII and large scale events. It is expected to organize the next edition of IMTA at the end of 2021. Specific plans will be made after the evaluation of the impact of the forthcoming edition scheduled for Junary 11th, 2021. After the abortion of X-OGRW organization, it is planned to re-considered the opportunity of such a meeting as a catalyst of new cooperation among TC16 member and the Italian, German and Russian communities working on mathematical aspects of pattern recognition.

Clustering with other committees and working groups. It is expected to activate links (in the form of joint events) with the organizers of the Open German Russian Workshop (OGRW) on Pattern Recognition and Image Understanding. Another foreseen action is towards the ERCIM Working Group on multimedia understanding through semantics, computation and learning (https://wiki.ercim.eu/wg/MUSCLE/).

Community building, social identity and white paper. After the restart of TC16 activities, a publicity plan has been launched. Besides diffusion in the mailing lists of the communities to which the core members of the TC16 belong, the program will include the gathering of the expressions of interests by other interested parties. A specific form has been prepared to collect, besides basic information, a list of break-through lines of research and challenges (see http://iapr-tc16.isti.cnr.it/index.php/survey). The feedback from the community will be analyzed in order to shape the direction lines of the TC16 and define shared and relevant working topics. The analysis of the received feedback will be eventually reported in a white paper. Such a collaborative approach can be also beneficial to the construction of an active community supporting the TC. To this end, promotion of the TC16 will be sought using social media and, in particular, creating a Linkedin group, which seem to be the better choice given the nature of the group. Slack's use will also be considered for a more lively sharing of news, recent research and datasets, open positions, and other events.

### 3.2. Recommendation to ExCo for TC leadership team for 2021-2022 term *(TC Chairs cannot serve for more than two terms)*

During this anomalous term, the current board has made efforts to restart the TC16 successfully. The success of the event IMTA-VII-2020 at ICPR 2020 suggests that the performed actions have had a relevant impact in resuming the activities and creating a community interested in the topics of the TC16. Nevertheless, not all the steps already planned reached final results, and they are still a work in progress. For this reason, we suggest confirming the current board for another term to complete what has begun.

## 4. Other Comments

The epidemic that hit the group's principal members in waves had complex effects to assess. Being the chair and the secretariat in Italy, during the first outbreak in spring 2020 it was tough to carry out the activities of the TC16 due to the broader organizational difficulties that affected the research labs and the institutions and due to the switch to smart working. The other TC16 participants then experienced similar effects. Thanks to the courage of the ICPR 2020 organizers, we were able to continue with the IMTA project, which had an unexpected and unparalleled success. Probably, the extensive participation in IMTA that we have registered is also due to the greater convenience of attending an online event, thanks to the saving of time and money in travel. However, we will have to evaluate in retrospect the effect of the workshop and the stimuli it will provide to the community.