

## REPORT ON OpenDreamKit DELIVERABLE D2.15

### Community building: Impact of development workshops, dissemination and training activities, year 4

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#### DELIVERABLE DESCRIPTION, AS TAKEN FROM GITHUB ISSUE #40 ON 2019-10-08

- **WP2: Community Building, Training, Dissemination, Exploitation, and Outreach**
- **Lead Institution:** Université Paris-Sud
- **Due:** 2019-08-31 (month 48)
- **Nature:** Report
- **Task:** T2.3 (#26)
- **Proposal:** p. 38
- **Final report (sources)**

An important key to the success of the ODK project is linked to its ability to **foster a community** in the spirit of the open source projects it is built on. Part of this relies on the organization and participation to scientific and development events of many different scales and objectives. Following up on D2.2 (#42) for year 1, and D2.11 #36 for year 2 and 3, we report here on more than 29 events we have been part of during year 4. This includes:

- the (co)organization of seven development workshops;
- the (co)organization of ten training and community building workshops -- including one in a developing country and one targeted at women;
- the organization of one research conference;
- communications at and participation to eleven external events.

We describe each event with its specific goals and explain the exact implication of ODK in the organization and realization of the event. We give a general overview of the impact of single events, thus drawing a picture of ODK impact as a whole.

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## 1. DEVELOPMENT WORKSHOPS

Throughout year 4 of the project, we organized five development workshops with a limited number of participants who met to work on a specific task. These workshops are an inherent part of OpenDreamKit development process as described in [T2.3](#): they bring together developers from within and outside of OpenDreamKit and allow effective work and discussions on many technical aspects. They also participate in building and maintaining a community of developers inside OpenDreamKit and within the open-source communities we belong to. Some of the workshops included a training and/or dissemination approach.

### **Event 1- LinBox Winter days 2018**

Richerenches (FR), 2018-12-04 to 2018-12-07

ODK partners involved: UGA

10 participants (including 4 from within ODK)

<https://github.com/linbox-team/fflas-ffpack/wiki/LinBox-winter-days-in-Richerenches-18>)

**OpenDreamKit implication.** OpenDreamKit participants: A. Breust, J-G. Dumas, C. Pernet, H. Zhu.

OpenDreamKit provided the main funding source for the workshop (accommodation, subsistence and some travel expenses), for about 3.5k€.

**Event summary.** The LinBox Winter Days 2018 took place in Richerenches (France) from December 4th to 7th. There were 10 participants from either Université Grenoble Alpes or Université of Montpellier. The focus of the meeting was twofold: advancing core development of the libraries in the LinBox ecosystem, and welcoming and integrating new developpers within the community. The main activities of the group during the meeting were:

- group brainstorming on new designs (e.g. refactoring of the dense matrix classes, of lifting containers, etc),
- pair programming of the resulting new designs,
- close interaction in bug correction and code review,
- tutorial presentations for introducing new developpers to the librairies.

**Results and impact.** A large number of issues and bugs have been successfully processed. New design for the lifting container classes and the dense matrix classes have been finalized and their implementation drafted. This effort was then successfully pursued and merged into the libraries.

### **Event 2- Atelier PARI/GP 2019**

Bordeaux (FR), 2019-01-14 to 2019-01-18

ODK partners involved: UPSud CNRS UVSQ UWarwick

36 participants (including 6 from within ODK)

<http://pari.math.u-bordeaux.fr/Events/PARI2019/>

**OpenDreamKit implication.** OpenDreamKit participants: B. Allombert, K. Belabas, J. Cremona, V. Delecroix, J. Demeyer, L. de Feo.

OpenDreamKit provided the main funding source for the workshop (accommodation, subsistence and some travel expenses), for about 13k€.

**Event summary.** The 12th Atelier PARI/GP took place in Bordeaux (France) from january 14h to 18th.

There were 57 registered participants from 31 different institutions (no registration fees).

A typical day of the workshop had introductory talks and tutorials in the morning; afternoons allowed ample time for hacking sessions, discussions and training.

The Atelier featured 10 morning talks on mathematical topics and implementation projects including 4 talks by OpenDreamKit members

- Bill Allombert “New GP features” and “Parallel GP programming”.
- John Cremona “Computing classical modular forms for the LMFDB”.
- Jeroen Demeyer “cypari2: Python bindings for PARI/GP”.

Slides for all talks are available at <http://pari.math.u-bordeaux.fr/Events/PARI2019/>

**Results and impact.** The workshop was productive and a successful teaching and dissemination event; 12 participants came from developing countries (Algeria, Djibouti, Lebanon, Morocco, Senegal, Tunisia, Turkey).

It provided final feedback on recent PARI/GP developments that paved the way for the release of pari-2.12-alpha (2019/06).



PARI/GP Atelier 2019, Bordeaux, France

### Event 3- Micromagnetism Workshop: Ubermag and mumax<sup>3</sup>

European XFEL, Schenefeld, Germany, 11-14 June 2019

ODK partners involved: XFEL

**Main goals.** The main goal of this workshop was to develop a micromagnetic calculator for driving mumax<sup>3</sup> micromagnetic simulation tool.

**OpenDreamKit implication.** The main implication of this workshop was that another computational backend can be used (apart from OOMMF) to run micromagnetic simulations. mumax<sup>3</sup> has certain advantages over OOMMF, mostly in terms of its capabilities of running micromagnetic simulations on GPU. This would enable us to reach a much larger target audience.

**Event summary.** The first day of the workshop consisted of presentations from all its participants in order to familiarise all participants about the basics of Ubermag and mumax<sup>3</sup>.

Another 3 days were focused on coding and the implementation of the mumax<sup>3</sup> calculator, setting up the repository's infrastructure, and discussions of future developments.

**Results and impact.** A micromagnetic calculator, based on mumax<sup>3</sup>, was developed and covers the most important capabilities of mumax<sup>3</sup>:

<https://github.com/ubermag/mumax3c>

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#### Event 4- Sage Gap Days 2019

Cernay-la-ville (FR), 2019-06-17 to 2019-06-21

ODK partners involved: UPSud

20 participants (including 8 from within ODK)

<https://wiki.sagemath.org/days101>

**Main goals.** This developer meeting was the third in a row with a focus on OpenDreamKit tasks related to packaging, portability and documentation tools for GAP and SageMath.

**Event summary.** An intensive week of brainstorms and coding sprints, structured by regular planning and debriefing sessions, and interspersed with a few presentations:

- Sage Combinat Widgets and Francy, Sage Explorer by O. Benassy
- Semantic aware Sage interface to GAP by Nicolas M. Thiéry
- Jupyter Viz by professor Nathan Carter from St Andrews university,
- Cppyy by Julian Rüth, PhD.
- RISE by Tomer Bauer, PhD student from Bar-Ilan University, in Israel

**OpenDreamKit implication.** This event was organized and funded by OpenDreamKit (Paris Sud). Accommodation and meals for all participants were covered by ODK funding sources. OpenDreamKit participants covered their own travel expenses.

**Demographic.** Eight OpenDreamKit participants (N. Thiéry, V. Delecroix, F. Rabe, V. Klein, S. Lelièvre, L. de Feo, O. Benassy, E.M. Bray) from four sites, together with twelve other participants from nine different institutions

#### Results and impact.

The workshop was the occasion of a major advance for packaging SageMath and dependencies with Conda. A first version of SageMath had been packaged two years ago in good parts by independent conda expert Isuru Fernando. However the packages had not been updated since due to a series of hurdles. Thanks to the coming of Isuru and brainstorms with local experts of SageMath and GAP, many of the hurdles have been lifted, leading to the packaging of the latest version of SageMath and paving the way for more regular updates in the future.

In addition, a lot of work was targeted at continuous integration, Python 3 support, docker packaging and interfaces between systems.

Finally the workshop was the occasion for a joint coding sprint between ODK participants and Nathan Carter, around visualization (Francy, Jupyter Viz) and live browsing of mathematical data (Sage Explorer, Group Explorer). This led to the sharing of much vision and know how, and opened the door for potential future convergences between the related projects.

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#### Event 5- GAP–Singular School and Meeting

PfalzAkademie, Lambrecht, Germany, 15–23 August, 2019

ODK partners involved:

33 participants (including 4 from within ODK)

<https://opendreamkit.org/meetings/2019-04-02-GAPSingularMeeting/>

**Main goals.** The main goals were to finish ODK related developer tasks as well as to introduce beginners to GAP and SINGULAR, present computer algebra-related work, and share ideas through workshops.

**ODK implication.** The event was fully funded by ODK. Costs are still pending due to overseas travel claims.

**Event summary.** The event consisted of three parts:

- School: a sequence of workshops to introduce beginners to GAP, SINGULAR, and open-source development principles.
- Mini-conference: talks to allow participants to present computer algebra-related work to each other.
- Workshops: a set of workshops dedicated to specific computer algebra problems.

**Demographics.** The workshop had just under 50 registered participants, not all of which were able to attend (VISA delays). The participants came from more than 10 countries on 4 continents. We had a total of 8 women attending.

**Results and impact.** In the School, tutorials were given that introduced participants to:

- Best practices in software development (Max Horn);
- Basic use of GAP (Michael Torpey);
- Advanced Topics in GAP (Thomas Breuer);
- Basic use of SINGULAR (Christian Eder, Andreas Steenpaß, Isabel Stenger);
- Parallel modular algorithms in Singular (Christian Eder, Andreas Steenpaß, Isabel Stenger);
- CAP: Categories, algorithms, programming (Sebastian Posur).

These tutorials were complemented by informal discussions, and chances for learners to answer questions. The “Best practices” and “Basic use of GAP” sessions followed material from appropriate Software Carpentry courses (<https://software-carpentry.org/lessons/>): “Version Control with Git” and “Programming with GAP” respectively.

The workshops of basic SINGULAR and GAP were well received - several participants were either novices in GAP or SINGULAR. For the non-beginners, the advanced workshops on modular algorithms in SINGULAR and on CAP (a GAP package for categories, in particular in, but not restricted to, algebraic geometry) proved very interesting.

The next part, contributed talks, covered only a single day. However the talks originated in many different areas of mathematics and covered many successful challenging applications of components (GAP, SINGULAR) of ODK.

The final part, comprised of workshops on GAP, SINGULAR and CAP allowed us to close off remaining issues with regard to the integration of the ODK work into the various packages, e.g. improvements to the integration of the fast multivariate polynomial arithmetic in Singular. The workshop was in particular extremely useful in bringing participants together to discuss some of the remaining technical challenges and in understanding the mathematical challenges real world researchers were facing and how they could be solved using tools developed during ODK. For example, it was discovered during the workshop that a bottleneck experienced by one of the participants was down to fast multivariate polynomial arithmetic (via rational functions) which was then directly worked on by participants of the meeting. There was also a project to improve integration of SINGULAR into the Singular.jl subsystem of the Oscar computer algebra system specifically so that Gröber bases could be computed over coefficient fields implemented by ODK components. This project was finalized and merged at the workshop after months of unsuccessful previous attempts.

The GAP workshop was part of the GAP 4.11 release process which is critical for the dissemination of ODK components such as LIBGAP. At the workshop, changes to the LIBGAP system were documented and significant progress was made towards rapping up the release to

reach users. This included dissemination of GAP into the Debian distribution. There were also lively discussions about the GAP-JUPYTER integration.



GAP–Singular meeting, PfalzAkademie, Lambrecht, Germany

## Event 6- Workshop on Data in Mathematics

Cernay, France, August 17th to 24th

ODK partners involved: UPSud FAU

14 participants (including 11 from within ODK)

<https://opendreamkit.org/2019/08/17/WorkshopOnDataInMathematics/>

### Main goals.

**ODK implication.** This event was organized and funded by OpenDreamKit (Paris Sud, FAU). OpenDreamKit funded accommodation for all participants, as well as travel expenses for all but two.

**Event summary.** This workshop brought together interested users and authors of mathematical datasets, data framework developers, and experts interested in integrating mathematical databases with computer algebra systems. Participants discussed general issues related to data in mathematics, as well as working on concrete steps towards improving the status.

**Demographic.** The workshop was attended by two PhD students, a postdoc, four research software engineers, and seven researchers from various areas of mathematics and computer science.

**Results and impact.** The workshop allowed for a lot of time for free discussion. Several pain points experienced by mathematicians that work with data came up this way, were noted, and several cases already acted upon. In particular, there appears to be a real need for a journal dedicated to mathematical datasets and mathematical software.

Discussions on provenance of data in mathematics, initiated by Dr. Michael Kohlhase, resulted in a draft of a standard and formalisation of math data provenance.

Similarly, participants collaborated on how the web interface for datasets in mathematics should look like. This effort was led by Dr. Andrea Kohlhase and resulted in a clickable prototype in addition to a long list of requirements, sorted into must–have, should–have, and can’t–have.

Participants from FAU are working on an infrastructure for math data and significant effort went into improving this prototype system. As planned, we were able to import several real-life datasets. This included writing up descriptions, metadata (including provenance), formalising the mathematics. In addition to the datasets that were planned for import, several participants identified the need for new datasets for their research communities, and have started to work on them. The diverse backgrounds of the participants made for a helpful environment for this.

Participants also worked on side projects related to data in mathematics. Odile Bénassy was able to quickly produce a basic Jupyter interface to the system, opening up new interface possibilities. Several user stories were collected by Gabe Cunningham, and will serve as use cases for the system. Participants also added content to a multilingual math glossary.

The following testimonials indicate the degree of progress made in a single week.

#### Gabe Cunningham

*“By bringing together the developers of the MathHub with the mathematicians who are producing and analyzing math data, the workshop accomplished in a week what would have otherwise taken months. It was immensely gratifying to see how quickly the system evolved into something that is already better than the state of the art for most mathematicians.”*

#### Andrea Kohlhase

*“We had a super intense workshop with people with very different, complementing competencies all strongly willing to work together towards the same goal of pushing the data on MathHub idea: a real team evolved and with that a push beyond my expectations.”*

#### Jukka Kohonen

*“For me this was a great way of getting to know people working towards open math data. It was also an opportunity to see the general idea from different perspectives, including concrete databases, user interfaces, and formal and informal logic interconnecting the data. All this and good concrete steps taken within a superbly leisurely setting – I was absolutely enjoying my time!”*

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### Event 7- Report Writing Sprint

Cernay-la-ville, France, 24th-31th of August 2019

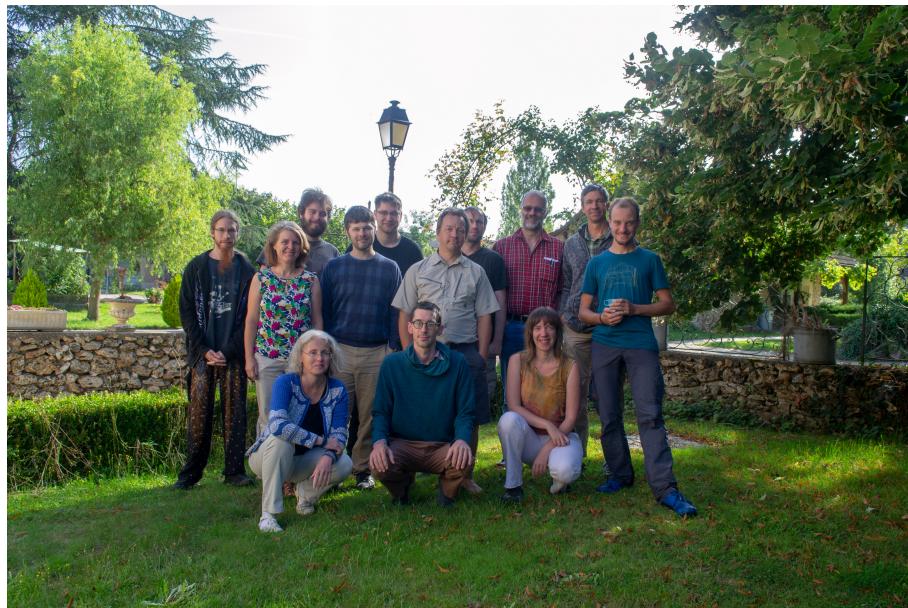
ODK partners involved:

13 participants (including 13 from within ODK)

<https://opendreamkit.org/2019/08/26/FinalReportsSprint/>

**Event summary.** This workshop brought together OpenDreamKit participants just before the end of the project to collectively: write the project reports, prepare demos for the final review, and other collaborative ODK work.

**OpenDreamKit implication.** 12 ODK members participated to this workshop. Paris-Sud paid for local expenses (food and accommodation); Other sites paid for the travel expenses of their members.



Workshop on Data in Mathematics, Cernay, France

**Results and impact.** The ODK members worked on the writing of 13 deliverables and also made progress on the technical report writing. 7 deliverables were submitted during that week. In addition, the already submitted deliverable D5.13 was improved and re submitted.

## 2. DISSEMINATION AND OUTREACH ACTIVITIES

We describe here all activities related to **T2.5**: these are all events oriented towards dissemination, training, and outreach. This includes events organized or co-organized by OpenDreamKit and also participating in external events and many communication activities.

### 2.1. Training and community building workshops in established mathematical communities

We have organized or coorganized a series of workshops to support communities of mathematicians in their use of open source computational software and VRE. Such workshops typically consist of a blend of tutorials at all levels and coding sprints with the following aims:

- **Training and attracting more users:** this is the perfect place for newcomers, especially students, to get acquainted with the systems; meanwhile, more experienced users get training on more advanced topics and on how to collaborate and share their production.
- **Disseminating and evaluating OpenDreamKit outcomes:** running many training sessions give ample opportunities to witness how end-users adopt or struggle with the OpenDreamKit outcomes, and how they fit their needs.
- **Improving the overall quality:** by fostering researchers in specific areas, Sage Days help bring interesting mathematics into the software, which is beneficial for Sage and so OpenDreamKit.
- **Community building:** the workshops foster a collaborative spirit where everyone is encouraged to share their expertise, help each other, make teams to tackle shared needs, and contribute back.

#### Event 8- Software Tools for Mathematics

Koper, Slovenia, 2018-09-24–2018-09-28

ODK partners involved: UPSud  
43 participants (including 3 from within ODK)  
<http://stm.famnit.upr.si/>

**Main goals.** The goal of the event was for mathematicians to improve their coding skills and knowledge of mathematical software.

**ODK implication.** Samuel Lelièvre (OpenDreamKit member from UPSud) was one of the organisers. The OpenDreamKit funds at Paris-Sud were used to fund travel and stays of speakers. The Faculty of Mathematics, Natural Sciences and Information Technologies at the University of Primorska and Andrej Marušič Institute at the University of Primorska provided coffee and snacks at coffee breaks as well as equipped lecture rooms. The Slovenian Discrete and Applied Mathematics Society provided gifts for all participants.

**Event summary.** The event consisted in a two-day Software Carpentry workshop (teaching participants the Unix shell, version control with Git, and programming with Python) followed by three days on mathematical software with mini-courses on CoCalc, GAP, SageMath and Jupyter, LaTeX and TikZ, as well as talks on other mathematical software and databases, and on mathematical research using software. A problem session allowed participants to submit mathematical problems they cared about and thought software might help with, a few of which were solved in the following days by other participants.

**Demographics.** The participants included a small number of bachelor students, several PhD students and postdocs, professors and researchers.

**Results and impact.** At the Software Carpentry workshop, the Unix shell was taught by Peter Palfrader and Jan Berčič, Git was taught by Alexander Konovalov and Peter Palfrader, and Python was taught by Julian Rüth and Nino Bašić.

During the mathematical software part, Alexander Konovalov taught GAP, Nino Bašić taught LaTeX and TikZ, Samuel Lelièvre taught SageMath and CoCalc, and Julian Rüth taught SageMath.

Many participants told the organisers, orally or by email, that this workshop was transformative for them; often they felt they had passed some confidence threshold: whereas before the conference they were interested in mathematical software but unsure how to install and use them, they were now confident how to do that, and felt they had the necessary resources to learn more. One of the participants even commented that they were able to use what they learned immediately in their research. Some of the participants are involved in the organisation of the upcoming European Congress of Mathematics (ECM 2020 Portorož, Slovenia), and expressed interest in highlighting open software for mathematics at the ECM.

Furthermore, a CoCalc instance was installed on University of Primorska servers due largely to this event.

This event was conceived due to the success of the Software Tools for Mathematics in Morelia earlier in 2018. Based on the success of both workshops, Samuel Lelièvre and Katja Berčič (who participated in the organisation of both) hope that the series will continue and are considering options for future installments.

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## Event 9- GAP in Algebraic Research – Summer School

Aachen, Germany, 19th-22nd of November 2018

ODK partners involved:

41 participants (including 1 from within ODK)

<https://lbfm-rwth.github.io/gap-in-algebraic-research-2018/>



Software Tools for Mathematics in Koper, Slovenia

**Main goals.** The aim of this “summer” school was to give an overview of different applications of GAP in mathematical research.

**ODK implication.** Alexander Konovalov was one of the instructors. Costs £560.

**Event summary.** The speakers presented their areas of research, the functionality that is available in GAP to investigate these areas computationally, and guided participants through these tools during the accompanying hands-on programming lab sessions.

**Results and impact.** Alexander Konovalov gave an introductory GAP Tutorial based on the Software Carpentry lesson “Programming with GAP” (<https://doi.org/10.5281/zenodo.597073>), demonstrated GAP Jupyter notebooks and parallel distributed calculations using the SCSCP package. The format of this part of the school’s programme followed the Software Carpentry teaching approaches. In particular, we collected the feedback on minute cards after each of the half-day sessions. Some quotes from the feedback written by the learners:

- Nice step-by-step introduction
- Good organisation of materials and presentation
- The content are quite well organised
- Idea with stickers is cool. This really makes asking questions easier
- I really like the use of stickers as tools for asking for help and give feedback
- I really liked the tutorial, well explained, and differences between listing on a group elements or a group G!!!
- Appropriate speed
- Started from the beginning, easy to follow
- The session was understandable
- I learned a lot of interesting ‘short’ commands
- Lots of shortcuts - I am very lazy
- Very useful tips on optimising the working process (autocompletion etc)
- Many nice details
- ”Real-life” example of application (average order of group elements) that demonstrate necessary syntax =)
- Good to solve a simple problem, not only technical details
- Programming with a goal in mind
- Very informative and useful

- Like presentation of different packages - also interesting for people knowing GAP
- Excellent the Jupyter notebook!! Incredible! I would like to see more about this application.
- References to "modern" interfaces like Jupyter instead of command line
- Some interesting tricks for people who already know GAP
- The graphical applications were awesome!



GAP in Algebraic Research Summer School, Aachen, Germany

### Event 10- Free Computational Mathematics

CIRM, Luminy, France, 11–15 Feb 2019

ODK partners involved: CNRS UNIKL UGent UVSQ USTAN

58 participants (including 17 from within ODK)

<https://opendreamkit.org/2019/02/11/FreeComputationalMathematicsConference>

**Main goals.** *Free Computational Mathematics* was a community building and training conference for a wide mathematical audience: it was one of the main dissemination events for OpenDreamKit and our public closing event.

**ODK implication.** This conference was organized jointly by OpenDreamKit's sites UPSud and UGent, under the lead of UPSud. The cost was about 60 000€, covered by UNIKL.

**Event summary.** We brought together users and developers of most OpenDreamKit software components (GAP, JUPYTER, LINBOX, MPIR, PARI/GP, SAGE, SINGULAR). The workshop followed a long trend of highly productive workshops that we organised in the past, consisting of keynote talks and hands-on tutorials with a focus on experimental research and computational

and development best practices. There was plenty of time for interactions and collaborative work. Part of the schedule was intentionally made up during the workshop itself, taking input from the participants on what trainings they wanted to see.

**Results and impact.** On the dissemination side, many participants wished for the training to extend for more than five days, and for similar events to be organized at their location. In particular our three participants from Nigeria went on to organize a similar event at the University of Ibadan, with support and trainers from OpenDreamKit (See Sage Days 102 below). On the community building side, this was the first time that such a wide mix of developers from PARI, Singular, GAP, LMFDB, SageMath, Oscar, and Jupyter were gathered together and closely collaborating, which was invaluable for long term community building.



Free Computational Mathematics, CIRM, Luminy, France

### Event 11- SageMath classes in Crete

Heraklion, March. 4-6, 2019

ODK partners involved: UPSud

10 participants (including 1 from within ODK)

**Main goals.** We organized a series of SageMath classes in the mathematical department of the University of Crete.

**ODK implication.** OpenDreamKit funded the trip of Viviane Pons to give the classes.

**Event summary.** A series of three classes was organized throughout the week. This was open both to students (from undergrad to PhD) and researchers of the math department of the University of Crete. The classes consisted of SageMath tutorials to allow the attendees to discover the software at their own pace. We used Jupyter notebooks with a focus on math related problems.

**Results and impact.** The students enjoyed the tutorials a lot. It was actually used as a starting point for more regular sessions tutored by their local teacher Eleni Tzanaki. We are now confident that SageMath will be taught at University of Crete as part of the math program. The meeting was also an occasion to prepare the up-coming Women in Sage event also organized in Crete.

### Event 12- Atelier PARI/GP 2019b

Roma (IT), 2018-04-09 to 2018-04-10

ODK partners involved: CNRS

36 participants (including 6 from within ODK)

<http://pari.math.u-bordeaux.fr/Events/PARI2019b/>

**Main goals.** This was a teaching and dissemination meeting, by invitation from the Roman Number Theory Association as a satellite event for their 5th mini-symposium.

**OpenDreamKit implication.** OpenDreamKit participants: B. Allombert and A. Page from Bordeaux.

OpenDreamKit funded travel and accommodation costs for B. Allombert for about 1.5k€. The ALGANT consortium, LIA LYSM (CNRS) and University Roma Tre co-funded the event.

**Event summary.** This Atelier PARI/GP took place in Roma (Italy) on April 9th and 10th. It was followed by a 3-day international research conference on Number Theory. There were 40 participants for the Atelier.

The 2-day Atelier followed the same pattern as the previous Roma Atelier in 2018, featuring a general introduction to PARI/GP and two specialized courses (graduate level) in the mornings:

- Bill Allombert “Finite fields”,
- Aurel Page “Algebraic number theory”.

Afternoons were devoted to practice and problem sessions.

Slides for all talks are available at <http://pari.math.u-bordeaux.fr/Events/PARI2019b/>

**Results and impact.** This was a successful teaching and dissemination event, with positive feedback from the participants and organizers.



Atelier PARI/GP, 5th Roman Number Theory Association mini-symposium, Rome

### Event 13- Sage Days 105: Free and Practical Software for Algebraic Combinatorics 2019

University of Ljubljana, Slovenia, 8th-12th of July 2019

ODK partners involved:

58 participants (including 2 from within ODK)

<https://wiki.sagemath.org/fpsac19>

**Main goals.** This workshop was organized as satellite event to the main yearly international conference on algebraic combinatorics FPSAC (Formal Power Series and Algebraic Combinatorics). It aimed at gathering researchers from this community interested in computation for training, community building, and coding sprints.

**ODK implication.** Nicolas M. Thiéry was one of the organizers. There was no registration fee. OpenDreamKit funded meals and nights taken by the participants at the local Youth Hostel (Dijaski dom Vic, Gerbičeva ulica 51a, Ljubljana).

**Event summary.** The workshop featured a total of 16 tutorial sessions, 8 demos and 6 presentations, including the following presentations by ODK participants: “Best practice for computer exploration”, “Live online notebooks with Binder”, “Object oriented programming in Sage”, “Authoring SageMath packages”, “free/libre software is good and what you can do about it”, “Sage-Combinat-Widgets, Francy”.

The first plenary talk was about inspiring the next generation, notably women, about the impact using and developing computational software can have on conducting one’s research in algebraic combinatorics. The main purpose of the remaining plenary talks was to pave the path for the implementation of new features in SageMath and related software, to ignite, inspire and fuel brainstorms and coding sprints with other participants. Training took the form of short demos to give an overview of the OpenDreamKit toolkit, tutorials that were presented to point participants to resources to explore according to their pace and taste, with continuous support from instructors, and guided tutorials/longer presentations in separate rooms. Participants were encouraged to skip the parts that were irrelevant to them (e.g. tutorials on material they already master) to engage into parallel collaborative activities such as coding sprints.

**Demographics.** Out of 56 participants, 19 were PhD students and 37 researchers or professors, 15 from european countries (Germany, France, Slovenia, Portugal, Netherlands, Austria, Iceland), 21 from North America (US, the Caribbean, Canada) 1 from Australia and 19 from all over the world (Israel, Korea, Turkey, India, China, Nigeria, Chile). We had 15 female participants to this workshop. Although still far from satisfactory with respect to the last four years this gender gap in the software development area tends to shrink, with several bright young women taking on lead roles.

**Results and impact.** More than one fifth of the FPSAC participants decided to participate to this event; they actively engaged into the collaborative atmosphere; a lot of expertise was shared, not counting new software contributions. One of the participant wrote back “Thanks again for a very useful Sage Days. I was happy that the Dynamics package got finished ... Its fantastic how you’ve shepherded this community over many years now, and the mathematical community is much better for it.”. Another decided to organize a similar satellite event to FPSAC’20.

## Event 14- Sage Days 100, University of Bonn

Bonn (Germany), July 22 – July 27, 2019

ODK partners involved: UPSud

25 participants (including 6 from within ODK)

<https://opendreamkit.org/2019/07/22/SageDays100/>

**Main goals.** The Sage Days 100 workshop gathered a variety of public (from master student with no prior knowledge of Sage, to senior lecturer with 10 years of contribution to SAGE source code). The goals were to introduce OpenDreamKit softwares to beginners, introduce good practice software development for most advanced users and have programmers present their specialized packages.

**OpenDreamKit implication.** The event was organized by Vincent Delecroix. The OpenDreamKit member Samuel Lelièvre participated in the event and provided individual help to participants. The on-site facilities and logistics were funded by the University of Bonn. OpenDreamKit funded the travel and lodging of 11 of the participants that came from across Europe (France, Germany and United Kingdom).

**Event summary.** The week was organized so that half of the time was left for people to work on their own project while advanced users can answer questions. During the tutorial sessions we had a mix of specialized package presentation, learning development tool (control version system, testing, debugging, etc). We also had a brief experience with pair programming where an advanced programmer was paired with a beginner to solve a challenge.

**Demographics.** Out of approximately 25 participants approximately half of them were from Germany and the other half from neighbouring countries (Switzerland, France, United Kingdom). We had an almost parity of male and female participants which is rare in software development workshops in general. The level of studies spread from one sixth master students, one sixth PhD students, one sixth postdocs and one half of senior participants (professor or associate professor, retired engineer).

**Results and impact.** One of the primary goal of the workshop was to introduce SAGE to students. I believe that we were successful given the feedback we obtained from participants. All of the participants answered to have learned something.

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### Event 15- ESSLLI 2019 - Course on Formalizing the Zoo of Logical Systems

Riga, Latvia, 05th-09th of August 2019

ODK partners involved: FAU

43 participants (including 2 from within ODK)

<http://esslli2019.folli.info/courses/formalizing-the-zoo-of-logical-systems>

**Main goals.** In this course, we disseminated methods and solutions developed during OpenDreamKit to young researchers. In particular, this involved the systematic modular formalization of formal languages in which mathematical knowledge is expressed.

**OpenDreamKit implication.** The course was organised by Michael Kohlhase (FAU) and Florian Rabe (FAU).

**Event summary.** The course consisted of 5 sessions of 90 minutes each, one each from Monday to Friday. It was attended by undergraduate, graduate, and PhD students from mathematics, philosophy, and computer science. Attendance was very big with 43 participants in the first sessions and 25 in the last.

**Results and impact.** The main result of the workshop was the dissemination of key OpenDreamKit ideas and methods.

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## 2.2. Fostering diversity

OpenDreamKit is deeply concerned with the diversity gap that exists in science in general and more specifically in mathematics and software development. Here are the events we organized during this period to support specifically women and developing countries in sciences.

### Event 16- Sage Days 98 : Women in Sage

Archanes (Greece), April 8 – April 12, 2019

ODK partners involved: UPSud

22 participants (including 1 from within ODK)

<https://opendreamkit.org/2019/06/28/WomenInSage/>

**Main goals.** The main goal of the event was to initiate more women to the software SAGE to reduce the gender gap in mathematics software development. Each participant had to propose a mathematics development project to be carried out during the week.

**OpenDreamKit implication.** The event was initiated by Viviane Pons from OpenDreamKit and co-organized with Eleni Tzanaki (University of Crete). It was funded solely by OpenDreamKit which covered: lodging for the participants (rented houses), food, and transportation for many of the participants.

**Event summary.** The event was organized as a workshop where every participant could work on their own project to develop their coding skills. We started the week with an introduction to Sage and some tutorials. Then each participant gave a 5 minute talk about their own research. After that, we worked on different projects, organizing status reports every day. In particular, we ran a group specifically to produce new contributions to Sage.

**Demographics.** All participants were women coming from 8 different countries (France, Belgium, Germany, Greece, UK, US, Romania and Peru), as per institutions, and more if we count nationalities (Australia, Lebanon, Spain). About half of them could be considered Sage beginners. We had 1 master student, 14 PhD students, 2 postdocs, and 5 *Maîtresses de conférences* or assistant professor or lecturer.

We were supposed to also welcome 3 women from Nigeria but they were sadly not able to obtain their visas on time.

**Results and impact.** A full report on the impact of this workshop can be read on our website:

<https://opendreamkit.org/2019/06/28/WomenInSage/>

The main goal was to make the participants more confident into their programming skills and more prone to become Sage contributors and attend classical Sage Days. It was a big success in that regard. Indeed, before the conference, only 17% of the participants had attended Sage Days more than once and 50% had never heard of it. After, the conference, 94% rated 3 or more out of 5 the chances that they would attend Sage Days event in the future. 100% of the participant rated 3 or more out of 5 the impact of the workshop on their future career and 100% said they met interesting people. Additionally, work was done on 5 Sage issues from of which 3 have been merged into Sage source code already.



Women in Sage, Archanes, Crete

### Event 17- Sage Days 102, University of Ibadan

Ibadan (Nigeria), July 15 – July 19, 2019

ODK partners involved: UPSud

80 participants (including 1 from within ODK)

<https://opendreamkit.org/2019/07/29/SageDays102/>



Sage Days 102, University of Ibadan, Nigeria

**Main goals.** The purpose of this event was to introduce students, lecturers, and researchers local to Nigeria, and some of the neighboring countries, to OpenDreamKit software, particularly SAGE and GAP, as well as to improve their programming skills in general and foster interest in contributing to open source mathematics software.

**OpenDreamKit implication.** Much of the initial animation for the event was animated by Viviane Pons, though the only OpenDreamKit member to attend was Erik Madison Bray, whose travel was funded by the project. OpenDreamKit also funded travel for three other instructors from outside the project, as well as two PhD students who attended from neighboring countries outside Nigeria. All on-site facilities and logistics were funded by the University of Ibadan.

**Event summary.** Significant time was spent helping people install such software on their personal machines: A particular challenge in Nigeria where, as many attendees lacked reliable internet connections, even downloading the software could pose a challenge. The workshop was primarily organized as a series of introductory lectures, including on using the UNIX shell and basic Python programming, then moving on to more application-specific uses of SAGE. This included topic-specific break-out sessions on numerical analysis, graph theory, and algebraic combinatorics. There were also successful break-out sessions on group theory and abstract algebra with GAP, and statistical analysis with R. Participants also gave short talks on some of their personal research and computational problems, and participated in a contest to design interactive widgets for the Jupyter notebook.

This workshop was a result of the Free Computational Mathematics conference at CIRM earlier the same year, which had three visitors from the University of Ibadan Department of Mathematics, and wanted to repeat the success of that workshop at their home institution.

**Demographics.** Out of approximately 80 participants, most came from the University of Ibadan as well as a few other institutions in Nigeria, mostly in the southern and south-eastern regions of the country. Two students came from Ghana, as well as one from Congo. One instructor (originally from the United States) came from France, one (originally from Ghana) came from Austria, and one (originally from Benin) came from South Africa. About one third of the attendees were women, and there was a roughly equal mix of PhD students, postdocs, graduate students, and a smaller number of professors and undergraduate students.

**Results and impact.** A full report on the impact of this workshop can be read on our website:  
<https://opendreamkit.org/2019/07/29/SageDays102/>

As there are relatively few opportunities for many students in Nigeria to travel outside the country, as there are few opportunities to meet with outside lecturers, it's difficult to meet the demand for such opportunities. Thus one of the primary goals of this workshop was to disseminate the software itself, and to give a strong-enough introduction to it that attendees could in turn introduce their peers who were not able to attend, and to feel tapped into a broader international community of researchers interested in computational mathematics. To that end I believe we were successful, with 80% of attendees rating their knowledge of SAGE at 1 out of 5 before the workshop, and over 90% rating their knowledge at 3 or more after the workshop. 83% of attendees also felt highly confident that they had been given the resources to continue to learn on their own, and to find help with SAGE in the future, as well as that the workshop was helpful for them to build opportunities for collaboration with their peers.

Also, recognizing that one workshop was not enough to reach the demand for such training, a group of the attendees spent the week incorporating an organization (the strategy of which is still being developed) to build local sustainability for this kind of training in the future, without relying as much on (unfortunately rare) external support like that provided by OpenDreamKit.

### 2.3. Research workshops

#### Event 18- Journées Nationales de Calcul Formel

Luminy (FR), 2019-02-04 to 2019-02-08

ODK partners involved: UVSQ UGA

58 participants (including 3 from within ODK)

<http://www.jncf2019.uvsq.fr/>

**Main goals.** This is the yearly meeting of the French community in Computer Algebra, open to an international audience, with lectures and contributed talks given mostly in English.

**OpenDreamKit implication.** Luca De Feo co-organized the JNCF 2019. The organization of the workshop was coordinated with the organization of the “Free Computational Mathematics” conference, taking place the following week in the same venue, to encourage cross-participation.

Luca De Feo and Clément Pernet gave presentations on Monday on the achievements of OpenDreamKit relevant to the Computer Algebra community.

OpenDreamKit participants: Luca De Feo from University of Versailles, Jean-Guillaume Dumas and Clément Pernet from University Grenobles Alpes.

OpenDreamKit sponsored the event (3000€♠TO DO: Double-check the figure♠).

**Event summary.** This conference took place in Luminy (France) from February 4th to 8th. About 58 mathematicians and computer scientists participated to the event. Three of the participants also participated in the “Free Computational Mathematics” conference the following week, while four other noted members of the French community in Computer Algebra, Joris van der Hoeven, Marie Françoise Roy, Fredrik Johansson and Bill Allombert, elected to only participate in the latter due to time constraints.

Slides for Luca De Feo and Clément Pernet’s presentations are available online from the conference web page: <http://www.jncf2019.uvsq.fr/edt.html>.

**Results and impact.** Computer Algebra is the birth place of computer-aided Mathematics, and all of OpenDreamKit software owe something to the field. Over the years, OpenDreamKit has constantly used the JNCF as an occasion to disseminate its achievements relevant to the community, through contributed talks.

The last edition of JNCF to happen concomitantly with the project was the occasion to double the dissemination efforts, and organize the JNCF in tandem with the main OpenDreamKit conference “Free Computational Mathematics”: two invited talks at the “Free Computational Mathematics” were delivered by noted members of the French Computer Algebra community, while one of the invited lectures at JNCF was delivered by Mohamed Barakat, a GAP developer and founder of the OSCAR consortium, close to the OpenDreamKit community. A full session was devoted to mathematical software on Monday afternoon, with two presentations given by OpenDreamKit members, and one by a MapleSoft executive, which triggered visible interest in the audience.

This was a successful workshop, and a great occasion to deliver successful developments of OpenDreamKit to its user base.

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## 2.4. Communication and participation in external events

### Event 19- GAP Days Fall 2018

Siegen (Germany), 17–21 Sep 2018

ODK partners involved: USTAN UOXF UNIKL

20 participants (including 3 from within ODK)

<https://www.gapdays.de/gapdays2018-fall/>

**Main goals.** This was a meeting for experienced GAP developers and users to discuss and contribute to the GAP project.

**OpenDreamKit implication.** Michael Torpey and Markus Pfeiffer attended, and worked on MathInTheMiddle and PackageManager.

OpenDreamKit participants: M. Torpey, M. Pfeiffer and D. Pasechnik

**Event summary.** This was a meeting for experienced developers and users of GAP to discuss and influence the future development of GAP. There were discussions and short talks on topics such as libGAP, Julia, and metapackages. There were also various coding sprints for the GAP system and various GAP packages.

**Results and impact.** M. Torpey and M. Pfeiffer made considerable progress on GAP’s MathInTheMiddle package, and after a discussion initiated at the meeting, M. Torpey started and made an initial release of PackageManager, a new package for GAP.

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### Event 20- Keynote at PyconFr

Lille (France), Oct. 6, 2018

ODK partners involved: UPSud

400 participants (including 1 from within ODK)

<https://www.pycon.fr/2018/>

**Main goals.** PyConFr is the annual gathering of the French Python community.

**OpenDreamKit implication.** Viviane Pons was invited to be the opening keynote of the conference.

**Event summary.** Viviane gave a 30 minute talk titled “Science and Open-Source: what do we learn from each other”. This was an occasion to discuss the many interactions between research and open-source development and highlight the role of projects such as OpenDreamKit.

**Results and impact.** The talk was well-received by the Python community and received much positive feedback.

**Event 21- JupyterLab workshop**

Austin (Texas), Nov. 1, 2018

ODK partners involved: Simula

15 participants (including 1 from within ODK)

**Main goals.** To develop JupyterLab further and set agenda for future development.

**OpenDreamKit implication.** Vidar Fauske attended to participate in real-time collaboration discussions.

**Event summary.** Core stakeholders in JupyterLab working together on high-impact tasks and direction of the project.

**Results and impact.** Significant progress was made on JupyterLab in general, with particular progress on the design and architecture of real-time collaboration support.

**Event 22- Conference Cohomology of arithmetic groups, lattice and number theory**

Luminy (FR), 2019-03-24 to 2019-03-29

ODK partners involved: CNRS

36 participants (including 6 from within ODK)

<https://conferences.cirm-math.fr/1995.html>

**Main goals.** This was a research conference on the cohomology of arithmetic groups, with a focus on computational techniques.

**OpenDreamKit implication.** Bill Allombert was invited to give a 1-hour introduction to PARI/GP for a software session during the conference. He gave a tutorial on the manipulation of lattices,  $L$ -functions, modular forms and curves of small genus in the system.

OpenDreamKit participants: B. Allombert from Bordeaux.

OpenDreamKit funded the participation of B. Allombert to the event (about 600€).

**Event summary.** This conference took place in Luminy (France) from March 24th to 29th, with the participation of about 70 mathematicians.

Slides for the PARI/GP presentation are available at <http://pari.math.u-bordeaux.fr/Events/CIRM2019/>

**Results and impact.** This was a successful teaching and dissemination event towards a community (arithmetic geometry, representation theory) for which computer-aided calculations is less natural than in other areas of mathematics: the talk was well-received with interesting feedback.

**Event 23- GAP Days Spring 2019**

Martin Luther University of Halle-Wittenberg (Germany), 18–22 Mar 2019

ODK partners involved: USTAN UPSud

22 participants (including 2 from within ODK)

<https://www.gapdays.de/gapdays2019-spring/>

**Main goals.** This was a meeting for experienced GAP developers and users to discuss and contribute to the GAP project. The overarching theme was algorithms for permutation groups.

**OpenDreamKit implication.** Michael Torpey and Markus Pfeiffer attended, and worked on software while learning more about GAP and permutation groups.

OpenDreamKit participants: M. Torpey and M. Pfeiffer

**Event summary.** This was a meeting for experienced developers and users of GAP to discuss and influence the future development of GAP. There was also an overarching theme of algorithms for permutation groups, with discussions and exercises relating to stabiliser chains and the Schreier–Sims algorithm. There were also various coding sprints for the GAP system and various GAP packages.

**Results and impact.** M. Torpey learned more about the core GAP system and permutation group algorithms. He also made progress with work on PackageManager, which he was able to advertise to others at the meeting.

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#### Event 24- Big Proof - Invite-only ICMS Workshop

Bayes Centre, Edinburgh, UK, 27th-31st of May 2019

ODK partners involved: FAU

50 participants (including 2 from within ODK)

<https://www.icms.org.uk/bigproof.php>

**Main goals.** The Isaac Newton Institute programme on Big Proof during the summer of 2017 drew a great deal of interest from mathematicians, philosophers, and computer scientists. In May 2019 a week-long follow-up workshop funded by the Isaac Newton Institute will take place at the International Centre for Mathematical Sciences in Edinburgh. This workshop will take forward a number of the key initiatives from Big Proof:

- Pragmatic foundations for the formalization of mathematical proofs.
- Social processes that support research, exposition, and learning in mathematics.
- Interchange formats and repositories for formal mathematical knowledge
- Scalable proof automation
- Applications of Big Proof technology

**OpenDreamKit implication.** Michael Kohlhase (FAU) and Florian Rabe (FAU) were invited participants. The former also gave an invited talk.

**Event summary.** The workshop consisted of 5 days of 1 hour talks and ample discussion. Due to the invite-inly format, a slew of top researchers from computer science, mathematics, and social sciences were present.

**Results and impact.** The main result of the workshop from the OpenDreamKit perspective was Kohlhase's presentation of the Math Data initiative developed within OpenDreamKit. Together with OpenDreamKit's Big Computation theme, these complement and integrate with the Big Proof topic.

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#### Event 25- nbgrader hackathon

Edinburgh, May 29th-31st

ODK partners involved: UPSud

10 participants (including 1 from within ODK)

<https://blog.jupyter.org/https-blog-jupyter-org-university-of-edinburgh-1>

**Event summary.** Within the Jupyter Community Workshop series funded by Bloomberg, the University of Edinburgh hosted a three-day event. Its core aspect was a hackathon focused on adding improvements, fixes and extra documentation for the course management tool nbgrader. Alongside this it held an afternoon of talks highlighting how Jupyter can be used in education at varying levels.

**ODK implication.** ODK participant Nicolas M. Thiéry was invited to participate to the hackathon and deliver a talk on Jupyter for teaching introductory programming.

**Results and impact.** The hackathon resulted in many improvements to nbgrader, including some contributions by Nicolas, that make it easier to integrate in a variety of environments.

Nicolas used the occasion to visit St Andrews, for brainstorms on upcoming deliverable reports and collaboration on Sage-GAP interfacing. This visit also led to the invitation of Nathan Carter to Sage Days 101 for collaboration on mathematical visualization and live data browsing in Jupyter.

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## Event 26- FPSAC'19 – International Conference on Formal Power Series and Algebraic Combinatorics

Ljubljana (SI), 2019-07-01 to 2019-07-05

ODK partners involved: UPSud FAU

250 participants (including 2 from within ODK)

<http://fpsac2019.fmf.uni-lj.si/>

OpenDreamKit participants: Nicolas M. Thiéry, Katja Berčič, Viviane Pons.

**Event summary.** **FPSAC** – Formal Power Series and Algebraic Combinatorics – is the major yearly international conference on Algebraic; topics of presentations covered all aspects of combinatorics and their relations with other parts of mathematics, physics, computer science, and biology. This year's edition took place in Ljubljana, Slovenia, from July 1st to 5th. About 250 mathematicians attended the event. One fourth of them also attended the computational workshop Sage Days 105 organized on the following week by ODK.

**OpenDreamKit implication.** N Thiéry is member of the permanent committee of the conference since three years and has been leading an effort to increase the strength of software demonstrations, as a way to advertise and give back credit to the software development efforts of its members. Indeed, this mathematical community has a long tradition of using computer experimentation which plays a fundamental role in the research. N. Thiéry chaired the software demonstration sessions which held a record of six presentations, instead of a handful for the previous years combined.

One presentation was delivered by K. Berčič, and presented an early version of a website generator for mathematical databases, an integral component of the [data.mathhub.info](http://data.mathhub.info) system prototype (reported on in D6.10). All the materials for K. Berčič's software demonstration are available online:

- slides <http://fpsac2019.fmf.uni-lj.si/resources/Slides/202slides.pdf>
- extended abstract <http://fpsac2019.fmf.uni-lj.si/resources/Proceedings/202.pdf>

OpenDreamKit funded the participation of Nicolas M. Thiéry, K. Berčič to the event (about 1100€). Coordinated efforts were undertaken with the FPSAC organizers to encourage joint participation to both events and optimize the funds used on both sides for supporting young researcher.

**Results and impact.** The software demonstrations were well received by the attendees. More than one half of the attendees were present at the session, and a quick poll showed that most of them were using computer experimentation on a regular basis, while a large fraction was often writing code for their research.

All of the presentations used ODK components, and all the demonstrations about computational software used Sage and were made available online using the Binder service, with links from the [schedule](#).

There was a notable interest for the [data.mathhub.info](http://data.mathhub.info) system prototype, which confirmed that there is a real need for such infrastructure in the combinatorics community.



International Conference on Formal Power Series and Algebraic Combinatorics,  
Ljubljana, Slovenia

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## Event 27- CICM2019 — Conference on Intelligent Computer Mathematics

Prague, Czech Republic, 08th-12th of July 2019

ODK partners involved: FAU

65 participants (including 7 from within ODK)

<https://cicm-conference.org/2019/cicm.php>

**Main goals.** Digital and computational solutions are becoming the prevalent means for the generation, communication, processing, storage and curation of mathematical information. Separate communities have developed to investigate and build computer based systems for computer algebra, automated deduction, and mathematical publishing as well as novel user interfaces. While all of these systems excel in their own right, their integration can lead to synergies offering significant added value. The Conference on Intelligent Computer Mathematics (CICM) offers a venue for discussing and developing solutions to the great challenges posed by the integration of these diverse areas.

**OpenDreamKit implication.** Florian Rabe (FAU) was a member of the steering committee. A workshop was co-organized by Dennis Müller (FAU). There were no costs to OpenDreamKit other than travel costs for OpenDreamKit members.

**Event summary.** CICM featured 3 invited talks, 5 days of presentations, a doctoral program, 3 workshops, and 1 tutorial.

**Results and impact.** OpenDreamKit members presented about 10 talks at the conference, various workshops, and the doctoral programme, describing various OpenDreamKit results. This triggered a number of discussions with researchers from adjacent fields in computer science as well as a few mathematicians.

Florian Rabe and Yasmine Sharoda (who visited FAU for one month during OpenDreamKit) were awarded the Best Paper Award for his paper on diagram operators — a new method for organizing large libraries of mathematics that was motivated by OpenDreamKit.

Sylvain Corlay (QuantStack) gave an invited talk on “Jupyter: From IPython to the Lingua Franca of Scientific Computing”. Jupyter being central to OpenDreamKit, this talk mentioned various technologies related to OpenDreamKit results.

Makarius Wenzel gave an invited talk on “Interaction with Formal Mathematical Documents in Isabelle/PIDE”, in which he also presented some of the technologies for which he was subcontracted by OpenDreamKit.

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### **Event 28- CICM2019 – Workshop on Large Mathematics Libraries**

Prague, Czech Republic, 08th-12th of July 2019

ODK partners involved: FAU

35 participants (including 7 from within ODK)

<https://cicm-conference.org/2019/cicm.php?event=lml&menu=general>

**Main goals.** Large formal and semiformal mathematics libraries are needed to support mathematics research, mathematics education, rigorous software development, and formal proof development. This workshop explored methods for designing, constructing, and maintaining large mathematics libraries as well as for finding, comparing, and applying the knowledge residing in these libraries.

**OpenDreamKit implication.** The workshop was co-organised by Dennis Müller (FAU). Florian Rabe (FAU) was a member of the programme committee. Michael Kohlhase (FAU) gave a talk presenting OpenDreamKit results.

**Event summary.** The workshop featured two invited talks by Makarius Wenzel and Claudio Sacerdoti Coen on making large libraries (Isabelle resp. Coq) available for system integration. It also included contributed talks on Logipedia by the Dedukti group, which closely collaborates with OpenDreamKit members, and mathematical datasets.

**Results and impact.** The main result of the workshop was to strengthen the awareness of and to support the community for managing large formal libraries. This has been a central topic in WP 6 of OpenDreamKit, and the discussions allowed presenting OpenDreamKit results.

In particular, the talks by Wenzel and Sacerdoti Coen presented results that were developed in collaboration with OpenDreamKit members in WP 6.

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### **Event 29- AMRS2018 — Conference on Applied Mathematics and Random Structures**

Birzeit, Palestine, 27th-30th of August 2019

ODK partners involved:

41 participants (including 1 from within ODK)

<https://lipn.univ-paris13.fr/~nicodeme/birzeit18RAND/>

**Main goals.** AMRS is a conference intended to foster collaborations between Palestinian and French universities or research centres; to sustain the critical efforts of the mathematics community in Palestine to set up a doctoral school. AMRS provided an opportunity for dissemination of important and recent results in the field of Applied Mathematics and Statistics with Applications to Economy, Industry, and Science.

**OpenDreamKit implication.** Thierry Monteil, an ODK member gave a tutorial for the freeware computer algebra system SAGE during the conference. There were no costs to OpenDreamKit other than travel costs for him.

**Event summary.** AMRS conference gathered 41 attendees around various fields of Applied mathematics: Statistics, Game Theory, Analytic Combinatorics, Probability, Differential or

Difference Equations, Matrices, Stochastic Optimal Control Problems, Partial Differential Equations, Binary Search Trees, Ideals on SkewMatrices. There were 13 talks given by 7 Palestinian professors, and 6 French); and 10 talks by students:

**Results and impact.** Thierry Monteil has introduced the basic concepts of SAGE and present many examples based on graphs algorithms to 24 students

19 from Birzeit– 3 from Al Quds– 1 from Polytechnic Palestine University Hebron (PPU)– 1 from Malaya There was a large majority of female students in the audience, 19 out of 24 students

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Disclaimer: this report, together with its annexes and the reports for the earlier deliverables, is self contained for auditing and reviewing purposes. Hyperlinks to external resources are meant as a convenience for casual readers wishing to follow our progress; such links have been checked for correctness at the time of submission of the deliverable, but there is no guarantee implied that they will remain valid.