Formal Methods Europe
Minutes of the 70th meeting
Held online
10 December 2020
www.fmeurope.org

Present at the meeting were:

- Simon Bliudze
- Ana Cavalcanti (Chair)
- John Cooke
- Ferruccio Damiani
- David Duke
- Lars-Henrik Eriksson (Secretary)
- Uli Fahrenberg
- Alessandro Fantechi
- Mario Gleirscher
- Stefania Gnesi
- Klaus Havelund
- Marieke Huisman
- Einar Broch Johnsen
- Cliff Jones
- Martin Leucker
- Diego Marmsoler
- José Oliveira
- Luigia Petre
- Nico Plat
- Pedro Ribeiro
- Elvinia Riccobene
- Matteo Rossi
- Augusto Sampaio
- Volker Stolz
- Maurice ter Beek
- Silvia Lizeth Tapia Tarifa

Apologies had been received from: Jonathan Bowen, Dino Mandrioli, Marcel Verhoef and B.W. Watson.

1   Welcome and agree upon agenda
Ana Cavalcanti welcomed the members present. The agenda was agreed upon.

2   Minutes of the previous meeting and review of actions
The minutes of the 2020 AGM were approved.

There were no open actions.

3   Plan for 2021
Ana Cavalcanti presented the plans of the Board for 2021 (attached to the minutes). The meeting approved of the plans. She also encouraged members to nominate for the FME Fellowship award.

4   Budget for 2021
Nico Plat presented the budget proposal for 2021. The board proposes that the draft budget which was distributed (attached to the minutes) be changed so that the committee funding is €1,250, with corresponding changes to the surplus, totals and end of year assets. The meeting approved the budget with this change.

5   Final report on FM'19
José Oliveira presented the final report on FM'19. (Report attached to the minutes.)

6 Status report on FM'21
Stefania Gnesi reports that everything is going well and that we hope to have a physical conference. The decision will be taken in spring. PC co-chair Marieke Huisman reports that they are about to invite speakers. The submission deadlines will be April 30 (abstract) and May 6 (full paper).

7 FormaliSE
Nico Plat and Stefania Gnesi reported on the current status of FormaliSE 2021. The event will be held online. It (and other ICSE events) will be spread out over the whole ICSE week, a few hours every day. PC co-chair Simon Bliudze reports that the PC has been formed and the 2nd CfP has been sent. Paper submission deadline will be in January.

8 Proposed policy, regulations and procedures for FME committees
Ana Cavalcanti presented the board's proposal for new policies, regulations and procedures for FME committees. There were no objections.

9 Committee reports
Awards Committee: Augusto Sampaio reported that the committee had revised and prioritised criteria for FME Fellows.

Book Review Committee: Matteo Rossi presented the committee activities. (Report attached to the minutes.)

Communications Committee: Einar Broch Johnsen reported that there is now an FME YouTube channel with keynote speeches. The committee has developed a standardised questionnaire for FM and FormaliSE attendants.

Industry Committee: Klaus Havelund presented the committee activities. The FME industry website has been changed to use the same template as used by the teaching committee, thanks to help from Marcello M. Bersani and Einar Broch Johnsen. Various additions have been made to the website, including adding companies offering formal methods, companies using formal methods, and some papers on surveys of formal methods. On the suggestion of Einar Broch Johnsen, the industry committee is together with Einar, as well as Pedro Ribeiro and Claudio Menghi from the communications committee currently exploring the idea of producing a video with interviews of formal methods people from industry.

Teaching Committee: Luigia Petre presented the committee activities. They have applied for a COST action for community building in FM teaching. A decision is expected in May. The FMTea workshop at FM'19 was very successful with large participation (c:a 45 attendants). Possibly organise a training school at FM'21?

10 Date and place of next meeting
The next meeting will be the AGM. Discussion about having the meeting at ETAPS in April. Marieke Hausman says that ETAPS will almost certainly be virtual. In that case there is no point. The board will decide on the next meeting, preferably to be held in conjunction with the yearly FME/BCS-FACS seminar.

11 Other Business
There was no other business.

Summary of open actions

None.
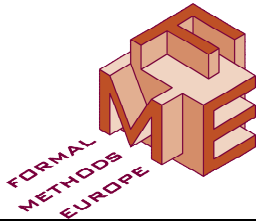
Priorities

- Success of FM 2021 and FormaliSE 2021
- Start plans for FM 2022

Symposia

The main focus is the successful running of FM2021 and FormaliSE 2021, and planning of FM 2022. We have organized a consultation of the community and will consider how to take their views into account. A main challenge is to consider and deal with the potential impact of the pandemic. Therefore, a lot of the effort of the board as a whole is going to be dedicated to this point: applying lessons learned, and recording lessons for the future.
Responsible: Stefania Gnesi

Membership

We have achieved a sustainable (modestly increasing) level of membership. We will continue to make sure that the membership reflects the active members of the society.
Responsible: Lars-Henrik Eriksson

Finances and sponsorship

We do not foresee a need to review our policies fundamentally in the coming year. However, we will invite special initiatives if appropriate.
Responsible: Nico Plat

External relations

We will continue our cooperation with BCS-FACS and FMICS. We will continue to support the work of the committees and establish a systemic means of interaction with them all.
Responsible: Ana Cavalcanti

Communications

We will continue to work with the Communications Committee to maintain the vitality of the various means of interaction with the community. Besides the website, which will remain as the FME's primary medium for disseminating its activities, we are using Twitter, LinkedIn, and YouTube. We will also continue holding the FME meetings as webinars. Finally, we will consult the membership to identify a possible programme of strategic activities to support the FME mission.
Responsible: Einar Johnsen and Ana Cavalcanti
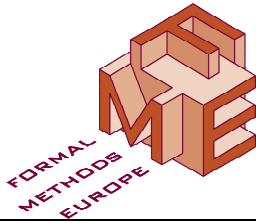
FME Fellowship and Lucas Prize

We will work with the Awards Committee to confer the fourth FME Fellowship during FM2021. We will discuss also the format of the award ceremony.
Responsible: Ana Cavalcanti and Augusto Sampaio

Book reviews

We will continue to work with the Book Review Committee to establish a steady stream of publications.
Responsible: Matteo Rossi

Support for teaching

We will continue to work with the Teaching Committee to take forward ideas raised in the membership consultation to support teaching of formal methods. We will strive to support colleagues in various ways, especially young academics.
**Responsible:** Luigia Petri

Formal methods in industry

We will work with the Industry Committee to take forward ideas raised in the membership consultation to engage with industry to promote and support use of formal methods. The industry day will continue to be an important part of our agenda, but we will seek to support other activities, increasing the visibility of formal methods via sharing of information and organisation of events, for example.
Responsible: Klaus Havelund

Coordination of events

We will keep the list of upcoming events in our homepage up to date and comprehensive to include major events in the area of formal methods.
Responsible: Einar Johnsen
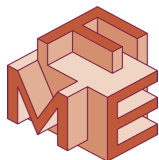
Draft budget FME 2021 *21-nov-20*

		Budget 2020				Budget 2021			
		Surplus and deficit		Balance		Surplus and deficit		Balance	
No.	Description	Debit	Credit	Debit	Credit	Debit	Credit	Debit	Credit
01	Total assets beginning of year			€ 54.375,71				€ 75.875,71	
02	Total assets end of year				€ 75.875,71				€ 70.275,71
	Administrative items								
03	Interest received on deposit account		€ 0,00				€ 0,00		
04	Banking and organisational cost	€ 200,00				€ 200,00			
05	IT infrastructure	€ 50,00				€ 150,00			
	Operational items								
06	Surplus FM'2019 Porto		€ 30.000,00						
07	FormaliSE	€ 2.500,00				€ 0,00			
08	Sponsorships	€ 3.500,00				€ 3.500,00			
09	Travel costs FME Board	€ 2.000,00				€ 1.000,00			
10	Miscellaneous	€ 250,00				€ 250,00			
11	Book committee					€ 500,00			
12	*Subtotals*	€ 8.500,00	€ 30.000,00	€ 54.375,71	€ 75.875,71	€ 5.600,00	€ 0,00	€ 75.875,71	€ 70.275,71
13	Net surplus	€ 21.500,00		€ 21.500,00		-€ 5.600,00		-€ 5.600,00	
14	*Totals*	€ 30.000,00	€ 30.000,00	€ 75.875,71	€ 75.875,71	€ 0,00	€ 0,00	€ 70.275,71	€ 70.275,71

Comments on various items

05	IT infrastructure	Amount increases because we will move the website to a commercial provider.
06	Surplus FM'2019 Porto	Current estimate is that the surplus will be euro 41.400 instead of euro 30.000
07	ICSE/FormaliSE 2020	FormaliSE 2021 will be completely virtual hence no costs
09	Travel costs FME Board	One physical meetuing expected in the 2nd half of the year, hence half the amount of previous year

FM'19

3rd world congress on formal methods

FM Week

FM 2019
23rd Symposium on Formal Methods

LOPSTR 2019
29th International Symposium on Logic-Based Program Synthesis and Transformation

MPC 2019
13th International Conference on Mathematics of Program Construction

PPDP 2019
21st International Symposium on Principles and Practice of Declarative Programming

RV 2019
19th International Conference on Runtime Verification

SAS 2019
26th International Static Analysis Symposium

TAP 2019
13th International Conference on Tests and Proofs

UTP 2019
7th International Symposium on Unifying Theories of Programming

VECoS 2019
13th International Conference on Verification and Evaluation of Computer and Communication Systems

Doctoral Symposium
Industry Day

and several Workshops and Tutorials!

7 — 11 october 2019

Alfandega Porto Congress Centre Porto, Portugal

fm2019.inesctec.pt
formalmethods19

www.fmeurope.org

Final report: results and lessons learned

November, 2020

1

FM'19 — Final report: results and lessons learned

FM'19 Organizing Committee
HASLab / INESC TEC & University of Minho

November, 2020

Contents

FINAL REPORT: RESULTS AND LESSONS LEARNED

DATE: NOVEMBER, 2020

1 Introduction

The 3RD WORLD CONGRESS ON FORMAL METHODS (FM'19) organized by INESC TEC for the FME Association took place in Porto last year, from October 7 to October 11, 2019. Its predecessors took place in Toulouse, France (September 20-24, 1999) and Eindhoven, NL (November 2-6, 2009), see figure 1. Below, the acronym "FM'19" will refer to the whole congress while "FM 2019" will refer to host symposium, the 23rd FME Symposium on Formal Methods.

1.1 FM Week

As its predecessor FM'09, in Eindhoven, FM'19 was structured around the idea of an *FM Week* of parallel events which involved:

- 9 main conferences or symposia (including FM 2019, the host symposium),
- 20 workshops (including two Festschrifts, a Doctoral Symposium and the Industry Day), and
- 7 tutorials

In detail:

- Conferences / symposia:

    FM — 23rd International Symposium on Formal Methods
    LOPSTR — 29th International Symposium on Logic-based Program Synthesis and Transformation
    MPC — 13th International Conference on Mathematics of Program Construction
    PPDP — 21st International Symposium on Principles and Practice of Declarative Programming
    RV — 19th International Conference on Runtime Verification
    SAS — 26th International Static Analysis Symposium
    TAP — 13th International Conference on Tests and Proofs
    UTP — 7th International Symposium on Unifying Theories of Programming
    VECoS — 13th International Conference on Verification and Evaluation of Computer and Communication Systems

- Workshops:

    DS — Doctoral Symposium
    i-Day — Industry Day
    AFFORD — 2nd Workshop on Practical Formal Verification for Software Dependability
    DALI — 2nd DaLí Workshop on Dynamic Logic: New Trends and Applications
    DataMod — 8th International Symposium "From Data to Models and Back (DataMod)"
    F-IDE — 5th Workshop on Formal Integrated Development Environment
    FMAS — 1st Workshop on Formal Methods for Autonomous Systems
    FMBC — 1st Workshop on Formal Methods for Blockchains
    FMIS — 8th Formal Methods for Interactive Systems Workshop
    FMTea — Formal Methods Teaching Workshop and Tutorial 2019
    HFM — 1st International Workshop on History of Formal Methods

Figure 1: Printed publicity of the three FM World Congresses —- FM'99 (Toulouse, France, September 20-24, 1999), FM'09 (Eindhoven, NL, November 2-6, 2009) and FM'19 (Porto, October 7-11, 2019).

NSAD — 8th International Workshop on Numerical and Symbolic Abstract Domains

OVT — The 17th Overture Workshop

OpenCERT — 9th International Workshop on Open Community approaches to Education, Research and Technology

REFINE — 19th Refinement Workshop

RPLA — 1st International Workshop on Reversibility in Programming, Languages, and Automata

SASB — 10th International Workshop on Static Analysis and Systems Biology

TAPAS — 10th Workshop on Tools for Automatic Program Analysis

SG65 — Colloquium in Honour of Stefania Gnesi

MH60 — Workshop for Manuel Hermenegildo's 60th Birthday

- Tutorials:

   ALLOY — Formal software design with Alloy and Electrum

   CbC — The Correctness by Construction Approach to Programming

   FM4BioMed — Tutorial and Workshop on Formal Methods for BioMedicine

   FRAMA-C-IoT — Formal Verification of IoT Software with Frama-C

   KeYmaeraX — Modular Formal Verification of Cyber-Physical Systems with KeYmaera X

   MLFV — ML + FV = ♥! A Gentle Introduction to the use of Machine Learning within Formal Verification Tools

   SRV — Stream-based Runtime Verification

One week before the congress, the organizers of FM4BioMed and MLFV decided to withdraw their tutorials due to lack of participants.

The Congress also included an FM Tool Exhibition which provided a forum for developers of academic or industrial tools that support the use of formal methods in different stages of system and software development. The list of tool exhibitors can be found in Appendix D.

1.2 The venue

FM'19 took place in the *Alfândega Porto Congress Center* (APCC)[1] complemented by the Museu das Descobertas (on the other side of the road) and Hotel Vincci Porto (along the same road facing river Douro) where invited speakers and other participants were accommodated. This hotel was within walking distance from the APCC main site (figure 2). The weather was sunny and warm. There was a shuttle (tram) between the APCC and the Vincci Porto hotel at lunch-time.

---

[1]Rightmost block of the main building shown in figure 3.
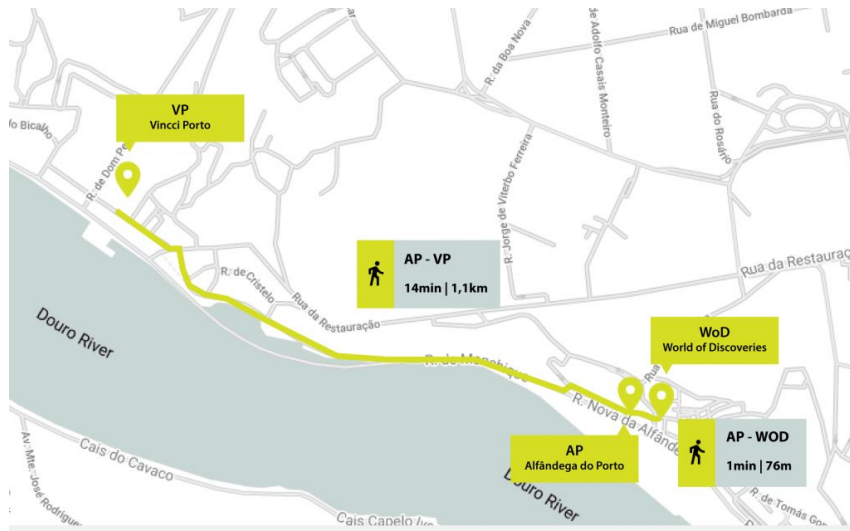
Figure 2: FM'19 venue.

Figure 3: Panoramic view of the APCC.

1.3 The schedule

For its main site FM'19 booked the rightmost block of the 2nd tier of the APCC main building (see the building plan in figure 18). This comprised the first 7 of the following spaces, listed below along with their seat capacities:

	Seats
01-AWS Hall (Infante)	350
02-Sony Hall (D.Maria)	150
03-Google Hall (D.Luis)	150
04-Miragaia Hall	90
05-S.Joao Hall	90
06-Arrabida Hall	150
07-Porto Hall	150
08-WD-Auditorium	80
09-WD-Ceuta Room	50
10-VP-Bolsa1	80
11-VP-Bolsa2	40
Total	1380

The WD-Auditorium and the WD-Ceuta Room are located across the road in the *Museu das Descobertas* and VP-Bolsa1 and VP-Bolsa2 are in the Vincci Porto Hotel, 14m walk westwards along the river. The overall schedule of FM Week events is shown in figure 5.[2]

Figure 4 gives the timetable of session blocks set up for the whole FM Week. Event organizers could use each slot the way they found most convenient. One hour slots were destined to invited speakers or (typi-

---

[2]For more detail please see figure 8.

Figure 4: The FM week standard timetable.

	7-Oct	8-Oct	9-Oct	10-Oct	11-Oct
01-AWS Hall (Infante)	FMTea	UTP	FM	FM	FM
02-Sony Hall (D.Maria)	PPDP	PPDP	PPDP	KeYmaeraX	FMBC
03-Google Hall (D.Luis)	DS	TAPAS	SAS	SAS	SAS
04-Miragaia Hall	MPC	MPC	MPC	FRAMA-C-IoT	i-Day
05-S.Joao Hall	FMIS	RV	TAP+VECoS	TAP	TAP
06-Arrabida Hall	AFFORD	SG65	FM	FM	FM
07-Porto Hall	OVT	RV	RV	RV	RV
08-WD-Auditorium	DataMod	LOPSTR+MH60	LOPSTR	LOPSTR	HFM
09-WD-Ceuta Room	REFINE	NSAD	DALI+VECoS	CbC	SRV
10-VP-Bolsa1	F-IDE	DataMod	DALI		ALLOY
11-VP-Bolsa2	OpenCERT	SASB	RPLA		FMAS

Figure 5: FM Week's schedule at FM'19.

cally) two paper presentations. Event chairs were free to stop earlier than 6pm or, if needed (eg. for steering committee meetings) stay there until 8pm on request.

1.4 The social program

Block 4 of the standard timetable did not happen on Thursday (Oct 10) afternoon because of the social program. This consisted of an excursion visiting a Port Wine cellar in Gaia, on the other bank of the river, after a ROTA DO DOURO cruise upstream, ending in the congress banquet. This took place at *The Baron's Hall and Gallery* of REAL COMPANHIA VELHA, the oldest Portuguese Port wine company (1756) still in operation, whose warehouses are located in Gaia. The banquet was shared among the following FM Week events: FM 2019, LOPSTR 2019, RV 2019, SAS 2019 and TAP 2019.

2 Operation

2.1 Organizing committee

The FM'19 organizing committee consisted of 7 staff + 5 technical/admin support, all from the INESC TEC research institute. From 6-Oct to 12-Oct the OC was reinforced with 29 volunteers (graduate students from the universities of Minho and Porto).

An overall list of FM'19-related contacts was compiled during the preparation of the congress which includes 1934 people at the time of writing.
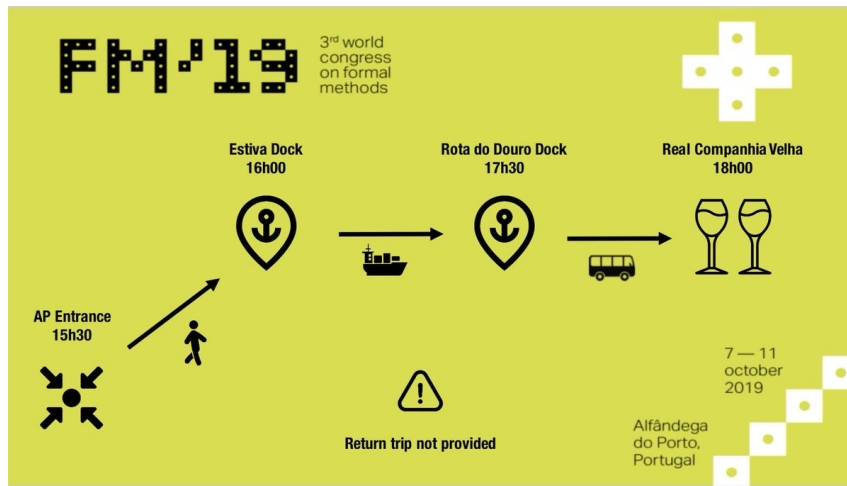
Figure 6: FM'19 social program trip.

Figure 7: FM'19 OC "machine room" in the APCC building.

2.2 Program committees

On the scientific front, a total of 590 experts were involved in the PCs of FM'19 events, from 51 different countries. An EasyChair Group Licence was purchased for 800 submissions altogether. This figure was calculated from the expected submission numbers timely communicated by the event chairs.

The list of all PC chairs (or organizers) of FM'19 events is given in Appendix B. The Tool Exhibition and workshop and tutorial chairs did a wonderful job in handling a significant number of workshops, tutorials and exhibitors.

PC of the FM 2019 Symposium. To strengthen the international character of the symposium, a PC of 99 members working in 42 countries was put together by the symposium chairs. (The list of all PC members of FM 2019 can be found in appendix A.) As in FM'09, the idea was that this would encourage researchers from geographical areas that are historically less strongly represented in the symposium to submit their papers to the symposium.

2.3 Green FM'19

Standard dissemination of scientific results through conferences and publications is essential to the progress of science but it has a negative impact on the environment. This is due not only to resource consumption and pollution from on-site operation based on disposable objects, but also to the high number of flights scientists take to arrive at conference destinations every year.

Consistently with the green coloured background of its graphical identity, FM'19 endeavored to implement an environment-friendly *Reduce–Recycle–Reuse* operation mode that avoided plastic or other throw-away objects. In particular, participants were invited to drop the plastic bag of their badge in designated boxes for

reuse at future FME events.

In partnership with Springer, FM'19 significantly cut back on printed paper by adopting Springer's access to electronic, paper-less conference proceedings instead of printed or USB proceedings, with the exception of UTP 2019 and SG65 whose commemorative nature called for a more physical record.

Lunchtime transportation between the congress venues was assured by traditional Portuguese trams (locally known as *eléctricos*) which are electrical vehicles (figure 9).
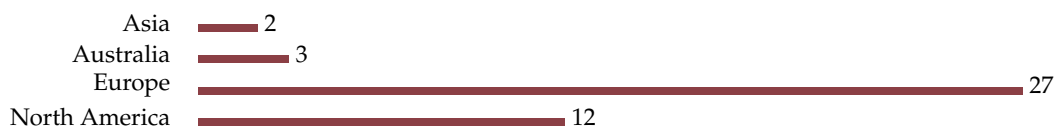
3 Results

A conference has quantifiable results with respect to its scientific program, participation numbers, and finances. These are addressed in the following sections.

3.1 Scientific Program

3.1.1 Invited speakers

The FM'19 congress involved 44 invited speakers altogether, with the following geographical distribution:

Those of the FM 2019 symposium are listed below. The complete list can be found in appendix C.

FM 2019 Invited Speakers

- **Erik Poll** — Erik Poll is Associate Professor at the Digital Security group at Radboud University in Nijmegen. Here he has carried out applied security research into smartcards, payment systems, security protocols and smart grids, and investigated the use of formal methods to support such security analyses, especially to analyse the software implementing the protocols involved. Earlier he worked on the verification of object-oriented programs, especially for Java and using the specification language JML.

- **June Andronick** — June Andronick leads the Trustworthy Systems group, world-leading in verified operating systems software, known worldwide for the formal verification of the seL4 microkernel. She is a Principal Research Scientist at Data61—CSIRO, and conjoint Associate Professor at UNSW Sydney, Australia. She was recognised in 2011 by MIT's Technology Review as one of the world's top young innovators (TR35). She previously worked in industry for the smart-card manufacturer Gemalto in Formal Methods research.

- **Shriram Krishnamurthi** — Shriram Krishnamurthi is a Professor of Computer Science and an Associate Director of the Executive Master in Cybersecurity at Brown University. With collaborators and students, he has created several influential systems and written multiple widely-used books. He also co-directs the Bootstrap math-and-computing outreach program. For his work he has received SIGPLAN's Robin Milner Young Researcher Award, SIGSOFT's Influential Educator Award, SIGPLAN's Software Award, and Brown's Henry Merritt Wriston Fellowship for distinguished contribution to undergraduate education. He has authored over a dozen papers recognized for honors by program committees. He has an honorary doctorate from the Università della Svizzera Italiana.

3.1.2 Journal First Track

For the first time in its history, the FM 2019 symposium included a **Journal-First Track** thanks to partnerships established between FME and prestigious formal methods journals.

Augusto Sampaio (UFPE, Brazil) accepted to be the **Journal-First Track** Chair with the support of the FME Fellows Cliff Jones (U. Newcastle, UK) and Manfred Broy (TUM, Germany), who selected papers and invited their authors to present their work at FM 2019.

The partner journals that supported the **Journal-first Track** of **FM 2019** were:[3]

- Formal Aspects of Computing (Springer)

- Formal Methods in System Design (Springer)

---

[3]FME and the FM'19 World Congress thank Springer for their collaboration in this initiative.

	(7,M)	(7,A)	(8,M)	(8,A)	(9,M)	(9,A)	(10,M)	(10,A)	(11,M)	(11,A)
01-AWS Hall (Infante)	FMTea	FMTea	UTP	UTP	FM	FM	FM	FM	FM	FM
02-Sony Hall (D.Maria)	PPDP	PPDP	PPDP	PPDP	PPDP	PPDP	KeYmaeraX		FMBC	FMBC
03-Google Hall (D.Luis)	DS	DS	TAPAS	TAPAS	SAS	SAS	SAS	SAS	SAS	SAS
04-Miragaia Hall	MPC	MPC	MPC	MPC	MPC	MPC	FRAMA-C-IoT		i-Day	i-Day
05-S.Joao Hall	FMIS	FMIS	RV	RV	VECoS	TAP	TAP	TAP	TAP	TAP
06-Arrabida Hall	AFFORD	AFFORD	SG65	SG65	FM	FM	FM	FM	FM	FM
07-Porto Hall	OVT	OVT	RV	RV	RV	RV	RV	RV	RV	RV
08-WD-Auditorium	DataMod	DataMod	LOPSTR	LOPSTR+MH60	LOPSTR	LOPSTR	LOPSTR	LOPSTR	HFM	HFM
09-WD-Ceuta Room	REFINE	REFINE	NSAD	NSAD	DALI	VECoS	CbC		SRV	SRV
10-VP-Bolsa1	F-IDE	F-IDE	DataMod	DataMod	RPLA	DALI			ALLOY	ALLOY
11-VP-Bolsa2	OpenCERT	OpenCERT		SASB		RPLA			FMAS	FMAS

Figure 8: Final overall schedule and room allocation (detailed).

Figure 9: The electric tram rented from Porto's STCP company Porto (founded in 1895) to shuttle participants between APCC and Hotel Vincci Porto at lunchtime.

Through such partnerships, the symposium included the presentation of the following papers:

- *Alloy*: a general-purpose higher-order relational constraint solver* by Aleksandar Milicevic, Joseph P. Near, Eunsuk Kang and Daniel Jackson — originally published in *Formal Methods in System Design* (Springer, 2017).

- *Conditions of contracts for separating responsibilities in heterogeneous systems* by Jonas Westman and Mattias Nyberg — originally published in *Formal Methods in System Design* (Springer, 2018).

- *Unifying separation logic and region logic to allow interoperability* by Yuyan Bao, Gary T. Leavens and Gidon Ernst — originally published in *Formal Aspects of Computing* (Springer, 2018).

3.1.3 Papers

The grand total of scientific contributions to the FM'19 congress was 381 papers (inc. invited talks) authored by 817 scientists. Most authors contributed to one event only, but some others spanned over two or even three events:

$$
\begin{array}{ll}
\text{1 event} & 737 \\
\text{2 events} & 69 \\
\text{3 events} & 11
\end{array}
\tag{1}
$$

The FM 2019 Symposium received 185 abstract submissions that materialized in 129 paper submissions distributed by the three submission categories as follows:

Regular 113
Short 6
Tool 10

From these submissions, 39 papers were accepted which, together with journal-first papers and invited papers totalized 45 contributions involving 138 authors with the following geographical distribution:

- FM 2019 authors grouped by continent:

Asia 15
Australia 4
Europe 84
North America 34
South America 1
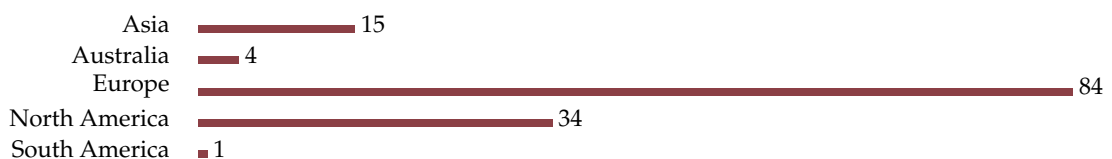
- FM 2019 authors "drilled down" by country:

Country	Authors
Australia	4
Austria	3
Brasil	1
China	1
Czech Republic	1
Denmark	2
France	16
Germany	29
India	4
Ireland	1
Israel	4
Italy	1
Japan	2
Luxembourg	3
Norway	3
Portugal	1
Romania	3
Singapore	4
Spain	1
Sweden	4
The Netherlands	6
USA	34
United Kingdom	10
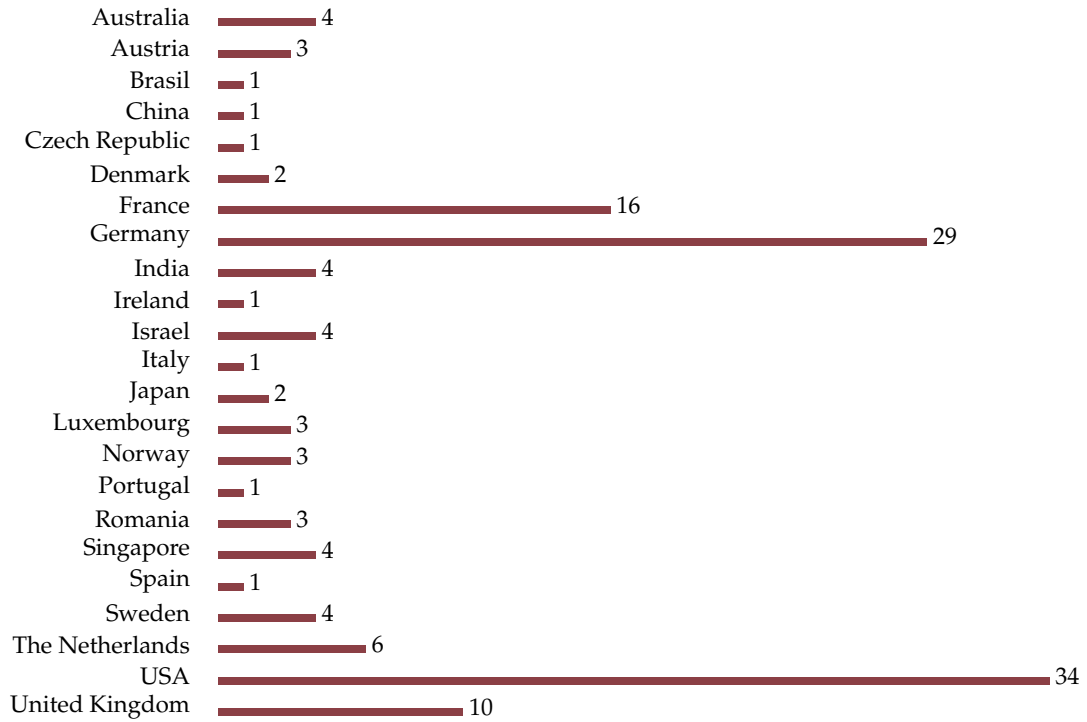
3.1.4 Awards

The following awards were conferred to the authors of the best contributions to the following events of FM'19, in the categories indicated:

- **FM 2019**

    – **FM best theory paper award**:

    Title: *Generic Partition Refinement and Weighted Tree Automata*
    Authors: Hans-Peter Deifel, Stefan Milius, Lutz Schröder and Thorsten Wißmann

    – **FM best tool paper award**:

    Title: *Pegasus: A Framework for Sound Continuous Invariant Generation*
    Authors: Andrew Sogokon, Stefan Mitsch, Yong Kiam Tan, Katherine Cordwell and André Platzer

- **DS 2019**

    – **Best Presentation award (in ex aequo)**:

    Title: *Delayed Hybrid Systems*
    Authors: Erzana Berani Abdelwahab

    – **Best Presentation award (in ex aequo)**:

    Title: *Discrete Polymorphism with Gradual Typing*
    Authors: Pedro Jorge Fernandes Ângelo

- **LOPSTR 2019**

    – **LOPSTR Best Paper Award**:

    Title: *On fixpoint/iteration/variant induction principles for proving total correctness of programs with denotational semantics*
    Authors: Patrick Cousot

- **RV 2019**

    – **Best Paper Award**:

Title: *Shape Expressions for Specifying and Extracting Signal Features*
Authors: Dejan Nickovic, Xin Qin, Thomas Ferrère, Cristinel Mateis and Jyotirmoy Deshmukh

   – **Test of Time**:
     Title: *Java-MaC: A Run-time Assurance Tool for Java Programs*
     Authors: Moonzoo Kim, Sampath Kannan, Insup Lee, Oleg Sokolsky and Mahesh Viswanathan

- **SAS 2019**

   – **Radhia Cousot Young Researcher Best Paper Award**:
     Title: *Fast and Precise Handling of Positive Weight Cycles for Field-sensitive Pointer Analysis*
     Authors: Yuxiang Lei

   – **Radhia Cousot Young Researcher Best Paper Award**:
     Title: *Revisiting Polyhedral Analysis for Hybrid Systems*
     Authors: Anna Becchi

3.1.5 Publications

The scientific events of the FM'19 World Congress led to the following publications:[4]

- **Formal Methods – The Next 30 Years**, Springer, LNCS 11800, 2019 [FM]

- **FM 2019 International Workshops (Volume I)**, Springer, LNCS 12232, 2019 [AFFORD, DataMod, FMAS, FMBC and FMIS]

- **FM 2019 International Workshops (Volume II)**, Springer, LNCS 12233, 2019 [HFM, NSAD, OpenCERT, OVT, REFINE, RPLA, SASB and TAPAS]

- **Logic-Based Program Synthesis and Transformation**, Springer, LNCS 12042, 2019 [LOPSTR]

- **Mathematics of Program Construction**, Springer, LNCS 11825, 2019 [MPC]

- **Proceedings of the 21st International Symposium on Principles and Practice of Declarative Programming**, ACM, ACM ISBN: 978-1-4503-7249-7, 2019 [PPDP]

- **Runtime Verification**, Springer, LNCS 11757, 2019 [RV]

- **Static Analysis**, Springer, LNCS 11822, 2019 [SAS]

- **Tests and Proofs**, Springer, LNCS 11823, 2019 [TAP]

- **Unifying Theories of Programming**, Springer, LNCS 11885, 2019 [UTP]

- **Verification and Evaluation of Computer and Communication Systems**, Springer, LNCS 11847, 2019 [VECoS]

- **From Software Engineering to Formal Methods and Tools, and Back**, Springer, LNCS 11865, 2019 [SG65]

- **Dynamic Logic: New Trends and Applications**, Springer, LNCS 12005, 2019 [DALI]

- **Formal Methods Teaching**, Springer, LNCS 11758, 2019 [FMTea]

- **Proceedings Fifth Workshop on Formal Integrated Development Environment**, ArXiv, 10.4204/EPTCS.310, 2019 [F-IDE]

3.1.6 Multimedia Output

The publicity plan of FM'19 included the effort to record videos of the talks of the whole FM 2019 symposium in the Youtube channel of FME.The Organizing Committee decided later to extend this action to the invited talks of the other conferences, but workshops could not be included due to their number, which was higher than initially expected.

Another initiative was to call all PC chairs to contribute with a video call-for-papers (CFP) of their events. Each video would be edited by the OC. The idea was to add a new means of dissemination to the usual communication channels, which typically are the web and email. Only FM, MPC, VECoS and HFM contributed to this effort — see the Calls for Papers page in the website.

Appendix E lists the videos available, including the "recap video" produced after the Congress.

---

[4]The two LNCS volumes of international workshops contain selected papers of the indicated workshops.

3.2 Participants

FM'19 had a total of 613 participants. Before we can analyze participant numbers for the various events and activities in FM'19, a brief explanation is needed about the registration process and its details.

3.2.1 Registration categories, deadlines and statistics

The whole congress was managed as a single block with a single budget, and so registration was centralized for all events. The table of figure 10 gives all the registration modalities and corresponding fees. The entries of the table are organized along three basic dimensions:

- **When** — three registration phases:
  - Early Registration (July 12 to September 10, AoE)
  - Late Registration (September 11 to October 5, AoE)
  - On site Registration (October 6 to October 11, AoE).

- **What** — selection of events to attend:
  - **Full Week** — this was a price convenient registration for participants wishing to attend the whole congress with no restrictions whatsoever.
  - **Conferences** — organized in groups depending on the number of days and on whether or not the events in the group had joined the social programme.
  - **Workshops** — again organized in groups depending on the number of days.
  - **Tutorials** — split into half-day and whole-day tutorials.
  - **Other events** — grouping the i-Day and the Doctoral symposium, with different fees.

- **Who** — all registration modalities had a **Student** variant with 25% discount (fees rounded to multiples of €5).

Registrations grouped by registration phase:[5]

$$\begin{array}{llr}
\text{Early} & \rule{8cm}{2pt} & 497 \\
\text{Late} & \rule{1.8cm}{2pt} & 112 \\
\text{On-site} & \rule{0.1cm}{2pt} & 5 \qquad\qquad\qquad (2)
\end{array}$$

Number of Full Week registrations:

$$\begin{array}{llr}
\text{Full Week} & \rule{4cm}{2pt} & 224 \\
\text{Other} & \rule{6cm}{2pt} & 389 \qquad\qquad\qquad (3)
\end{array}$$

The following chart shows the overall percentage of students. This was quite close to the initial forecast of 20%:[6]

$$\begin{array}{llr}
\text{Non-student} & \rule{7.5cm}{2pt} & 81\,\% \\
\text{Student} & \rule{1.8cm}{2pt} & 19\,\% \qquad\qquad\qquad (4)
\end{array}$$

Most participants came from academia[7] as the following chart shows:

$$\begin{array}{llr}
\text{Academia} & \rule{8cm}{2pt} & 86\,\% \\
\text{Others} & \rule{1.2cm}{2pt} & 14\,\%
\end{array}$$

3.2.2 Discounts and scholarships

The following discounts were practiced:

- Conference chairs had the fee of their events waived.

- To stimulate workshop and tutorial chairs to gather participants in their events, every 10 non-student workshop registrations would waive the fee for one guest speaker or organizer of the event.

Discounts were implemented in the registration portal by issuing discount codes. There was a limited number of scholarships available for PhD students wishing to attend the Doctoral Symposium (DS). Applicants had to submit a support letter written by their supervisors. Moreover, all volunteers had their Student Full Week registration fee waived.

---

[5]Only one participant registered for different events in different registration phases.

[6]All volunteers were students and are thus included in this count.

[7]Class "Academia" includes all participants from universities or research institutes. Class "Others" includes participants from industry (the vast majority) or governmental departments.

KIND	GROUP	EVENT(S)	EARLY Regular	EARLY Student	LATE Regular	LATE Student	ON SITE Regular	ON SITE Student	OBS
FULL WEEK	All	All	780	585	975	780	1170	980	Fee includes the FM Week social event
CONFERENCES	1-Day Conference	UTP VECoS	190	140	240	190	290	240	
	3-Day Conference	*FM* *LOPSTR* *SAS* *TAP*	570	430	710	570	860	710	Fee includes the FM Week social event; FME members with a €20 discount on the FM
		MPC PPDP	480	360	600	480	720	600	
	4-Day Conference	RV	690	515	860	690	1030	860	Fee includes the FM Week social event
WORKSHOPS	1-Day Workshop	*AFFORD* *DALI* *F-IDE* *FMAS* *FMBC* *FMIS* *FMTea* *HFM* *NSAD* *OpenCERT* *OVT* *REFINE* *RPLA* *SASB* *TAPAS*	140	105	175	140	210	180	
	2-Day Workshop	DataMod	280	210	350	280	420	350	
TUTORIALS	1/2-Day Tutorial	CbC FRAMA-C-IoT KeYmaeraX	100	75	125	100	150	130	
		MLFV							Cancelled
	1-Day Tutorial	ALLOY SRV	140	105	175	140	210	180	
		FM4BioMed							Cancelled
OTHER EVENTS	1-Day Event	*DS*	140	105	175	140	210	180	
		i-Day	190	140	240	190	290	240	

Figure 10: Registration modalities and fees (€).

3.2.3 Registration portal

The choice of Weezevent as registration portal for FM'19 was among the most important decisions that the Organizing Committee had to make.

The previous FM symposium had been co-located with FLoC 2018, which had used the CEVENT platform. FLoC 2018 was a big cluster of events and therefore CEVENT seemed like the right option. To sanction this choice, the OC contacted the organizers of FLoC 2018 who said they liked CEVENT. However, they had doubts about the value for money of CEVENT for FM'19, that might not be large enough to benefit from economies of scale.

Another choice was Weezevent, which members of the OC had used before in previous events organized by INESC TEC. Weezevent fee per transaction was 2.43% against 3.99% in CEVENT, which had an extra annual fixed cost proportional to every 100 registrations. Weezevent had a free option with no fixed costs, but this had the disadvantage of not enabling Full Week participants to indicate the events in which they intended to participate. This had to be provided as free text.

The OC chose the free version of Weezevent at the cost of building a back-office that would treat the Weezevent database (exported as a CSV file) locally to extract the information needed for planning the resources for each event and for statistical purposes.

3.2.4 Participant statistics

FM'19 total of 613 participants distributes per continent as follows:

The fact that Full Week registrants were free to participate in whichever events they liked during the whole week made the calculation of participants per event hard to compute accurately. They were invited to (optionally) indicate which events they were most interested in. Some gave such information, some did not and some others gave partial or vague information. Choices overlapping in time were very common.

Figure 11 shows two criteria for handing the vagueness of these data. The dark green bars count how many participants indicated each event in their registration preferences. The dark red bars take overlapping choices into account by dividing, per day[8], each participant per the events they chose on that day. Full week participants who did not specify any preferences were spread evenly by all events taking place in parallel. This made the number of participants per day on each event a real number, that is rounded off in the table of figure 12. Average numbers per event are shown in the red bars of figure 11. This approach is perhaps too kind to smaller events that might otherwise have less participants, but the numbers are proportional to the specific indications given by all other participants.

The geographical distribution of the 186 participants who included the FM symposium in their preferences is as follows:

Figure 13 "drills down" this distribution by country.

The stands of the Tool Exhibition were balanced between academia and industry (or governmental departments, cf. footnote 7):

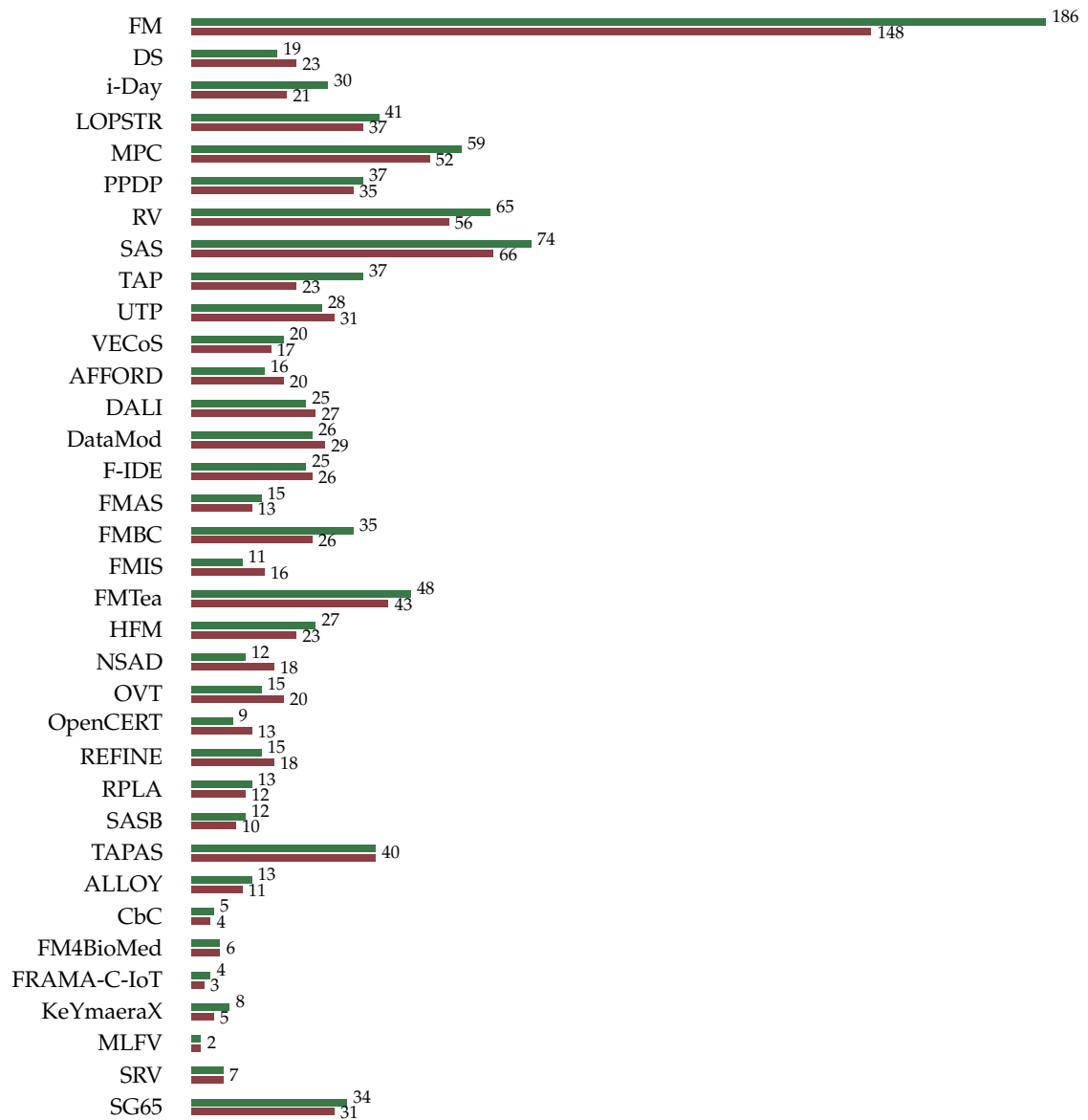[8]In fact per morning/afternoon slots due do to half day events.

Figure 11: FM'19 participants per event counted by two criteria: counting registration preferences (dark green stripes) or taking event overlapping into account (dark red stripes).

	7 Oct	8 Oct	9 Oct	10 Oct	11 Oct	Total
FM	0	0	146	157	139	442
DS	23	0	0	0	0	23
i-Day	0	0	0	0	21	21
LOPSTR	0	40	34	39	0	113
MPC	55	56	45	0	0	156
PPDP	38	37	29	0	0	104
RV	0	67	52	55	49	223
SAS	0	0	64	69	65	198
TAP	0	0	13	29	27	69
UTP	0	31	0	0	0	31
VECoS	0	0	17	0	0	17
AFFORD	20	0	0	0	0	20
DALI	0	0	27	0	0	27
DataMod	29	30	0	0	0	59
F-IDE	26	0	0	0	0	26
FMAS	0	0	0	0	13	13
FMBC	0	0	0	0	26	26
FMIS	16	0	0	0	0	16
FMTea	43	0	0	0	0	43
HFM	0	0	0	0	23	23
NSAD	0	18	0	0	0	18
OVT	20	0	0	0	0	20
OpenCERT	13	0	0	0	0	13
REFINE	18	0	0	0	0	18
RPLA	0	0	12	0	0	12
SASB	0	10	0	0	0	10
TAPAS	0	40	0	0	0	40
ALLOY	0	0	0	0	11	11
CbC	0	0	0	4	0	4
FM4BioMed	0	6	0	0	0	6
FRAMA-C-IoT	0	0	0	3	0	3
KeYmaeraX	0	0	0	5	0	5
MLFV	0	0	0	2	0	2
SRV	0	0	0	0	7	7
SG65	0	31	0	0	0	31
MH60	0	0	0	0	0	0
Total	301	366	439	363	381	1850

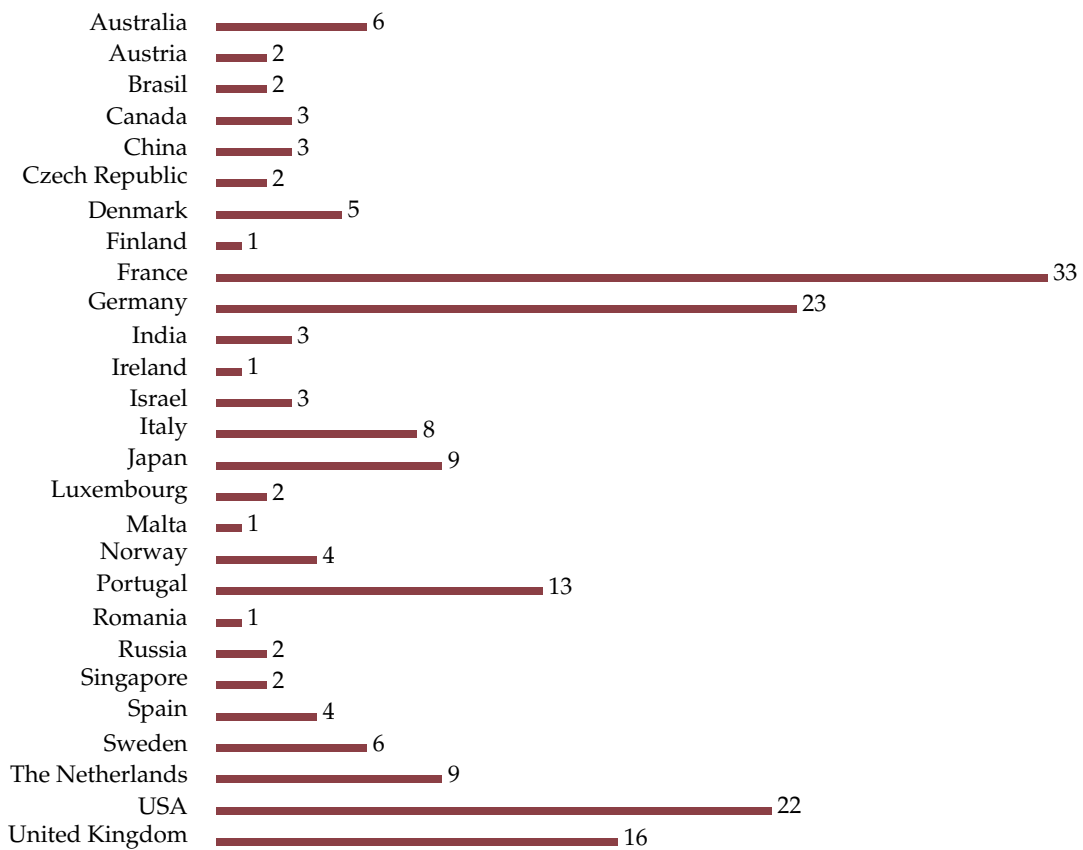Figure 12: FM'19 participants per day.

Figure 13: Distribution per country of the participants who included the FM symposium in their preferences.

3.3 Financial report

3.3.1 Introduction

This section contains the financial details of the overall operation of the FM'19 World congress.

The budget and finances of FM'19 was managed *in solidum*, that is, in a single block integrating the Symposium and all FM Week events. Every time an event expressed interest in joining the Congress or accepted the invitation to join, the Organizing Committee asked its chairs if they accepted this model, in which the FM'19 organization would assume the financial risk. All chairs accepted this model, in particular those of the co-located conferences.

This meant maintaining permanent contacts with the event organizers, seeking feedback or asking for predictions about, for example, expected number of registrations, expected attendance (related to the first one), whether they would like to participate in the social program and so on. Such figures were therefore constantly being updated, as were the simulations of various scenarios designed to assess risks.

Reports with these scenarios were regularly presented to the FME Treasurer at regular meetings, the frequency of which increased over time. Participant numbers were considered the most sensitive variable in the design of the general budget for FM'19 because the final figures would be known too late for any mitigation strategy to be triggered. Four scenarios were always on the table:

1. Optimistic: participation as indicated by event chairs and organizers.

2. Less optimistic: 10% lower than that indicated by event chairs and organizers.

3. Realistic: participation 25% lower than that indicated by event chairs and organizers.

4. Pessimistic: participation 40% lower than that indicated by event chairs and organizers.

All these scenarios were already present in the budget proposal of February 15, 2019, that was annexed to the contract signed between INESC TEC and FME. The reference scenario was the *realistic* one, which was thought to take into account the inevitable overlap of events. Based on previous symposia[9] we worked on the basis of a 20 / 80% split between student / non-student participants, and the distribution 80/19/1% of early/late/on-site registrations. These estimates later proved to be quite accurate, see plots (2) and (4).

---

[9]These figures are taken from the budget of FM 2016.

The initial amounts of fees were arbitrated based on the previous installments of the events, as communicated by organizers or event chairs. A first revision was made when the number of accepted papers became known in the symposium and in the co-located conferences, allowing for some fine-tuning. Further revisions took place as sponsor support increased, as final quotes were given for costs such as space, catering, technical support, etc. The final fee values can be found in the table in figure 10.

3.3.2 Overall results

The financial data fall into the following categories:

$$
\text{Overall}
\begin{cases}
\text{Income}
\begin{cases}
\text{Fees} \\
\text{Sponsors}
\end{cases} \\
\text{Expenses}
\begin{cases}
\text{Weezevent} \\
\text{Operation} \\
\text{Spaces} \\
\text{Catering} \\
\text{Invited speakers} \\
\text{Social programme}
\end{cases} \\
\text{Overheads}
\end{cases}
$$
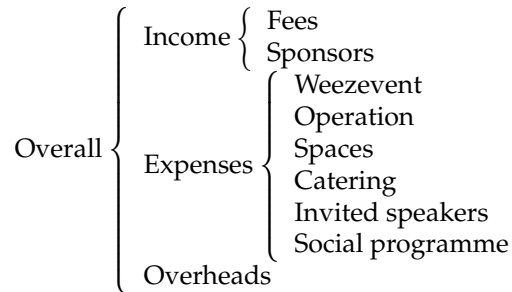
The overall balance in the above categories is:

	€
Fees	276994
Sponsors	85539
Weezevent	−6698
Operation	−62031
Spaces	−54558
Catering	−62445
Inv. speakers	−32595
Social	−34717
Overheads	−40489
Result	69000

(5)

Below we give a brief overview of these figures:

Fees — The registration fees for all activities in FM'19 are listed in the table in figure 10. Considering the total number of participants, the average fee was €451 per participant staying the whole week.

Sponsors — The effort to find sponsors for FM'19 was continuous throughout the whole operation.

The ATP association for promoting tourism in Porto and Northern Portugal gave generous financial support to FM'19 under the *Turismo de Portugal* program for stimulating the organization of international events in Portugal.[10]

Five sponsorship modalities were defined whose details are given in figure 14. The organization of FM'19 is grateful to the following companies and organizations that were generous enough to support the world congress at the indicated sponsorship levels:

- IT-Portugal Congress Support Program
    - Assoc. Turismo do Porto e do Norte
- Platinum
    - AWS
    - Google LLC
    - Sony Corporation
- Gold
    - ASML
    - PT-FLAD-Chair
    - Semmle
    - Springer Verlag
- Silver

---

[10]The financial support was €17500.

20

Basic	€500	Logo + www link in the 'Sponsors' section of FM'19 main page
Bronze	€1 000	*Basic +* Leaflet or other promotional material provided by sponsor in bag of every FM'19 participant
Silver	€2 000	*Bronze +* Ticket for either one conference or three one-day events (i-Day, workshop, tutorial, etc) Logo of sponsor to be interleaved in the electronic displays throughout the conferences
Gold	€6 000	*Silver +* Two additional tickets as above Stand / demonstration area in the lobby (desk + chairs + power supply) Institutional video (max. 3 minutes) to be played during breaks (timesharing FM'19 announcements etc)
Platinum	€9 000	*Gold +* Two more additional tickets as above Promotional info printed in badge ribbons of participants Room named after sponsor for the whole week

Figure 14: The five sponsorship levels defined for FM'19 as a whole.

- – Efacec
- – GMV
- – Oracle Labs
- – Runtime Verification
- – Standard Chartered Bank
- – UTRC-Ireland
- Bronze
  - – AdaCore
  - – CMUP
  - – Foundations of Perspicuous Software Systems
  - – i2S
- Basic
  - – Checkmarkx
  - – ClearSy
  - – Microsoft
  - – Natixis
  - – Neadvance
  - – Prover Technology
- Other partnerships
  - – Porto Tech Hub

On average, sponsors' generosity contributed with €139 to each participant of FM'19.

Catering — Catering costs were €35 per person per day, this including lunch and two coffee/tea breaks (morning, lunchtime and afternoon). The OC chose the most advantageous offer from a set of four

catering companies bounded to the contract with the APCC. This also included the Welcome Reception on October 7, which was free for all participants already in Porto on that day. There was a minimum number of lunches per day to guarantee the said unit value, otherwise there would be an increase. To make sure that this minimum would be guaranteed every day, daily (and event) participation in a matrix was simulated from an early age. The final version of this matrix is shown in figure 12. On average, the final cost of all catering services at FM'19 (five days) was €102 per participant.

Invited speakers — Paying for the accommodation and travel costs of the invited speakers (in addition to the exemption from the event fee for which they were invited) was part of the agreement with the co-located conferences under the condition that all flights should be booked and paid by the organization. This offer did not extend to the workshops, as it would greatly increase the associated risk, due to their number and the uncertainty regarding the number of participants.[11]

Operation — The breakdown of the operational costs per category can be found in (6). On average, these costs amounted to €102 per participant.

$$
\begin{array}{r|r}
 & \text{€} \\
\hline
\text{Accommodation} & -3071 \\
\text{Audiovisual} & -24968 \\
\text{Awards} & -3220 \\
\text{Consumables} & -1223 \\
\text{Equipment} & -1339 \\
\text{Licences} & -1766 \\
\text{Personnel} & -8583 \\
\text{Posting} & -508 \\
\text{Printing} & -3578 \\
\text{Publicity} & -80 \\
\text{Tram} & -1950 \\
\text{Travel} & -2370 \\
\text{Volunteers} & -7777 \\
\text{Welcome Reception} & -1598 \\
\hline
\text{Total} & -62031
\end{array}
\tag{6}
$$

These costs cover the whole operation started in 2018 until writing the current report. Travel includes the trip of the general chair to Oxford to announce FM'19 in the FM 2018 symposium.

Social program — The social program was planned for the FM 2019 symposium and other events that wished to join. Timely feedback was requested from all conference chairs and workshop organizers on whether or not they wanted to join the social program. FM, SAS, LOPSTR, RV and TAP joined. By default, the fees for these events already included the social program, as did the registration for the full week — see figure 10. Extra tickets for the social program were available.

As independent celebrations, UTP 2019 and SG65 had separate banquets the cost of which was also included in the fees. As SAS was the event through which the Google sponsorship was obtained, it made sense to support their steering committee dinner as well.

The other co-located events that gave feedback declined the invitation as they intended to organize something on their own. In such cases the OC helped in finding/reserving restaurants but took no further responsibility thereupon.

The cost components of the social program are marked by (*) below in (7).

$$
\begin{array}{r|r}
 & \text{€} \\
\hline
\text{Banquet (*)} & -25760 \\
\text{Boat trip (*)} & -3300 \\
\text{Buses (*)} & -750 \\
\text{SAS SC} & -337 \\
\text{SG65} & -1600 \\
\text{UTP} & -690 \\
\text{Wine tasting (*)} & -2280 \\
\hline
\text{Total} & -34717
\end{array}
\tag{7}
$$

Spaces — The choice of the APCC Congress Center as the main venue for FM'19 was perhaps the most important decision of the organization. Having gained fame as a kind of "visiting room" of the city of Porto,

---

[11]The only exceptions were DALI and RPLA 2019, whose organizers helped with sponsorships on the condition that costs of their invited speakers should be covered by such sponsors.

where many events of this type take place, it was a natural choice, albeit at its cost. It was decided to reserve a wing of the building that would also have conditions for the coffee breaks and tool exhibition. As APCC is very requested and busy all the time, there was a risk of losing this possibility if the reservation was not made well in advance. At such an early date the number of expected workshops was not so large as it came to be, and it was necessary to reserve more spaces nearby: Vincci Porto Hotel and the World of Discoveries Museum. On average, the final cost of all spaces and facilities reserved for FM'19 (five days) was €90 per participant.

Weezevent — In registering for FM'19, participants were encouraged to pay by credit card on the Weezevent platform, but the possibility of paying by bank transfer was also open. To each payment through Weezevent a commission of 2.43% had to be paid, which was booked as an expense.

Overheads — As indicated in the budget proposal appended to the contract signed between FME and INESC TEC, an overhead of 16% was charged by the latter over the expenses, following the institute's internal financial rules.

3.3.3 Break down per event

The table of figure 15 gives a distribution of the overall result of FM'19 (5) "drilled-down" to event level, in proportion to each event volume measured in its average number of participants and time span. It includes the tutorials that were cancelled because they were chosen by some participants anyway and impacted on the whole cost (eg. spaces reserved).

The number of participants has a major impact on each event's individual result, which should be read with caution: the popularity of Full Week registrations, many of which did not specify which events would be attended, suggests reading the figures in the table not too sharply.

Perhaps more interesting than the individual results is the projection of the numbers across groups or event categories. For instance, the following chart

$$
\begin{array}{l}
\text{conference} \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad 65135 \\
\text{others} \quad -4890 \\
\text{workshop} \quad\quad\quad\quad 8755
\end{array} \tag{8}
$$

groups the individual results by event type — conferences, workshops or others (tutorials and tool exhibition). The negative results of the tutorials is mainly due to their relatively smaller number of participants, whose fees did not cover the fixed (eg. space) costs.

Another interesting projection is that summarizing the table by event "clusters":

$$
\begin{array}{l}
\text{Co-located} \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad 23658 \\
\text{Co-located WS} \quad 1841 \\
\text{FM cluster} \quad\quad\quad\quad\quad\quad\quad\quad\quad 19934 \\
\text{LOPSTR cluster} \quad\quad\quad 6788 \\
\text{SAS cluster} \quad\quad\quad\quad\quad\quad\quad 16779
\end{array} \tag{9}
$$

These event clusters unfold as follows:

Co-located MPC, RV, TAP, UTP and VECoS

Co-located WS AFFORD, ALLOY, CbC, DALI, DataMod, FM4BioMed, FMAS, FMBC, FRAMA-C-IoT, KeYmaeraX, MLFV, OpenCERT, RPLA and SRV

FM cluster DS, F-IDE, FM, FMIS, FMTea, HFM, OVT, REFINE, T-E, SG65 and i-Day

LOPSTR cluster LOPSTR, PPDP and MH60

SAS cluster NSAD, SAS, SASB and TAPAS

What is meant by a cluster and why the clusters above? The SAS cluster is the easiest to explain, as this symposium usually comes with three satellite workshops: NSAD, SASB and TAPAS. LOPSTR and PPDP have co-located in the past and actually shared invited speakers this time. MH60 ran after LOPSTR in the same room.

As to the FM cluster, it includes the usual "suspects" — a doctoral symposium, a teaching workshop, the Overture workshop, the refinement workshop, the industrial day and the tool exhibition — plus events that have co-located with FM symposia in the past such as F-IDE and FMIS. The SG65 *Festschrift* and HFM were new but, would FM be a regular FM symposium, they would surely be hosted in.

All other co-located conferences and workshops go into the co-located clusters.

3.3.4 Balance

A quick analysis of bar charts (8) and (9) reveals the expected:

- Tutorials alone are not financially viable, while workshops do not go negative but show a profit that is risky: lower numbers of participants could turn their overall result negative. Chart (8) clearly shows how conferences and symposia contributed to the final result.

- Chart (9) shows that conferences without attached workshops have positive results, but these are not that comfortable if each conference is taken in isolation ($\pm \in 4700$ per conference on average). The outcome of the LOPSTR cluster is similar.

- Clearly, the best results go to the FM and SAS clusters, not forgetting that both were supporting workshops in their cluster.

The result of the FM cluster also gives an indication of what the likely outcome would have been had FM'19 been a regular symposium. It is quite clear that having run in parallel with other conferences was generally beneficial, even at the risk of having to absorb possible losses from such events.

4   Lessons learned and suggestions for the future

FM'19 was the 3rd World Congress on Formal Methods organized by FME. The FM 2019 host symposium was the 23rd in FME's records. One can guess the questions that fill people's minds: what is happening in the FM community? How are we proceeding?

FM'19's motto *"The Next 30 Years"* was forward looking:

> *(...) Since then the diversity and complexity of computer technology has changed enormously and the formal methods community has stepped up to the challenges those changes brought by adapting, generalising and improving the models and analysis techniques that were the focus of that first symposium. The theme for FM 2019 is a reflection on how far the community has come and the lessons we can learn for understanding and developing the best software for future technologies.*

The challenges that the community will have to face in the future have inspired the architecture of FM'19 itself, which was set up to build bridges with other relevant research areas in computing and mixing with other conferences and workshops with some allowed diversity.

For instance, FM'19 hosted the FMBC 2019, FMAS 2019 and RPLA 2019 workshops, which are first in their expected series in applying formal techniques to trendy topics such blockchain, autonomous systems and reversible (inc. quantum) languages. On the other hand, HFM — the first workshop on history of formal methods — was set to look into the past — a past that must be recorded and studied.[12]

This final section of this report goes back to the themes of the previous sections, now with the intention not to report on the past but rather to point to future FME events. Some brief comparative analysis will be made between FM'09 and FM'19 based on data contained in the final report of the first [1].

4.1   FM Week

The idea of organizing an "FM Week" was inspired by the architecture of FM'09. This is definitely a good idea that should be followed in future events. FM'19 was slightly larger than FM'09, as the following chart shows:[13]
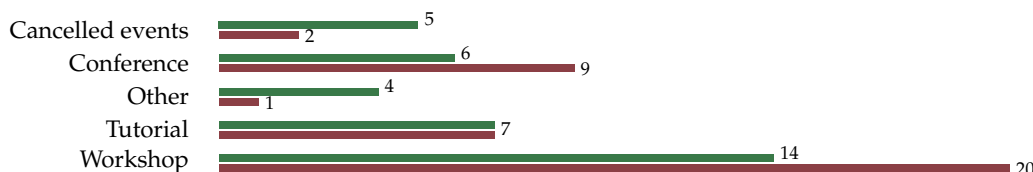
The main differences are that FM'19 hosted longer conferences than FM'09 (3-4 days) and had less tutorials cancelled due to lack of participants (2 cancelled at FM'19, 5 cancelled at FM'09).

What can one do to prevent event cancellations due to lack of registrations? Not much. But perhaps offering very generous (but no-refund) rates for tutorials at early registration time could help.

---

[12]Unfortunately, the MLFV and FM4BioMed tutorials had too few registrations to take place. They would bridge with machine learning and biomedecine.

[13]In all charts to follow the dark green bars plot FM'09 data and the dark red ones FM'19 data. Symposia and conferences are grouped together in Conference.

	Fees	Sponsors	Weezevent	Operation	Spaces	Catering	Inv. speakers	Social	Overheads	Tot
FM	74048	16523	−1790	−14669	−6006	−14965	−9070	−14381	−9741	19949
DS	2791	845	−67	−899	−1001	−766	−534	0	−523	−154
i-Day	3590	801	−87	−663	−1001	−726	−2698	0	−828	−1612
LOPSTR	18763	4187	−454	−3964	−2753	−3792	−1439	−3644	−2567	4337
MPC	21948	5816	−531	−4811	−3003	−5267	−777	0	−2302	11073
PPDP	14596	3868	−353	−3240	−3003	−3503	−3455	0	−2169	2741
RV	33878	12121	−819	−7388	−5005	−7541	−4790	−5435	−4957	10064
SAS	32946	16262	−796	−7082	−3003	−6658	−5690	−6735	−4794	14450
TAP	11493	2565	−278	−2122	−2503	−2323	−1109	−2232	−1691	1800
UTP	5254	1172	−127	−1100	−1001	−1062	−462	−690	−711	1273
VECoS	2763	617	−67	−510	−1001	−558	−1254	0	−542	−552
AFFORD	2452	743	−59	−614	−1001	−673	0	0	−376	472
DALI	3305	1001	−80	−828	−1001	−907	−495	0	−530	465
DataMod	7269	2201	−176	−1821	−2002	−1994	0	0	−959	2518
F-IDE	3264	988	−79	−818	−1001	−895	0	0	−447	1012
FMAS	1604	486	−39	−402	−1001	−440	0	0	−301	−93
FMBC	3216	974	−78	−806	−1001	−882	0	0	−443	980
FMIS	1918	581	−46	−481	−1001	−526	0	0	−329	116
FMTea	5287	1601	−128	−1324	−1001	−1450	0	0	−625	2360
HFM	2851	863	−69	−714	−1001	−782	0	0	−411	737
NSAD	2208	669	−53	−553	−1001	−606	0	0	−354	310
OVT	2422	733	−59	−607	−1001	−664	0	0	−373	451
OpenCERT	1662	503	−40	−416	−1001	−456	0	0	−306	−54
REFINE	2175	659	−53	−545	−1001	−597	0	0	−351	287
RPLA	1533	1712	−37	−384	−1001	−420	−822	0	−426	155
SASB	841	357	−20	−295	−501	−323	0	0	−182	−123
TAPAS	4960	1502	−120	−1243	−1001	−1360	0	0	−596	2142
ALLOY	1347	408	−33	−338	−1001	−370	0	0	−279	−266
CbC	329	140	−8	−115	−501	−126	0	0	−120	−401
FM4BioMed	763	231	−18	−191	−501	−209	0	0	−147	−72
FRAMA-C-IoT	223	94	−5	−78	−501	−86	0	0	−107	−460
KeYmaeraX	410	174	−10	−144	−501	−157	0	0	−130	−358
MLFV	190	80	−5	−67	−501	−73	0	0	−103	−479
SRV	895	271	−22	−224	−1001	−246	0	0	−239	−566
SG65	3800	1151	−92	−1330	−1001	−1042	0	−1600	−810	−924
MH60	0	0	0	0	−250	0	0	0	−40	−290
Tool-E	0	2640	0	−1245	−3003	0	0	0	−680	−2288
Tot	276994	85539	−6698	−62031	−54558	−62445	−32595	−34717	−40489	69000

Figure 15: FM'19 results "drilled-down" to event level.

4.2 The venue

It is well known that a good choice of venue is important. Some priority should be given to having a well connected airport nearby, and this was the main reason for discarding the initial options of Braga or Guimarães as venues for FM'19.

But there are likely changes in the horizon. FM'19 in Porto was the last conference on formal methods that took place before the Covid-19 pandemics. As we all have experienced since last March, on-line conferences have proved more viable than previously thought. It is therefore likely that conferences in the future will be hybrid in the sense of also offering rates for on-line participation. This will challenge post-pandemic scientific event organizers to innovate in this direction without destroying the emotional spirit of conventional face-to-face conferences.

4.3 The schedule

The initial plan for FM'19 was to have all the workshops and tutorials in the first two days and the main conferences in the rest of the week. However, the number of workshops made this impossible and we had to spread them through the whole five days. On the other hand, one conference was longer than three days.

Some participants liked the idea of having events of different geometry on the same day but others complained that the main events were clashing with small scale ones they also wanted to attend.

An idea for the future is to work on the basis of *clusters* — recall (9) — and try to maximise the possibility of one attending all the events in the same cluster. To some extent this was tried already this time, for instance making sure that the usual FM workshops did not collide with the FM symposium.

4.4 The social program

An attractive social program is always something that increases the interest in participating in a conference. However, it presents a risk because many participants end up not wishing to participate in such side initiatives.

FM'19 went for a compromise solution: the OC studied the possibility of diluting the cost of the social program in the rates of the events that joined the program. This option also circumvented the difficulties of participants obtaining reimbursements for such expenses had they been charged independently.

This option is recommended for the future as long as the impact on fees is acceptable.

4.5 Program committees

Further to the data and statistics of section 2.2, the following bar chart was compiled with data taken from [1] (dark green bars):
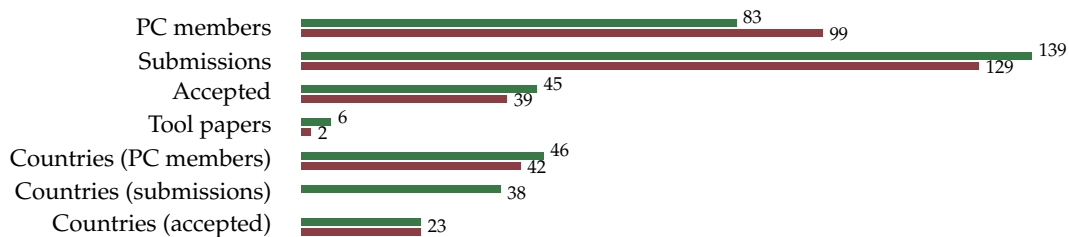
It compares the PCs of the FM 2009 and FM 2019 symposia and the submission data of both.

Although the PC of FM 2019 was larger (covering more or less the same number of countries) the number of submissions was slightly smaller, after a peak of 185 abstract submissions. By coincidence, the number of countries of authors of accepted papers was exactly the same.[14]

The history of all submissions to FM symposia since 1999 is given in figure 16.[15] The figures of the FM 2019 symposium are aligned with the average. The exceptional numbers of FM'99 seem difficult to reach twenty years later, given the more crowded calendar of research conferences on formal methods and computing of today.

We can ask ourselves about the countries in which FM authors live that we know of, but do not appear in the chart of page 12. It is quite clear that the main contributors come from Europe and the United States. By contrast, the following countries seem under-represented there: Brasil, China, Italy, Japan and Spain.

---

[14]We did not record the countries where all submissions came from, and so this information is missing from the chart.

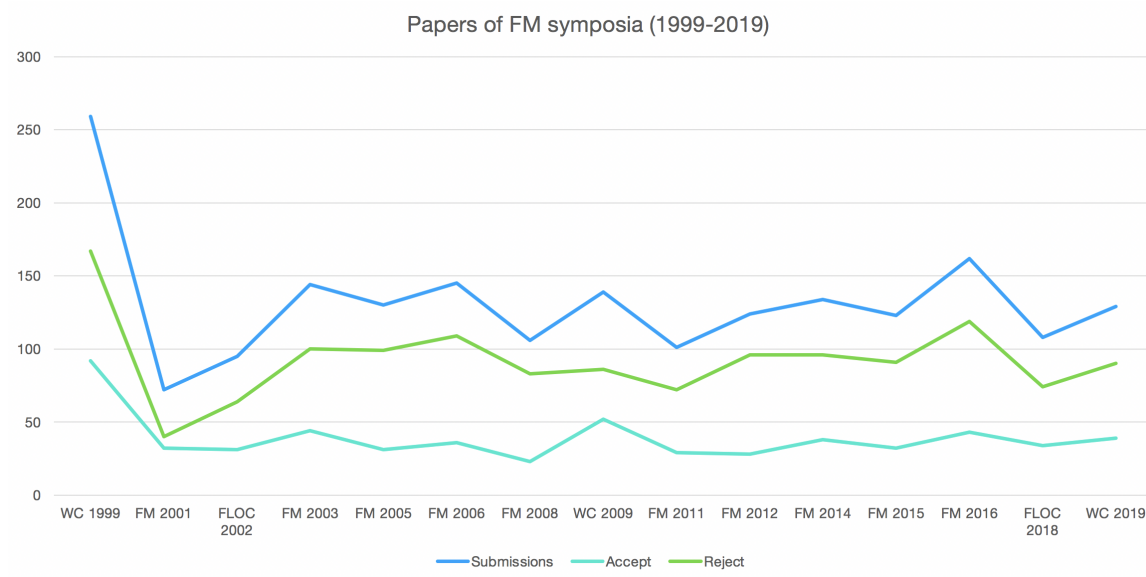[15]We thank Stephania Gnesi for these data, to which we have added those of FM'19.

Figure 16: Record track of submissions to FM symposia (1999-2019).

4.6 Scientific Program

4.6.1 Journal First Track

For the first time, the FM 2019 symposium included a Journal-First Track. This was a very good decision of the FME board in its bringing top quality papers to the social forum that had only been published in journals. Live discussions are central to the scientific process and it would be good if FME could invite other prestigious journals to join future journal-first tracks.

4.6.2 Papers and submissions

Details about this topic have been given already in section 4.5 above. It is difficult to explain why the 185 abstract submissions to the FM symposium materialized in only 129 paper submissions. The first number, however, expresses the interest and awareness of the FM community with respect to the FM 2019 symposium.

4.7 Multimedia

The overall multimedia output of FM'19, listed in section E of the appendix, is available from the Youtube channel of FME. The initial plans were to subcontract a professional company to do this, including live streaming. However, the cost of this service was found prohibitive, putting the overall budget at risk.[16] A compromise was found in hiring a professional to guide volunteers (students of social communication degrees) in doing the media coverage.

This kind of activity is needed in conferences more and more. PC chairs were invited to send call-for-papers video clips that would be treated locally and published on Youtube. However, the idea was not widely accepted and only a few chairs did so.[17]

4.8 Green FM'19

FM'19's global effort for an environment-friendly *Reduce–Recycle–Reuse* mode of operation avoided plastic or other throw-away objects. All plastic bags of badges that participants left at the end of FM'19 are ready to be sent for reuse to organizers of future FME events.

But the most expressive result in this respect was FM'19's cut back on printed paper by adopting Springer's access to electronic, paper-less conference proceedings instead of printed or USB proceedings. This significantly saved paper and posting costs and is recommended for the future..

The nostalgic participant will always think that something is lost whenever no physical evidence is left that a conference has taken place. A good compromise is to have paper books only for PC chairs or, at most, members of the steering committee.

---

[16]The cost would have been €12801 just for the two main rooms of the APCC.
[17]Please see `http://formalmethods2019.inesctec.pt/?page_id=1294`.

4.9 Publicity

All the publicity[18] and overall operation of FM'19, from its announcement in July 2018 at the FM 2018 symposium, until the conclusion of all its activities, was centered on the congress website supported by the `@formalmethods19` account at the Twitter social network. During the congress, another network was created on Slack, available to all participants wishing to contact the organizing committee or interact with each other. One particular Slack channel was restricted to volunteers and the organizing committee to grant permanent access to relevant or urgent information and operational directives.

The overall graphical and image design was the responsibility of an INESC TEC design team, who ensured a consistent graphical identity.

Some promotional videos of the congress were made that are also listed in section E of the appendix.

Each co-located event was responsible for the construction of their own website and their own dissemination activity, including calls for papers and so on. All such sites were linked to the main Congress website. This was managed dynamically and incrementally, always issuing news on Twitter whenever there was any significant update taking place.

All this did not dispense with leaflets distributed at FM 2018 in Oxford and the usual mailing of the A3 poster of the congress to a list of more than 400 addresses that evolved from the one provided by FME.

We suggest that the Twitter account `@formalmethods19` be kept and "reused" in future FM symposia.

4.10 Participants

The final report of FM'09 shows the country of residence for all participants in one or more activities of FM'09. These data are put in parallel with those of FM'19 in the bar chart of figure 17.

Perhaps the most visible differences in the chart are the more than doubling of French and Italian participants and the fourfold increase in US participants. The increase in those from Portugal is obvious, especially since all the volunteers, who were recruited from postgraduate degrees in computing, were considered regular participants. The converse effect is observed in the drop in Dutch participants, since FM'09 took place in Eindhoven, NL.

On the bare "arithmetics" of countries lost or gained, one may say that Argentina, Estonia, Hungary, Kazakhstan, Mexico, Switzerland, Taiwan and Vietnam are gains, while Cyprus, Iran and Turkey are losses. Even regarding this kind of analysis as rather dubious, perhaps a marketing plan involving FM colleagues in all these countries would be useful to keep the gains and regain the losses in future symposia.

4.11 Finances

In contrast with FM'09, where the FM symposium had an independent budget from that of the FM Week, FM'19 worked *in solidum* on a single, overall budget. The books of FM'19 closed with a net positive result of €69000, to be split 60/40 between FME and INESC TEC according to the terms of the contract underlying the organization of the congress.

Looking back, it is clear that the overall result is essentially due to two factors: there were more participants than anticipated in the initial budget, which was based on previous average participation figures, and there was a more significant contribution from sponsors than initially predicted.

The overall result is also due to the co-located conferences, which brought quite a number of participants to the congress as well. In addition, the tourist factor should not be overlooked, given that the city of Porto has, in recent years, been one of the privileged tourist hubs of Portugal, in an increasing and consistent way, only shaken by the public health crisis that we all know, but this had not started yet when the congress took place.

As a final comment to the *in solidum* approach to the finances of FM'19, perhaps the hardest bit of the operation was managing a large number of invited speakers, some of whom were very late in responding to emails, increasing the costs of their flights and accommodation. A less personal approach (with strict deadlines and so on) is recommended for the future.

4.12 Prospect for the future

All in all, perhaps the (not fully accurate but nevertheless) most suggestive perspective on how geography-wide FM'19 was as a *World Congress on Formal Methods* is this look at the participants of the FM symposium, taken from figure 11:

European ▬▬▬▬▬▬▬▬▬▬▬ 131
Non-European ▬▬▬▬ 55

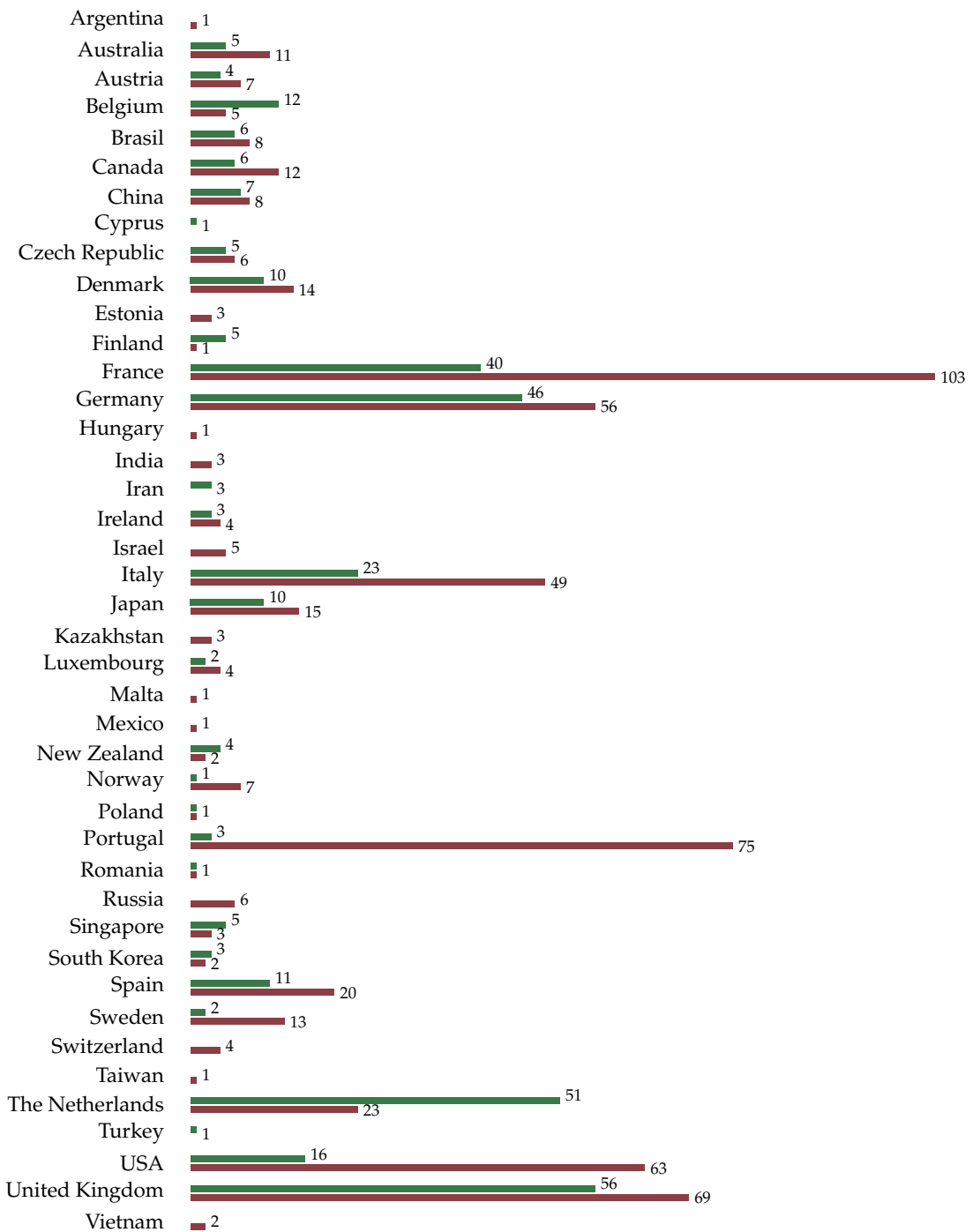---

[18]Details in appendix F.

28

Figure 17: Comparative chart of participants in the FM'09 (dark green bars) and FM'19 (dark red bars) World Congresses.

FME was born in Europe and still is mostly European. The main challenge ahead for *The Next 30 Years* is continuing fighting for a wider spread of the FM approach to computing technology in two directions, one geographical and the other semantic: more world-wide and more inclusive with respect the fast evolving IT sector, keeping in mind the balance of intent so nicely captured by the quote:

> *"My experience has been that theories are often more structured and more interesting when they are based on the real problems; somehow they are more exciting than completely abstract theories will ever be."*(Donald Knuth, 1971)

Appendices

A Programme Committee of the FM 2019 Symposium

- Alberto Lluch Lafuente (*Denmark*)
- Alcino Cunha (*Portugal*)
- Alessandro Cimatti (*Italy*)
- Alessandro Fantechi (*Italy*)
- Alexandre Petrenko (*Canada*)
- Ali Jaoua (*Quatar*)
- Ana Cavalcanti (*United Kingdom*)
- Ana Sokolova (*Austria*)
- Anastasia Mavridou (*USA*)
- André Platzer (*USA*)
- Andrea Vandin (*Denmark*)
- Anna Philippou (*Cyprus*)
- Annabelle McIver (*Australia*)
- Anne Haxthausen (*Denmark*)
- Antonio Cerone (*Kazakhstan*)
- Atsushi Igarashi (*Japan*)
- Augusto Sampaio (*Brasil*)
- Axel Legay (*Belgium*)
- Bernhard K. Aichernig (*Austria*)
- Bruce Watson (*South Africa*)
- César Muñoz (*USA*)
- Carla Ferreira (*Portugal*)
- Christel Baier (*Germany*)
- Colin O'Halloran (*United Kingdom*)
- Constance Heitmeyer (*USA*)
- Dalal Alrajeh (*United Kingdom*)
- Dang Van Hung (*Vietnam*)
- Daniel Schwartz-Narbonne (*USA*)
- David Chemouil (*France*)

- Dominique Méry (*France*)
- Einar Broch Johnsen (*Norway*)
- Elena Troubitsyna (*Finland*)
- Elvira Albert (*Spain*)
- Erik de Vink (*The Netherlands*)
- Farn Wang (*Taiwan*)
- Fatemeh Ghassemi (*Iran*)
- Federico Olmedo (*Chile*)
- Frank de Boer (*The Netherlands*)
- Gabriele Lenzini (*Luxembourg*)
- Gerardo Schneider (*Sweden*)
- Gethin Norman (*United Kingdom*)
- Gilles Barthe (*Spain*)
- Gordon Pace (*Malta*)
- Gustavo Betarte (*Uruguay*)
- Helen Treharne (*United Kingdom*)
- Hernán Melgratti (*Argentina*)
- Ian J. Hayes (*Australia*)
- Jaco van de Pol (*The Netherlands*)
- Jan Peleska (*Germany*)
- Jane Hillston (*United Kingdom*)
- Jim Woodcock (*United Kingdom*)
- João Ferreira (*Portugal*)
- Joost-Pieter Katoen (*Germany*)
- Jorge Sousa Pinto (*Portugal*)
- José Fiadeiro (*United Kingdom*)
- Julien Brunel (*France*)
- Jun Sun (*Singapore*)
- June Andronick (*Australia*)
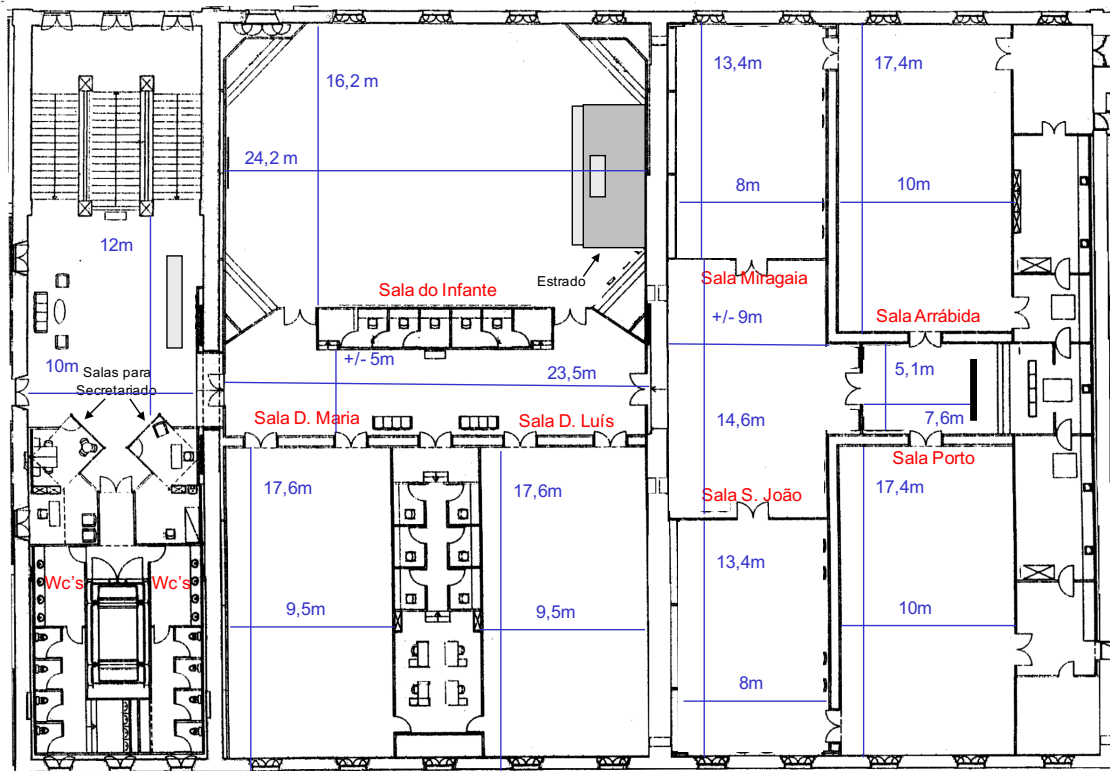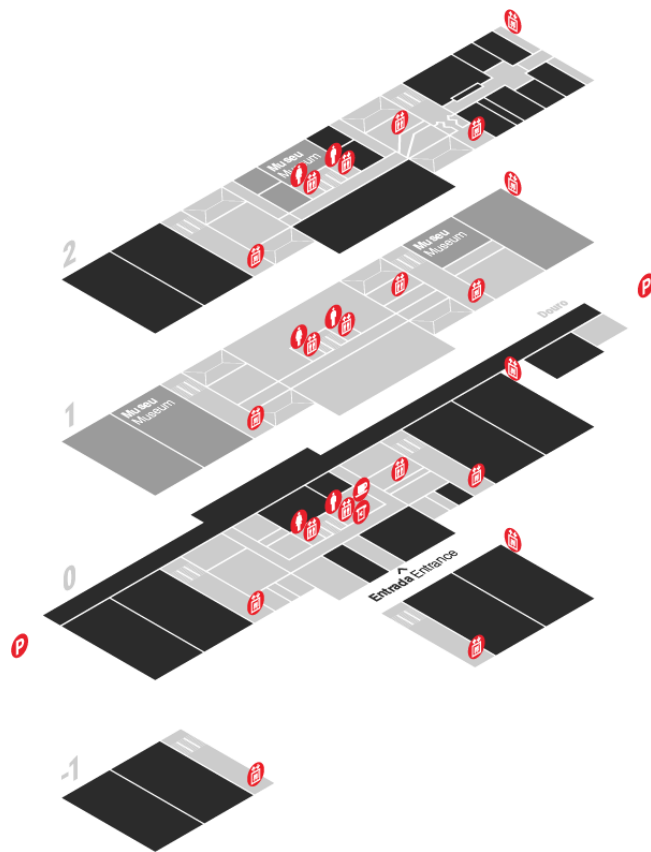- Kirsten Winter (*Australia*)

Figure 18: APCC spaces (2nd floor of west wing).

Figure 19: Ceuta room in the WD building..

- Klaus Havelund (*USA*)
- Laura Kovács (*Austria*)
- Lijun Zhang (*China*)
- Luís Barbosa (*Portugal*)
- Mário S. Alvim (*Brasil*)
- Malte Lochau (*Germany*)
- María Alpuente (*Spain*)
- Marcello Bersani (*Italy*)
- Marcelo Frias (*Argentina*)
- Marielle Petit-Doche (*France*)
- Marielle Stoelinga (*The Netherlands*)
- Marsha Chechik (*Canada*)
- Matteo Rossi (*Italy*)
- Maurice ter Beek (*Italy*)
- Michael Dierkes (*France*)
- Michele Loreti (*Italy*)
- Mohammad Mousavi (*Sweden*)
- Néstor Cataño (*Colombia*)
- Natasha Sharygina (*Switzerland*)
- Nikolaj Bjørner (*USA*)
- Nikolay Shilov (*Russia*)
- Olfa Mosbahi (*Tunisia*)
- Osman Hasan (*Pakistan*)
- R. Venkatesh (*India*)
- Reiner Hähnle (*Germany*)
- Rosemary Monahan (*Ireland*)
- Sergiy Bogomolov (*Australia*)
- Silvia Ghilezan (*Serbia*)
- Stefania Gnesi (*Italy*)
- Steve Reeves (*New Zealand*)
- Suman Jana (*USA*)
- Sun Meng (*China*)
- Tahiry Rabehaja (*Australia*)
- Tarmo Uustalu (*Iceland*)
- Thai Son Hoang (*United Kingdom*)
- Tim Nelson (*USA*)
- Tim Willemse (*The Netherlands*)
- Willem Visser (*South Africa*)
- Yang Liu (*Singapore*)
- Zhenjiang Hu (*Japan*)

B List of all PC chairs or organizers

- **FM 2019** — Annabelle McIver and Maurice ter Beek
- **Workshops & Tutorials** — Emil Sekerinski and Nelma Moreira
- **T-E** — Stephan Merz and Thierry Lecomte
- **i-Day 2019** — Joe Kiniry and Thierry Lecomte
- **DS 2019** — Alexandra Silva and Antónia Lopes
- **LOPSTR 2019** — Maurizio Gabbrielli

- **MPC 2019** — Graham Hutton

- **PPDP 2019** — Ekaterina Komendantskaya

- **RV 2019** — Bernd Finkbeiner and Leonardo Mariani

- **SAS 2019** — Bor-Yuh Evan Chang

- **TAP 2019** — Chantal Keller and Dirk Beyer

- **UTP 2019** — Augusto Sampaio and Pedro Ribeiro

- **VECoS 2019** — Mohamed Kaâniche and Pierre Ganty

- **AFFORD 2019** — Alan Wassyng, Alexander Romanovsky, Daniel Ratiu and Fuyuki Ishikawa

- **DALI 2019** — Alexandru Baltag and Luís Barbosa

- **DataMod 2019** — Mirco Nanni, Riccardo Guidotti and Vashti Galpin

- **F-IDE 2019** — José Proença, Rosemary Monahan and Virgile Prevosto

- **FMAS 2019** — Marie Farrell, Matt Luckcuck and Michael Fisher

- **FMBC 2019** — Bruno Bernardo, Diego Marmsoler and Néstor Cataño

- **FMIS 2019** — José Creissac Campos and Steve Reeves

- **FMTea 2019** — Brijesh Dongol and Luigia Petre

- **HFM 2019** — Brian Randell and Troy Astarte

- **NSAD 2019** — Laure Gonnord

- **OVT 2019** — Carl Gamble and Luis Diogo Couto

- **OpenCERT 2019** — Antonio Cerone and Luís Barbosa

- **REFINE 2019** — Brijesh Dongol, John Derrick and Steve Reeves

- **RPLA 2019** — Markus Holzer and Martin Kutrib

- **SASB 2019** — Jean Krivine and Pedro T. Monteiro

- **TAPAS 2019** — David Delmas

- **SG65** — Alessandro Fantechi, Laura Semini and Maurice ter Beek

- **MH60** — John Gallagher, Pedro Lopez-Garcia and Roberto Giacobazzi

- **ALLOY** — Alcino Cunha, David Chemouil, Eunsuk Kang and Julien Brunel

- **CbC** — Bruce Watson, Ina Schaefer, Loek Cleophas and Tobias Runge

- **FM4BioMed** — Ion Petre, Luigia Petre and Orieta Celiku

- **FRAMA-C-IoT** — Allan Blanchard, Frédéric Loulergue and Nikolai Kosmatov

- **KeYmaeraX** — André Platzer and Stefan Mitsch

- **MLFV** — Moussa Amrani

- **SRV** — César Sánchez, Martin Leucker and Volker Stolz

C List of FM'19 Invited Speakers

FM 2019 Invited Speakers

- **Erik Poll** — Erik Poll is Associate Professor at the Digital Security group at Radboud University in Nijmegen. Here he has carried out applied security research into smartcards, payment systems, security protocols and smart

grids, and investigated the use of formal methods to support such security analyses, especially to analyse the software implementing the protocols involved. Earlier he worked on the verification of object-oriented programs, especially for Java and using the specification language JML.

- **June Andronick** — June Andronick leads the Trustworthy Systems group, world-leading in verified operating systems software, known worldwide for the formal verification of the seL4 microkernel. She is a Principal Research Scientist at Data61—CSIRO, and conjoint Associate Professor at UNSW Sydney, Australia. She was recognised in 2011 by MIT's Technology Review as one of the world's top young innovators (TR35). She previously worked in industry for the smart-card manufacturer Gemalto in Formal Methods research.

- **Shriram Krishnamurthi** — Shriram Krishnamurthi is a Professor of Computer Science and an Associate Director of the Executive Master in Cybersecurity at Brown University. With collaborators and students, he has created several influential systems and written multiple widely-used books. He also co-directs the Bootstrap math-and-computing outreach program. For his work he has received SIGPLAN's Robin Milner Young Researcher Award, SIGSOFT's Influential Educator Award, SIGPLAN's Software Award, and Brown's Henry Merritt Wriston Fellowship for distinguished contribution to undergraduate education. He has authored over a dozen papers recognized for honors by program committees. He has an honorary doctorate from the Università della Svizzera Italiana.

DS 2019 Invited Speaker

- **Sung-Shik Jongmans** — Sung-Shik Jongmans is assistant professor at Open University of the Netherlands and researcher in the Formal Methods group at Centrum Wiskunde & Informatica (CWI), Amsterdam. He has a PhD degree from Leiden University (2016) and was visiting researcher at Imperial College London (2017-2019). His research interests include concurrency and programming languages; at the intersection of theory and practice, he currently works on design and implementation of DSL techniques for code generation, optimization, and verification of synchronization and communication protocols.

iD 2019 Invited Speakers

- **Constance Heitmeyer** — Constance Heitmeyer heads the Software Engineering Section of NRL's Center for High Assurance Computer Systems. Her research focuses on techniques for modeling and analyzing critical software systems and on methods for assuring the safety

and security of these systems. Chief designer of NRL's Requirements Toolset, she has published 150+ papers on a wide range of software-related research topics and is a frequent invited speaker at conferences and universities. She has transferred the results of her research to many practical, safety-critical systems, including NASA's International Space System and a Navy weapons system. Recently, she led the team that provided formal evidence, including a formal model, a set of security properties, mechanized proof that the model satisfies the properties, and a demonstration that the source code satisfies the model, for certifying the security of a software-based communications system. Currently, she leads the formal methods V&V team whose objective is to provide assurance that a space robot performs its autonomous operations safely and correctly.

- **Michael Leuschel** — Michael Leuschel is full professor at the Institut für Informatik of Heinrich-Heine-Universität Düsseldorf, Germany, where he leads the Software Engineering and Programming Languages group. His research focusses on model-based problem solving using symbolic model checking. He has been one of the main developers of ProB, a successful animator, constraint solver and model checker for the B-Method. ProB is certified T2 SIL4 according to the Cenelec EN 50128 standard. Michael's research is also behind the development of the ECCE system for partial deduction.

LOPSTR 2019 Invited Speakers

- **Germán Vidal** — German Vidal is a Professor of Computer Science at the Universitat Politecnica de Valencia, Spain. He leads a research group on Multi-paradigm Software Technology at the Valencian Research Institute for Artificial Intelligence (VRAIN). His research has mainly considered declarative programming languages and formalisms (e.g., term rewriting, functional and logic programming, the actor model) and research topics related to program semantics, integrated functional-logic languages, partial evaluation, software testing, program analysis, etc. Currently, his work mainly focuses on reversible computation and its application to program debugging in message-passing concurrent languages.

- **John Gallagher** — John Gallagher received a Ph.D. in Computer Science from Trinity College Dublin, Ireland in 1983. After employment in research and development in a software company in Hamburg, Germany, and post-doc appointments at the Weizmann Institute of Science, Israel and Katholieke Universiteit Leuven, Belgium, he was employed at the University

of Bristol, UK from 1990 to 2002. Since 2002 he has been a professor at the Roskilde University, Denmark and since 2008 he has also been a part-time research professor at IMDEA Software Institute, Madrid, Spain. His research interests focus on program transformation and generation, program analysis, constraint logic programming, rewrite systems, temporal logics, semantics-based emulation of languages and systems, and verification using abstraction.

MPC 2019 Invited Speakers

- **Annabelle McIver** — Annabelle McIver is a Professor of Computer Science at Macquarie University in Sydney. Annabelle trained as a mathematician at Cambridge and Oxford Universities. Her research uses mathematics to prove quantitative properties of programs, and more recently to provide foundations for quantitative information flow for analysing security properties. She is co-author of the book *Abstraction, Refinement and Proof for Probabilistic Systems*, and of the forthcoming title *The Science of Quantitative Information Flow*.

- **Assia Mahboubi** — Assia Mahboubi is a permanent researcher at Inria and an endowed Professor at the Department of Mathematics of the VU Amsterdam. Her research interests are the foundations and formalization of mathematics in type theory and the automated verification of mathematical proofs. She was previously a member of the Mathematical Components team at the Inria Microsoft Research joint centre, known for a machine-checked proof of the Odd Order theorem in finite group theory. She has been one of the main contributors to this collaborative effort. Her current projects are related to the formal verification of mathematical software.

PPDP 2019 Invited Speakers

- **Amal Ahmed** — Amal Ahmed is an Associate Professor at the Khoury College of Computer Sciences at Northeastern University, where she leads the SILC group (Secure Interoperability, Languages, and Compilers). Her current research focuses on correct and secure compilation with support for safe inter-language linking of compiled code. Her group's recent work also involves dependent-type-preserving compilation, new foundations for gradual typing, and formalizing the Rust type system. She is known for her work scaling the logical relations proof method, including "semantic" type soundness, to realistic languages. She received a PhD from Princeton, an MS from Stanford, and an AB from Brown, all in CS. Her awards include an NSF Career Award and a Google Faculty Research Award.

- **Mariangiola Dezani** — Mariangiola Dezani-Ciancaglini is emeritus professor at the University of Torino since 2017. She was nominated EATCS Fellow in 2015. She has been member and chairman of program committees of international conferences, teacher of postdoctoral schools, supervisor of Ph.D. theses. She is or has been member of the editorial board of Information and Computation, the Computer Journal and Springer-Nature Computer Science, member of the IFIP Working Group 2.2 and member of the Academia Europaea.

- **Naoki Kobayashi** — Naoki Kobayashi is a professor at Department of Computer Science, Graduate School of Information Science and Technology, The University of Tokyo. He received his PhD from the University of Tokyo in 1996. His current major research interests are in principles of programming languages, especially type systems, higher-order model checking, and automated program verification.

RV 2019 Invited Speakers

- **Akshay Rajhans** — Dr. Akshay Rajhans is a Principal Research Scientist at MathWorks. His work and research interests lie in multi-formalism model-based design of cyber-physical systems. He organizes the MathWorks Research Summits and other external research conferences, and has been an invited speaker and a panelist at various research gatherings for over a decade. Earlier, he worked on electronic control for diesel engine applications at Cummins and on non-intrusive load monitoring at Bosch Research. He has a Ph.D. from Carnegie Mellon University and an M.S. from University of Pennsylvania. (Akshay Rajhans is kindly sponsored by Runtime Verification Inc.)

- **David Basin** — David Basin is professor of Computer Science at ETH Zurich and department head. He received his Ph.D. in Computer Science from Cornell University in 1989 and his Habilitation from the University of Saarbrucken in 1996. From 1997–2002 he held the chair of Software Engineering at the University of Freiburg. He is the founding director of the Zurich Information Security Center, which he led from 2003-2011. He is Editor-in-Chief of the ACM Transactions on Privacy and Security and an ACM fellow. (David Basin is kindly sponsored by Runtime Verification Inc.)

- **Sanjit A. Seshia** — Sanjit A. Seshia is a Professor in the Dept. of Electrical Engineering and Computer Sciences at the University of California, Berkeley. He received an M.S. and Ph.D. in CS from Carnegie Mellon University, and a B.Tech. in CS and Eng. from the Indian Institute of Technology, Bombay. His research interests are in formal methods for dependable and

secure computing, with a current focus on the areas of cyber-physical systems, computer security, and robotics. He has made pioneering contributions to the areas of satisfiability modulo theories (SMT), SMT-based verification, and inductive program synthesis. He is co-author of a widely-used textbook on embedded, cyber-physical systems and has led the development of technologies for cyber-physical systems education based on formal methods. His awards and honors include a Presidential Early Career Award for Scientists and Engineers (PECASE), an Alfred P. Sloan Research Fellowship, and the Frederick Emmons Terman Award for contributions to electrical engineering and computer science education. He is a Fellow of the IEEE. (Sanjit A. Seshia is kindly sponsored by Runtime Verification Inc.)

SAS 2019 Invited Speakers

- **Caterina Urban** — Caterina Urban is a Research Scientist at INRIA and École Normale Supérieure in Paris. Her main research interest is the development of formal methods and static analysis tools to enhance the reliability of computer software and to help understanding complex software systems. Prior to INRIA, she was a postdoc at ETH Zurich. She received her PhD in Computer Science with full marks and honors from École Normale Supérieure, where she was advised by Radhia Cousot and Antoine Miné. During her PhD she spent five months as a visiting research scholar at the NASA Ames Research Center and Carnegie Mellon University in California. She holds a Bachelor's and a Master's degree in Computer Science from the Università degli Studi di Udine in Italy, where she was born and grew up. (Caterina Urban is kindly sponsored by Google LLC.)

- **Mayur Naik** — Mayur Naik is an Associate Professor of Computer and Information Science at the University of Pennsylvania. His current research interests lie at the intersection of machine learning and symbolic reasoning, with applications to computer-aided approaches for improving software quality and programmer productivity. His contributions span the areas of static analysis, constraint solving, testing, security, concurrency, and mobile computing. He received a Ph.D. in Computer Science from Stanford University in 2008. Previously, he was a researcher at Intel Labs, Berkeley from 2008 to 2011, and a faculty member at Georgia Tech from 2011 to 2016. (Mayur Naik is kindly sponsored by Google LLC.)

- **Somesh Jha** — Somesh Jha received his B.Tech from Indian Institute of Technology, New Delhi in Electrical Engineering. He received his Ph.D. in Computer Science from Carnegie Mellon University under the supervision of Prof. Edmund Clarke (a Turing award winner). Currently, Somesh Jha is the Lubar Professor in the Computer Sciences Department at the University of Wisconsin (Madison). His work focuses on analysis of security protocols, survivability analysis, intrusion detection, formal methods for security, and analyzing malicious code. Recently, he has also worked on privacy-preserving protocols and adversarial ML (AML). Somesh Jha has published several articles in highly-refereed conferences and prominent journals. He has won numerous best-paper and distinguished-paper awards. Prof Jha also received the NSF career award. Prof. Jha is the fellow of the ACM and IEEE. (Somesh Jha is kindly sponsored by Google LLC.)

- **Suresh Jagannathan** — Suresh Jagannathan is the Samuel D. Conte Professor of Computer Science at Purdue University. His research interests are in programming languages generally, with a specific focus on program verification, functional programming, and concurrent and distributed systems. From 2013-2016, he served as a program manager in the Information Innovation Office at DARPA, where he conceived and led programs in probabilistic reasoning and machine learning, program synthesis, and adaptive computing. He has also been a visiting faculty scholar at Cambridge University, where he spent a sabbatical year in 2010; and, prior to joining Purdue, was a senior research scientist at the NEC Research Institute in Princeton, N.J. He received his Ph.D from MIT. (Suresh Jagannathan is kindly sponsored by Google LLC.)

TAP 2019 Invited Speakers

- **Ana Cavalcanti** — Ana Cavalcanti is Professor of Software Verification at York and Royal Academy of Engineering Chair in Emerging Technologies working on *Software Engineering for Robotics: modelling, validation, simulation, and testing*. She held a Royal Society-Wolfson Research Merit Award and a Royal Society Industry Fellowship to work with QinetiQ in avionics. She has chaired the PC of various well-established international conferences, is on the editorial board of four international journals, and is Chair of the board of the FME Association. She is, and has been, PI on several large research grants. Her current research is on theory and practice of verification and testing for robotics.

- **Heike Wehrheim** — Heike Wehrheim is a full professor of Computer Science at Paderborn University, Germany. Before, she worked as a post-doc at the University of Oldenburg, obtained her PhD from Hildesheim University and studied at the University of Bonn. Her research interest are formal methods and software verifi-

cation, in particular recently the combination of different verification techniques.

UTP 2019 Invited Speaker

- **C.A.R. Hoare** — Tony Hoare's highest official academic qualification is an MA in Classical Greats at Oxford (1952-1956). He earned professional qualifications as an Interpreter of Russian (1956-8) and as a Statistician (1958-9). He exercised his Russian as an intern at Moscow State University (1959-60), and on many subsequent visits to the Soviet Union (or Russia) and to Armenia. His first job was in the UK Computer Industry at a small computer manufacturer, where he held posts as Programmer, Chief Engineer, and Researcher (1960-68). He then applied for the Chair of Computing Science at the Queen's University, Belfast, and to his surprise he was appointed (1968-77). He left Belfast with regret, to return to Oxford University as Professor of Computation back at Oxford (1977-99). His first retirement job was in Cambridge with Microsoft Research (1999-2017) where he stimulated an international Grand Challenge Initiative in Verified Software. Since his second retirement, he has been an unpaid Visitor at Microsoft Research and an Honorary Member of the Cambridge University Computing Laboratory.

VECoS 2019 Invited Speakers

- **Ali Mili** — Ali Mili holds a PhD in CS from the University of Illinois and a Doctorat es-Sciences d'Etat from the University of Grenoble. He served as chairperson of the Computer Science Department at the University of Tunis and currently serves as Professor and Associate Dean in the Ying Wu College of Computing at NJIT, Newark, NJ.

- **Jose F. Morales** — Jose F. Morales holds a PhD in Cs from the Technical University of Madrid (UPM). He is a member of the CLIP group at UPM and researcher at the IMDEA Software Institute. His main research interests are logic programming, compilers, and program analysis and verification.

AFFORD 2019 Invited Speaker

- **Paolo Masci** — Paolo Masci is a Senior Research Scientist with the Formal Methods Group at the National Institute of Aerospace (NIA), USA. Prior to joining NIA, Paolo carried out his research in different institutions, including INESC-TEC and Universidade do Minho (Portugal), Queen Mary University of London (UK), Italian National Research Council (Italy), and University of Pisa (Italy). From 2012 to 2018, he was visiting researcher at the US Food and Drug Administration (FDA), and his main research focus was on tools and methods for early identification of software anomalies in medical devices. At NIA, Paolo conducts research on theorem proving technology for verification of safety-critical aerospace applications. His research interests include verification of human-machine interfaces, co-simulation technologies, and rapid prototyping.

DALI 2019 Invited Speaker

- **Dexter Kozen** — Dexter Kozen is the Joseph Newton Pew, Jr. Professor in Engineering, at Cornell University. One of the fathers of dynamic logic and the Mu-calculus, he is also credited for a number of major contributions in logic, theory of computation, automata theory and computational complexity. Along is career Dexter received several awards, including an Outstanding Innovation Award from IBM Corporation and the honor of a professorship at The Radboud Excellence Initiative, Radboud University Nijmegen in the Netherlands.

DataMod 2019 Invited Speakers

- **Ana Cavalcanti** — Ana Cavalcanti is Professor of Software Verification at York and Royal Academy of Engineering Chair in Emerging Technologies working on *Software Engineering for Robotics: modelling, validation, simulation, and testing*. She held a Royal Society-Wolfson Research Merit Award and a Royal Society Industry Fellowship to work with QinetiQ in avionics. She has chaired the PC of various well-established international conferences, is on the editorial board of four international journals, and is Chair of the board of the FME Association. She is, and has been, PI on several large research grants. Her current research is on theory and practice of verification and testing for robotics.

- **Mieke Massink** — Mieke Massink received her master's degree in CS from the University of Nijmegen (NL), in 1988; she received her Laurea in CS from the University of Pisa in 1995 and her PhD degree in CS from the U. Nijmegen in 1996. In 1992 she received the "Dr. I.B.M. Frye Stipend" of the U. Nijmegen for the most promising female PhD researcher. She is currently a researcher in the Formal Methods and Tools lab at CNR-ISTI *A. Faedo*, Italy. Prior to this she held positions at the U. Nijmegen and U. Twente, both in the Netherlands, and in the context of several European projects, the CNR-CNUCE institute, Italy, and the University of York (UK). She has been lecturing at the U. Pisa from 1996 to 1998 and from 2006 to 2009 and at the University of Florence from 2005 to 2017. She is lecturing in the Tuscan PhD program in Smart Computing from 2015; in Feb. 2011 she was Visiting Professor at the MT-Lab, DTU, Copenhagen, DK. Her research interests

include the development and application of formal languages for specification and verification of concurrent, safety critical and software intensive systems, including collective adaptive systems which may exhibit emergent behaviour, and HCI related aspects of such systems.

F-IDE 2019 Invited Speaker

- **Wolfgang Ahrendt** — Wolfgang Ahrendt is professor at Chalmers University of Technology in Gothenburg, Sweden. He obtained his Ph.D. in Computer Science at the University of Karlsruhe in 2001. His work focuses on topics related to deductive software verification. He is one of the people behind the source code level verification approach and tool called KeY, and co-published the recent 'KeY book'. Among others, he also worked on compositional verification of distributed objects, on combining static and run-time verification, and lately on smart contract verification. He is PC co-chair of the iFM conference, December 2019.

FMAS 2019 Invited Speakers

- **Claudio Menghi** — Claudio Menghi received his BSc and MSc degrees in computer science from the Politecnico di Milano where he later obtained his Ph.D. degree in 2015. From 2017 to 2018, he was a Postdoctoral researcher at the University of Gothenburg and Chalmers. He is now a Research Associate at the University of Luxembourg. His research interests are in the field of formal methods and software engineering, with specific interests in cyber-physical systems, robotics, and formal verification.

- **Kristin Rozier** — Prof. Kristin Yvonne Rozier heads the Laboratory for Temporal Logic in Aerospace Engineering at Iowa State University; previously she spent 14 years as a Research Scientist at NASA. She earned her Ph.D. from Rice University and B.S. and M.S. degrees from The College of William and Mary. Her advances in computation for the aerospace domain earned her many awards including: the NSF CAREER Award; the NASA Early Career Faculty Award; American Helicopter Society's Howard Hughes Award; Women in Aerospace Inaugural Initiative-Inspiration-Impact Award; two NASA Group Achievement Awards; two NASA Superior Accomplishment Awards; Lockheed Martin Space Operations Lightning Award; AIAA's Intelligent Systems Distinguished Service Award. She is an Associate Fellow of AIAA and a Senior Member of IEEE, ACM, and SWE. Dr. Rozier has served on the NASA Formal Methods Symposium Steering Committee since working to found that conference in 2008.

FMBC 2019 Invited Speaker

- **Ilya Sergey** — Ilya Sergey is a tenure-track Associate Professor at Yale-NUS College (Singapore), holding a joint appointment with NUS School of Computing. From 2015 to 2018 he was with the CS Dept. of UCL. Prior to joining UCL he was a postdoc at IMDEA Software Institute (2012-2015). From 2008 to 2012 he was RA at the CS Dept. of KU Leuven, where he obtained his PhD. During his doctoral studies he was a visiting PhD fellow at the CS Dept. of Aarhus University and a research intern at the PPT group at MSR Cambridge. He got a MSc degree in Mathematics and CS in 2008 from Dept. of Mathematics and Mechanics of St. Petersburg State University. Before joining academia he worked as a software developer at JetBrains.

FMIS 2019 Invited Speaker

- **Michael Harrison** — Michael Harrison is Emeritus Professor and Senior Research Investigator at Newcastle University. He is a visiting researcher at the University of Minho, Portugal. His research focuses on the systematic analysis of the functional behaviour of interactive systems using a combination of model checking and automated theorem proving techniques. Most recently these techniques have been applied to medical devices (particularly infusion pumps and dialysis machines). Another branch of his research is concerned with the use of stochastic modelling techniques to analyse user tasks. Currently the latter aspect of his work is being used in the context of processes involved in managing massive 'big bleed' traumas.

FMTea 2019 Invited Speaker

- **Carroll Morgan** — Carroll Morgan was at the University of Oxford in the 1980-90's; since 2000 he has been at the University of New South Wales and in the Trustworthy Systems Group of CSIRO's Data61 in Sydney. He is the author of *Programming from Specifications* (Prentice-Hall 1990,4,8), of *Abstraction, Refinement and Proof for Probabilistic Systems* (Springer 2005, with Annabelle McIver), and of *The Science of Quantitative Information Flow* (Springer 2019 to appear, one of six authors). His current interest is refinement-based techniques for security-respecting program development, with a particular emphasis on source-level reasoning.

HFM 2019 Invited Speaker

- **Mark Priestley** — After a career as a programmer and lecturer in software engineering, Mark Priestley is now an independent scholar of the history and philosophy of computing with a particular interest in the early history of programming. His publications include the books *A Science of Operations* and *ENIAC in Action* (coauthored with Thomas Haigh and

Crispin Rope). His most recent book, *Routines of Substitution* (Springer, 2018), is a study of John von Neumann's work in software development in the mid-1940s. Read more at http://www.markpriestley.net.

NSAD 2019 Invited Speaker

- **Enea Zaffanella** — Enea Zaffanella is Associate Professor in Computer Science at the University of Parma (Italy). His research work has been focusing on the development and improvement of abstract domains for static analysis and verification tools, including both symbolic domains (in particular, for the analysis of variable sharing in logic languages) and numeric domains (in particular, efficient representations and algorithms for NNC polyhedra and new widening operators for several polyhedral domains). He has been one of the original founders of BUGSENG (a spin-off of the University of Parma, developing tools for static analysis) and he is one of the main developers of PPL (Parma Polyhedra Library). More recently, he is experimenting new ideas in the PPLite library.

OVT 2019 Invited Speaker

- **Ana Paiva** — Ana Paiva is Assistant Professor with Habilitation in the Dept. of Informatics Engineering of the Faculty of Engineering of the University of Porto (FEUP). Also a researcher at INESC TEC in the area of Software Engineering, she obtained her PhD (2007) with her thesis *Automated Testing of Graphical User Interface Specification*, in the context of which she visited Microsoft Research and gave talks on automated GUI testing with Spec Explorer. Ana has researched and published in the area of implementing and automating model-based testing. She is a member of PSTQB (*Software Testing Qualification Board*) and also a member of several ISTQB (*International Software Testing Qualification Board*) working groups.

OpenCERT 2019 Invited Speaker

- **Andreas Meiszner** — Dr Andreas Meiszner is a seasoned portfolio worker who worked across a number of sectors and functions. In two of his most recent portfolios he has tutored, mentored and coached beyond 500 professional doctoral students (mid to seniors, aged 35 to 70), first with the University of Liverpool (UK), and since 2016 also with the DoctorateHub. 500+ students imply 500+ workplace-based problems from 500+ organizations from across the globe. This allowed Andreas to understand how to tackle problems at scale, be it the tame, the complex, or the wicked.

REFINE 2019 Invited Speaker

- **Régine Laleau** — Régine Laleau is professor at Université Paris-Est Créteil (UPEC) and member of the team *Specification and Verification of Systems* of the LACL (Laboratory of Algorithmic, Complexity and Logic) laboratory. She was head of the LACL from June 2008 to December 2016. She is also associate professor at Université de Sherbrooke (Québec). Her research is in the field of formal methods, software engineering and information systems. It includes the coupling of formal methods and semi-formal ones, combination of formal methods for the specification of systems and requirements engineering.

RPLA 2019 Invited Speaker

- **Robert Glück** — Robert Glück is a Professor of Computer Science at the University of Copenhagen. His main research interests are programming languages and software systems. His current research focus is on reversible computing, program generation, and metaprogramming. He has chaired and edited the proceedings of several conferences and workshops in North America, Europe and Asia. Robert Glück has been the principle investigator of a number of research awards and projects. (Robert Glück is kindly sponsored by CMUP/FCT.)

SASB 2019 Invited Speakers

- **Anne Siegel** — Anne Siegel is a research director at CNRS, at IRISA, the computer science lab. of Rennes. She is the head of the " data and knowledge management " department of the lab. She is a member of the Dyliss group which develops formal methods for the integration of heterogenous data in biology. She started her carreer in mathematics by studying symbolic dynamical systems in tilings before exploring the field of systems biology. Her researches now focus on constraint-based methods to interpret large-scale observations of a molecular system in a dynamical system framework, with applications to marine biology, extremophile microbiology and health.

- **Miguel Rocha** — Miguel Rocha is an Associate Professor with Habilitation at the Department of Informatics and a Senior Researcher of the Centre of Biological Engineering, at the University of Minho. He is currently the Director of the Master in Bioinformatics and elected member of the Scientific Council of the School of Engineering. He has a background in computer science, a PhD thesis in machine learning, and a vast curriculum in Machine Learning and Bioinformatics/ Systems Biology, including 180+ publications in peer-reviewed journals/conferences (ORCID: 0000-0001-8439-8172), 7 projects as a PI, and a patent application. He has supervised 12 PhD and 50+ MSc students. He is responsible for

several curricular units related to Bioinformatics, Machine Learning/ Data Mining and programming, in both first degree, master and doctoral courses.

TAPAS 2019 Invited Speakers

- **Bernard Schmidt** — Bernard Schmidt is a research engineer in the Verification and Validation Group in Corporate Research at Robert Bosch GmbH. He works on static code analysis and formal methods and incorporating them into industrial development processes. He joined Bosch in 2014. Before he worked for 7 years on formal verification of hardware dependent software at the University of Kaiserslautern. He holds a Dipl.-Ing. degree in computer engineering where he first met the topic of formal verification of digital hardware.

- **Pascal Lacabanne** — Pascal Lacabanne is an avionics software engineer at Airbus. He is a member of the software engineering team responsible for defining and supporting the methods and tools used by internal operational avionics software development teams. He is currently in charge of the deployment of static analysis tools into the latest industrial development processes. He joined Airbus in 2016. Before that, he has been working for 4 years on operational research at ifrSKEYES, a software company developing aircraft maintenance solutions. As a first experience, he has been working for 3 years on computational fluid dynamics based on lattice Boltzmann methods at CS, an IT service company.

D   List of FM'19 Tool Exhibitors

- CARNEGIE MELLON UNIVERSITY

  Tool — **KeYmaera X**

  Presenters — Stefan Mitsch

  When — Oct 11

  Description — Self-driving cars, autonomous robots, modern airplanes, or robotic surgery: we increasingly entrust our lives to computers and therefore should strive for nothing but the highest safety standards - mathematical correctness proof. Proofs for such cyber-physical systems can be constructed with the KeYmaera X prover. As a hybrid systems and hybrid games theorem prover, KeYmaera X analyzes the control program and the physical behavior of the controlled system together. KeYmaera X implements differential dynamic logic (dL), a logic for specifying and verifying properties of hybrid systems with mixed discrete, continuous, and adversarial dynamics. KeYmaera X features a minimal core of just 1700 lines of code that isolates all soundness-critical reasoning. Such a small and simple prover core makes it much easier to trust verification results. Pre-defined and custom tactics built on top of the core drive automated proof search. KeYmaera X comes with a web-based front-end that provides a clean interface for both interactive and automated proving, highlighting the most crucial parts of a verification activity.

- CEA LIST

  Tool — **Frama-C**

  Presenters — Allan Blanchard, Virgile Prevosto, Julien Signoles

  When — Oct 9

  Description — Frama-C is an open-source industrial-strengh extensible and collaborative framework for code analysis of C programs. Its open-source distribution includes 28 plug-ins for analyses and program transformations of C source code possibly annotated with formal annotations written in the ACSL specification language. It notably includes the deductive verification tool WP that aims at proving functional properties, the abstract interpreter Eva that is suitable for checking the absence of undefined behaviors at compile time and the runtime verification tool E-ACSL that generates monitors in order to detect invalid ACSL annotations and undefined behaviors at runtime.

- CHECKMARX

  Tool — **CxSAST**

  Presenters — Nuno Oliveira

  When — Oct 9

Description — CxSAST - Checkmarx CxSAST is part of the Checkmarx Software Exposure Platform addressing software security risk across the entire SDLC. CxSAST is a flexible and accurate static analysis solution used to identify hundreds of security vulnerabilities in both custom code and open source components. It is used by development, DevOps, and security teams to scan source code early in the SDLC across over 25 coding and scripting languages.

- CLEARSY

  Tool — **Atelier B / Clearsy Safety Platform**

  Presenters — Etienne Prun, David Deharbe

  When — Oct 7-11

  Description — The CLEARSY Safety Platform is aimed at easing the development and the deployment of safety critical applications, up to SIL4. It relies on the smart integration of formal methods (including mathematical proof), redundant code generation and compilation, and a hardware platform that ensures a safe execution of the software.

- FBK TRENTO

  Tool — **nuXmv**, **xSAP**, **OCRA**

  Presenters — Stefano Tonetta

  When — Oct 11

  Description — nuXmv, xSAP, and OCRA form a collection of tools developed in FBK to support various model-based design activities with formal methods: nuXmv implements state-of-the-art SAT/SMT-based algorithms for model checking and temporal logic analysis; xSAP provides functionalities for model-based safety analysis; and OCRA supports contract-based analysis of architectural models. The three tools have been used in an integrated tool chain as back-end of higher-level model-based design tools such as COMPASS and CHESS, and evaluated in various industrial case studies.

- MICROSOFT RESEARCH, INRIA

  Tool — **TLA+ Tools**

  Presenters — Markus Kuppe, Stephan Merz

  When — Oct 10-11 (+private demos on other days on request)

  Description — TLA+ is a formal specification language, mainly intended for concurrent and distributed algorithms and systems. It is supported by the TLA+ Toolbox that integrates an IDE for editing TLA+ specifications and PlusCal algorithms, the syntactic and semantic analyzer, the TLC model checker, and (optionally) the TLA+ Proof System. The model checker can be run locally on the machine that the Toolbox is running on as well as remotely on a cluster or in the cloud. The tools are mainly developed and maintained by Microsoft Research and Inria. The presentation will present the functionality of the TLA+ tools and their application to the verification of simple case studies.

- NASA LANGLEY RESEARCH, NATIONAL INSTITUTE OF AEROSPACE

  Tool — **VSCode-PVS**

  Presenters — Paolo Masci, César Muñoz

  When — Oct 9-11

  Description — This tool demonstration presents VSCode-PVS, a modern integrated development environment for the Prototype Verification System (PVS). The new environment integrates the editing and proof management functionalities of PVS in Visual Studio Code, a popular code editor widely used by software developers. VSCode-PVS provides functionalities that developers expect to find in modern verification tools, but are not available in the standard Emacs front-end of PVS, such as auto-completion, point-and-click navigation of definitions, live diagnostics for errors, and literate programming. The main features of VSCode-PVS will be demonstrated through a set of examples based on publicly available specifications developed by NASA.

- NEWCASTLE UNIVERSITY, SYSTRA UK

  Tool — **SafeCap**

  Presenters — Paulius Stankaitis, Alexei Iliasov

  When — Oct 9-11

Description — SafeCap is a platform for applying static formal verification to railway signalling. In cooperation with Siemens Rail Automation UK we have developed a industrial strength extension for processing and verifying UK standard of control tables. Separately, in cooperation with Systra UK, we have developed an extension for translation of signalling computer software into symbolic transition systems and verification of safety principles via inductive safety invariant. In the demo we shall demonstrate the generic part of the tool with the applications to verification of synthetic data sets and transition systems, further we shall demonstrate the functionality of control tables and signalling data verification. We shall also present and offer to share a number of public domain railway case studies comprising node/edge layout models, control tables and signalling data

- PROVER

  Tool — **PSL**, **Prover Certifier**, **HLL**

  Presenters — Lars Helander, Iago Abal

  When — Oct 11

  Description — Prover SL CE (PSL) is a state-of-the-art SAT-based model-checker, and the result of Prover's 30-year-long experience in applying formal verification in industry. PSL is used around the world on large industrial models to certify the safety of mission-critical systems, especially in the railway domain. Our newest multi-core support (Turbo-Threads) allows PSL to handle even larger systems and provides impressive speed-ups. Recently, we have added support for IEEE754 floating point. We are also working on using artificial intelligence techniques to adapt PSL's search strategy to specific problems, and we have already obtained significant performance gains that add up to what is delivered by turbo-threading.

  Prover Certifier is a product built on top of PSL, based on diversification and equivalence-checking, that can produce complete safety evidence for CENELEC EN50128 SIL 4 certification using formal verification. Prover Certifier has seen many successful applications around the world; it can be used as a standalone solution or linked to our interlocking design automation solution, Prover Trident

  The main input to both PSL and Prover Certifier is an HLL model. HLL is itself a declarative, stream-based language, suitable for modeling and expressing temporal properties of discrete-time sequential systems. HLL is soon to become an open industry standard. Using one of our many translators, you can automatically translate computer programs or relay systems to HLL in order to investigate and prove them mathematically.

- UNIV. DÜSSELDORF

  Tool — **ProB**

  Presenters — Michael Leuschel

  When — Oct 11

  Description — The ProB animator, constraint solver and model checker: ProB is an animator, constraint solver and model checker for the B-Method It allows fully automatic animation of B specifications, and can be used to systematically check a specification for a wide range of errors. The constraint-solving capabilities of ProB can also be used for model finding, deadlock checking and test-case generation. In this tool exhibition we focus on recent developments of ProB: - the ProB Jupyter kernel for interactive notebooks for documentation; - the new Java FX user interface, along with new visualization techniques (e.g., based on SVG graphics); - a summary of new features in the ProB kernel (regular expressions, memoization, ...) and the model checking backend (use of LTSmin, ...); - a summary of recent industrial applications and T2 tool qualifications.

- UNIV. OF GENOA, UNIV. OF SASSARI

  Tool — **ReqV**

  Presenters — Luca Pulina

  When — Oct 10-11

  Description — In the context of safety- and security-critical Cyber-Physical Systems (CPSs), checking the sanity of functional requirements is an important, yet challenging task. It is largely recognized that a flaw in the requirements specification can lead to delays, additional expenses and, possibly, the failure of the project. Nonetheless, due to the intrinsic difficulty of dealing with natural language sentences, requirements are often checked manually, an error-prone and time-consuming activity. Given the increasing demand and complexity of CPSs, and the need to reduce time-to-market and costs, practical solutions to enable automated verification of requirements are in order.

Formal methods provides a viable solution, but they often requires overburdening formalization and a high degree of expertise. As a trade-off between formalization and usability, a recurrent solution in the literature is the use of Property Specification Patterns (PSPs), English-like structured natural sentences that provides a direct mapping to one or more logics. ReqV is a tool developed in the context of the H2020 EU CERBERO project that leverage on PSPs to tackle the problem stated before. We extended PSPs by considering Boolean as well as atomic numerical assertions of the form $x =_* c$, where X is a variable of the system, $c \in R$ is a constant real number and the operator $=_* \in <, <=, =, >=, >$ have the usual interpretation. Furthemore, we presented an encoding to reduce the inner consistency of extended PSPs, i.e., logical errors in the specification that prevents any possible system to satisfy all requirements, to the Linear Temporal Logic (LTL) satisfiability problem. We also extended the previous work with a new algorithm to find a minimum set of conflicting requirements in case of inconsistency, and we collected all these functionalities in a Java library called SpecPro4. ReqV exploits these capabilities to provide an easy-to-use interface for the verification of requirements. Its goal is to enable users with no background knowledge of formal methods and logical languages to write requirements in PSP forms and check their consistency. ReqV also aims at minimizing the setup process for the user, and therefore it is developed as a web application that can easily be accessed with a browser.

- UNIV. OF OSLO

  Tool — **RailCons tools**

  Presenters — Christian Johansen, Bjørnar Luteberget

  When — Oct 9-11

  Description — RailCons is a research project that has been running for 4 years and will end in August 2019. This project was funded partially the Norwegian Research Council and by the company Railcomplete, where one PhD student was hired to do research on "Automated Methods and Tools for Ensuring Consistency of Railway Designs". There have been produced five related tools/prototypes, three of these have been already presented at iFM, SEFM, FMCAD (with two Best Paper Awards), the forth one will be presented at FM'19, and the fifth is being submitted to iFM'19. More info exists on the project's webpage (including videos, posters, papers, slides).

- UPPSALA UNIVERSITY, AALBORG UNIVERSITY

  Tool — **Uppaal**

  Presenters — Peter Gjøl Jensen, Kim Guldstrand Larsen, Marius Mikučionis

  When — Oct 10-11

  Description — Uppaal is a suite of tools for formal verification, model-based testing, performance analysis and synthesis of real-time systems. The suite originates from academic papers and experiments, it has become popular in teaching and found its way into a number of industrial applications, such as communication protocols, embedded systems, consumer electronics and automotive designs. At the core the tools use extended timed automata specification as a model to simulate, validate, verify properties, find optimal solutions, interactively visualize the behavior and diagnostic traces, generate test cases in native programming languages, estimate time and cost of operation, and find and optimize control strategies for steering the system in adverse environments. The demonstration shows the principles behind the tools and some instances of specific applications.

E Multimedia

The following list compiles all videos produced throughout the FM'19 World Congress (including the preparation phase) all published in the FME YouTube channel.[19]

- **FM'19** — 3rd World Congress on Formal Methods

- **FM'19** — Events and Program

- **FM'19** — Green Initiative

- **FM'19** — Keynote Speakers Interviews

- **FM'19** — Recap Video

---

[19]At video compilation time we sadly realized that a couple of videos had technical problems and had to be left unpublished.

- **FM'19** — Social Program

- **FM'19** — Venue

- **FM 2019** — Session 1: Keynote 1

- **FM 2019** — Session 2A: Verification

- **FM 2019** — Session 2B: Synthesis Techniques

- **FM 2019** — Session 3: Lucas Award

- **FM 2019** — Session 4B: Journal First Presentation 1

- **FM 2019** — Session 5: Model Checking Circus

- **FM 2019** — Session 7: Keynote 2

- **FM 2019** — Session 8A: Model Checking

- **FM 2019** — Session 8B: Analysis Techniques 1

- **FM 2019** — Session 8B: Analysis Techniques 1

- **FM 2019** — Session 9: FME Fellowship Award Ceremony

- **FM 2019** — Session 10: Keynote 3

- **FM 2019** — Session 11A: Analysis Techniques 2

- **FM 2019** — Session 11B: Specification Languages

- **FM 2019** — Session 11B: Specification Languages

- **FM 2019** — Session 11B: Specification Languages

- **FM 2019** — Session 11B: Specification Languages

- **FM 2019** — Session 12A: Reasoning Techniques

- **FM 2019** — Session 12A: Reasoning Techniques

- **FM 2019** — Session 12B: Journal First Presentation 2

- **FM 2019** — Session 13: Modelling Languages

- **FM 2019** — Session 14A: Learning-Based Techniques and Applications

- **FM 2019** — Session 14A: Learning-Based Techniques and Applications

- **FM 2019** — Session 14A: Learning-Based Techniques and Applications

- **FM 2019** — Session 14B: Journal First Presentation 3

- **FM 2019** — Session 15: Refactoring and Reprogramming

- **FM 2019** — Video Call for Papers

- **G65 2019** — Session 1: PPDP Invited Talk

- **G65 2019** — Session 5: UTP Keynote

- **G65 2019** — Session 7: PPDP and LOPSTR Invited talk

- **G65 2019** — Session 11: LOPSTR and PPDP Invited talk

- **HFM 2019** — Video Call for Papers

- **LOPSTR 2019** — Session 2: UTP Keynote

- **LOPSTR 2019** — Session 4: LOPSTR & G65 Invited talk

- **LOPSTR 2019** — Session 9: LOPSTR Invited talk

Figure 20: The A3 poster of FM'19.

- **LOPSTR 2019** — Session 12: LOPSTR and G65 Invited talk

- **MPC 2019** — Session 1: MPC Keynote

- **MPC 2019** — Session 6: UTP Keynote

- **MPC 2019** — Session 10: FM Keynote

- **MPC 2019** — Video Call for Papers

- **RV 2019** — Session 2: Keynote (Joint Session with UTP)

- **RV 2019** — Session 6: Invited Talk (Room Porto)

- **RV 2019** — Session 10: Invited Talk (Room Porto)

- **RV 2019** — Session 13: Invited Talk

- **SAS 2019** — Session 1: Keynote: Mayur Naik

- **SAS 2019** — Session 3: Keynote: Caterina Urban

- **SAS 2019** — Session 5: Keynote: Somesh Jha

- **SAS 2019** — Session 8: Keynote: Suresh Jagannathan

- **TAP 2019** — Session 1: TAP Keynote

- **TAP 2019** — Session 5: Invited Tutorial

- **UTP 2019** — Session 2: Keynote

- **VECoS 2019** — Session 2: Invited talk

- **VECoS 2019** — Session 4: Invited talk

- **VECoS 2019** — Video Call for Papers

F   FM'19 Publicity Actions

F.1   Digital Marketing

F.1.1   Website

Description The World Congress website acted as the main means of communication for global dissemination to all identified target groups. The website of FM'19 thus contains all relevant information regarding all events, including important dates, registration, venue, program, and so on.

Timing The website was launched in July 2018, at FM 2018 in Oxford, on the day FM'19 was announced.

F.1.2   Twitter

Description Regarding the presence of the congress in the social media, FM'19 had an active Twitter account (https://twitter.com/formalmethods19) which was used to communicate and to disseminate all relevant news and topics related to FM'19 events.

Timing July 2018

F.1.3   YouTube

Description The FME channel on YouTube was used to share some teasers regarding FM'19 and the specific events that were part of the FM Week. This channel was also used during and after FM'19 in order to publish the videos of all talks of the main conferences.

Timing January 2019

F.1.4   Slack

Description The FM'19 OC created a Slack channel available to all participants wishing to contact the organizing committee or interact with each other.

Timing October 2019

F.2   Printed Publicity

F.2.1   Flyers

Description FM'19 leaflets were produced and distributed at FM 2018 in Oxford.

Timing July 2018

F.2.2   Posters

Description The A3 poster of FM'19 was posted to a list of more than 400 addresses that evolved from the one provided by FME. This was also used during the congress for advertising and signage (corridors, etc).

Timing December 2018

F.3   Content Marketing

F.3.1   Email marketing

Description The idea was to create several newsletters that were sent months before through the FM'19 mailing list to keep everybody informed about the venue, most recent news about FM'19 events and so on.

Timing May 2019

F.3.2 Video Marketing

Description In the newsletters, several videos were announced marketing about the events that were part of FM'19 and giving useful information regarding the venue.

Timing January 2019

F.3.3 Videos of Talks

Description The talks of the whole FM 2019 symposium and the keynote talks of the other FM'19 conferences and symposia were recorded. All of these videos are available on the FM'19 section of the FME Youtube channel.

Timing October 2019

F.3.4 Live Streaming

Description Tony Hoare's invited lecture, which was shared by several conferences, was streamed live via the FM'19 section of the FME Youtube channel.

Timing October 8th, 2019

F.4 Public Relations

F.4.1 Press Releases

Description One week before the conference, a press release was produced and disseminated by INESC TEC in order to capture the national attention and make an impact on social media.

Timing September 2019

F.4.2 Flash Interviews

Description After the FM Week, all chairs of FM'19 events were invited to pitch about their experience at FM'19. These videos were published on the FME YouTube channel.

Timing October 2019

F.5 FM'19 Social Program

F.5.1 After Hours

Description The After Hours Program comprised three places (*Café au Lait*, *Casa da Música* and *Maus Hábitos*) where participants could meet up on three different days at 22h to have a drink and socialize.

Timing October 8th, 9th and 11th 2019

References

[1] Jos Baeten, Tijn Borghuis, and Erik de Vink. FM 2009 final report: results and lessons learned, June 2010.