

# iTWIST'2020 – international Traveling Workshop on Interactions between low-complexity data models and Sensing Techniques

## Scientific Program

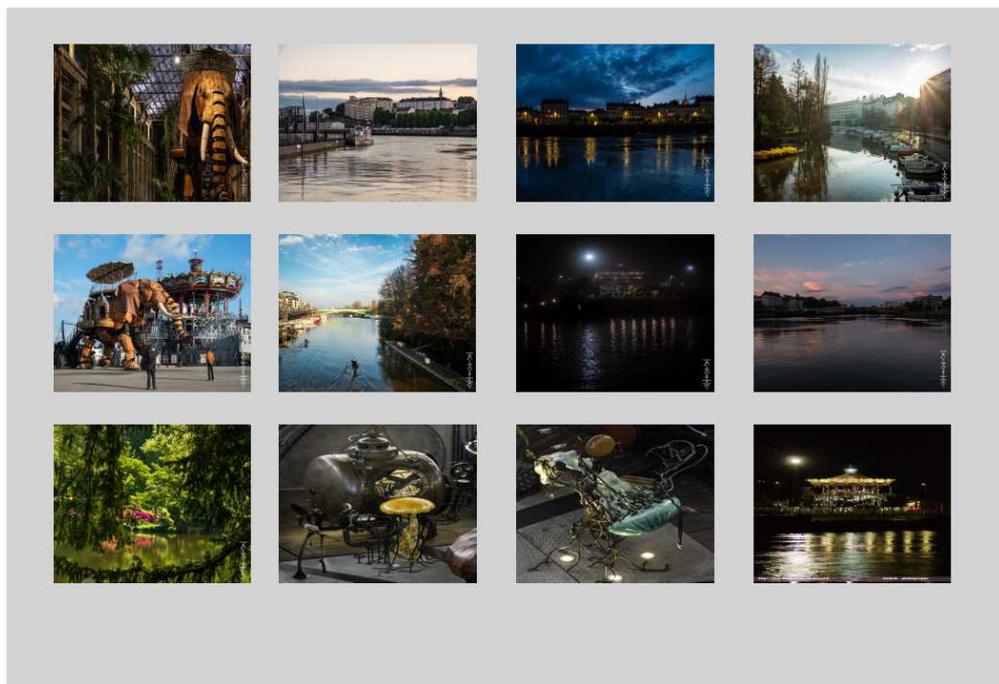
Doctoral School: November 30 - December 1st, 2020

Workshop: December 2-4, 2020

Virtual Nantes

All workshop talks will be given on Zoom:  
<https://ec-nantes.zoom.us/j/93155141457>

Doctoral school links can be found at page 4.



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# 1. Introduction

We are happy to welcome you to the 100% virtual iTWIST'2020!

Initially scheduled in June 2020, the workshop was moved to the end of the year, hoping that the evolution of the COVID-19 crisis would allow us to maintain physical attendance. This is not the case unfortunately, and it appeared to us that switching to a purely virtual edition at these dates was the best option.

We deeply regret not to be able to welcome you in Nantes, where our initial scheduling included free time periods and social events aiming at fostering discussions and collaborations, which we believe are of primary importance for the iTWIST series. We hope, however, that you will find interest in attending the workshop in its current form.

For this edition, 80 people registered to the workshop and 41 people registered to the doctoral school. The 44 accepted papers have been assigned to an oral presentation. We would like to thank all of you for maintaining your participation. In particular, we are very grateful to all speakers, who kindly accepted to give their talks remotely.

We are honored to have 7 keynote speakers, whose talks will cover a wide range of recent scientific issues covering theoretical aspects and applications of the use of low-complexity data models together with sensing techniques:

- On the underappreciated role of sparsity in deep variational autoencoder models
- AI for Sound: from independent component analysis and sparse representations to deep learning
- A function space view of overparameterized neural networks
- Rank optimality for the Burer-Monteiro factorization
- Leveraging low-dimensional models for human-in-the-loop machine learning tasks
- The BLASSO: continuous dictionaries for sparser reconstructions
- The landscape of dictionary learning.

Eight regular sessions are organized into the most prominent themes of the iTWIST series: Sparsity (x2), Sensing Theory and Methods (x2), Learning Methods, Non-negative Matrix Factorization, Off-the-grid Sparsity, Clustering and Source Separation. Specific sessions are scheduled on three major application fields of such methodologies: Audio Processing, Microscopy Imaging, and Computational Imaging.

The conference proceedings will be made available on [arXiv](#) soon.

The doctoral school will include 4 tutorials:

- Nonnegative and Low-rank Approximations (for unsupervised machine learning)
- Global optimization based on branch-and-bound algorithms
- Computational optimal transport
- Deep learning for medical image analysis

We would also like to warmly thank the iTWIST steering committee for their constant support and feedback on many organizational aspects.

Finally, we thank all the administrative staff at the LS2N laboratory and École Centrale de Nantes, who helped us in preparing the (two!) former physical event attempts, and then helped us in the organization of this virtual event.

We hope that you will enjoy the doctoral school and the workshop.

For any question or issue, please contact us by email at [itwist20@univ-nantes.fr](mailto:itwist20@univ-nantes.fr).

The organizing committee,

Sébastien Bourguignon, Cédric Herzet, Jérôme Idier and Charles Soussen

## 2. Doctoral school program

Schedules are given in local (French) time, GMT +1.

**Monday, Nov. 30, 10:15 -10:30.**

**Welcome**

Zoom link: <https://ec-nantes.zoom.us/j/98286869991>

**Monday, Nov. 30, 10:30-12:00 and 13:30-15:00.**

**Jérémy Cohen, Nonnegative and Low-rank Approximations**

Zoom link: <https://ec-nantes.zoom.us/j/98286869991>

**Monday, Nov. 30, 15:30-18:00.**

**Jordan Ninin, Global Optimization using Branch & Bound**

Zoom link: <https://ec-nantes.zoom.us/j/98286869991>

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**Tuesday, Dec. 1, 9:00-10:00 and 10:30-12:00.**

**Diana Mateus, Deep learning for medical image analysis**

Zoom link: <https://ec-nantes.zoom.us/j/94299415113>

**Tuesday, Dec. 1, 13:30-15:00 and 15:30-18:00.**

**Gabriel Peyré, Computational optimal transport**

Zoom link: <https://ec-nantes.zoom.us/j/93121861353>

### 3. Workshop at a glance

Time	Wednesday 02/12	Thursday 03/12	Friday 04/12
8h45-9h00	<b>Welcome</b>		
9h00-9h30	<b>David Wipf</b>		<b>Vincent Duval</b>
9h30 - 10h00		<b>Irene Waldspurger</b>	
10h00 - 10h30	[Sparsity I, <i>id 17, 29, 31, 48</i> ]		[Off-the-grid Sparsity, <i>id 7, 13, 28, 45, 49</i> ]
10h30 - 11h00		<b>Coffee Break</b>	+
11h00 - 11h30	<b>Coffee Break</b>		<b>Coffee Break</b>
11h30 - 12h00	[Sensing Theory and Methods I, <i>id 9, 11, 18, 27</i> ]	[Learning Methods, <i>id 14, 30, 35, 41, 39</i> ]	[Clustering & Source separation, <i>id 8, 12, 34, 43</i> ]
12h00 - 12h30			
<b>Lunch</b>			
14h00-14h30		[Sensing Theory and Methods II, <i>id 25, 26, 37, 42</i> ]	
14h30-15h00	<b>Mark Plumbley</b>		<b>Karin Schnass</b>
15h00 - 15h30	[Audio Processing, <i>id 6, 21, 47</i> ]	[Microscopy Imaging, <i>id 20, 22, 38</i> ]	[Computational Imaging, <i>id 32, 33, 44, 46</i> ]
15h30 - 16h00	+	+	
	<b>Coffee Break</b>	<b>Coffee Break</b>	
16h00-16h30			<b>Closing Words</b>
16h30 - 17h00	<b>Rebecca Willett</b>	<b>Christopher Rozell</b>	
17h00 - 17h30		[Non-negative Matrix Factorization, <i>id 10, 15, 16, 24</i> ]	
17h30 - 18h00	[Sparsity II, <i>id 19, 23, 36, 40</i> ]		

## 4. Workshop program, Wednesday, Dec. 2

Schedules are given in local (French) time, GMT +1.

Zoom link for all sessions: <https://ec-nantes.zoom.us/j/93155141457>

**Wednesday, Dec. 2, 8:45-9:00. Welcome**

**Wednesday, Dec. 2, 9:00-10:00. David Wipf** (Visual Computing Group, Microsoft Research, Beijing, China)

**On the underappreciated role of sparsity in deep variational autoencoder models**

Chair: Matthieu Kowalski

This talk will trace the progression of Bayesian-inspired models for finding low-dimensional structure in data, from simple frameworks like robust PCA and Bayesian compressive sensing, to more complex heirs such as the variational autoencoder (VAE). The latter represents a popular, flexible form of deep generative model that can be stochastically fit to observed samples from a given random process using an a variational bound on the underlying log-likelihood. Although originally motivated as a way of generating new samples that approximate an unknown distribution, the VAE can also be leveraged to find low-dimensional manifold structure in training data.

Despite the lack of a canonical sparsity-promoting penalty as commonly adopted by classical methods, I will highlight how parsimony naturally emerges from the VAE and its predecessors, often with distinct provable advantages over deterministic alternatives. For example, subtle mechanisms will be discussed that allow such models to robustly dismiss outliers and smooth away bad local minima all while adapting to an unknown inlier manifold of arbitrary dimension. And as a byproduct of this process, in certain settings the VAE in particular can also generate realistic samples that mirror the data distribution within such manifolds devoid of outliers.

**Wednesday, Dec. 2, 10:00-11:00. Sparsity (I)**

Chair: Frédéric Champagnat

- 10:00-10:15. Laurence Denneulin, Nelly Pustelnik, Maud Langlois, Ignace Loris and Éric Thiébaud, *Primal-dual splitting scheme with backtracking for handling with epigraphic constraint and sparse analysis regularization*, #17
- 10:15-10:30. Ramzi Ben Mhenni, Sébastien Bourguignon and Jérôme Idier, *SLS (Single  $\ell_1$  Selection): a new greedy algorithm with an  $\ell_1$ -norm selection rule*, #29
- 10:30-10:45. Diego Delle Donne, Matthieu Kowalski and Leo Liberti, *MIP and Set Covering approaches for Sparse Approximation*, #31
- 10:45-11:00. Srdan Lazendic, Hendrik De Bie and Aleksandra Pizurica,  *$\ell_0$  and  $\ell_1$  approaches to sparse coding of octonion valued signals*, #48

## Wednesday, Dec. 2, 11:30-12:30. Sensing Theory and Methods (I)

Chair: Thomas Oberlin

- 11:30-11:45. Antoine Chatalic and Rémi Gribonval, *Learning to Sketch for Compressive Clustering*, #9
- 11:45-12:00. Farouk Yahaya, Matthieu Puigt, Gilles Delmaire and Gilles Roussel, *Gaussian Compression Stream: Principle and Preliminary Results*, #11
- 12:00-12:15. Alban Gossard, Pierre Weiss and Frédéric de Gournay, *Off-the-grid data-driven optimization of sampling schemes in MRI*, #18
- 12:15-12:30. Vincent Schellekens and Laurent Jacques, *When compressive learning fails: blame the decoder or the sketch?*, #27

## Wednesday, Dec. 2, 14:00-15:00. Mark Plumbley (Centre for Vision, Speech and Signal Processing, University of Surrey, UK)

### AI for Sound: from independent component analysis and sparse representations to deep learning

Chair: Cédric Févotte

Imagine you are standing on a street corner in a city. Close your eyes: what do you hear? Perhaps some cars and busses driving on the road, footsteps of people on the pavement, beeps from a pedestrian crossing, rustling and clonks from shopping bags and boxes, and the hubbub of talking shoppers. You can do the same in a kitchen as someone is making breakfast, or as you are travelling in a vehicle. Now, following the success of machine learning technologies for speech and image recognition, we are beginning to build computer systems to tackle this challenging task: to automatically recognize real-world sound scenes and events. In this talk, I will discuss some of the techniques and approaches that we have been using to analyze and recognize different types of sounds, including independent component analysis, nonnegative matrix factorization, sparse representations and deep learning. I will also discuss how we are using data challenges to help develop a community of researchers in recognition of real-world sound scenes and events, explore some of the work going on in this rapidly expanding research area, and touch on some of the key issues for the future, including privacy for sound sensors and the need for low-complexity models. We will discuss some of the potential applications emerging for sound recognition, from home security and assisted living to exploring sound archives, and we will close with some pointers to more information about this research area.

## Wednesday, Dec. 2, 15:00-15:45. Audio Processing

Chair: Vincent Lostanlen

- 15:00-15:15. Valentin Leplat, Nicolas Gillis and Man Shun Ang, *Blind Audio Source Separation with Minimum-Volume Beta-Divergence NMF*, #6
- 15:15-15:30. Pierre-Hugo Vial, Paul Magron, Thomas Oberlin and Cédric Févotte, *Phase retrieval with Bregman divergences: Application to audio signal recovery*, #21
- 15:30-15:45. Mathieu Lagrange and Félix Gontier, *Bandwidth extension of musical audio signals using dilated convolutional neural networks*, #47

**Wednesday, Dec. 2, 16:00-17:00. Rebecca Willett (University of Chicago, USA)**

**A function space view of overparameterized neural networks**

Chair: Aleksandra Pizurica

Contrary to classical bias/variance tradeoffs, deep learning practitioners have observed that vastly overparameterized neural networks with the capacity to fit virtually any labels nevertheless generalize well when trained on real data. One possible explanation of this phenomenon is that complexity control is being achieved by implicitly or explicitly controlling the magnitude of the weights of the network. This raises the question: What functions are well-approximated by neural networks whose weights are bounded in norm? In this talk, I will give some partial answers to this question. In particular, I will give a precise characterization of the space of functions realizable as a two-layer (i.e., one hidden layer) neural network with ReLU activations having an unbounded number of units, but where the Euclidean norm of the weights in the network remains bounded. Surprisingly, this characterization is naturally posed in terms of the Radon transform as used in computational imaging, and I will show how tools from Radon transform analysis yield novel insights about learning with two and three-layer ReLU networks. This is joint work with Greg Ongie, Daniel Soudry, and Nati Srebro.

**Wednesday, Dec. 2, 17:00-18:00. Sparsity (II)**

Chair: Ignace Loris

- 17:00-17:15. Mehdi Chahine Amrouche, Hervé Carfantan and Jérôme Idier, *A partially collapsed sampler for unsupervised nonnegative spike train restoration*, #19
- 17:15-17:30. Clément Dorffer, Thomas Paviet-Salomon, Gilles Le Chenadec and Angélique Dremeau, *Learning sparse structures for physics-inspired compressed sensing*, #23
- 17:30-17:45. Thi Thanh Nguyen, Charles Soussen, Jérôme Idier and El-Hadi Djermoune, *Exact Recovery Analysis of Non-Negative Orthogonal Greedy Algorithms*, #36
- 17:45-18:00. Dominique Pastor, Erwan Beurier, Andree Ehresmann and Roger Waldeck, *A mathematical approach to resilience*, # 40

## 5. Workshop program, Thursday, Dec. 3

Schedules are given in local (French) time, GMT +1.

Zoom link for all sessions: <https://ec-nantes.zoom.us/j/93155141457>

**Thursday, Dec. 3, 9:30-10:30. Irene Waldspurger** (CNRS, University Paris-Dauphine, France)

### **Rank optimality for the Burer-Monteiro factorization**

Chair: Yann Traonmilin

The Burer-Monteiro factorization is a classical heuristic used to speed up the solving of large scale semidefinite programs when the solution is expected to be low rank: One writes the solution as the product of thinner matrices, and optimizes over the (low-dimensional) factors instead of over the full matrix. Even though the factorized problem is non-convex, one observes that standard first-order algorithms can often solve it to global optimality. This has been rigorously proved by Boumal, Voroninski and Bandeira, but only under the assumption that the factorization rank is large enough, larger than what numerical experiments suggest. We will describe this result, and investigate its optimality. More specifically, we will show that, up to a minor improvement, it is optimal: without additional hypotheses on the semidefinite problem at hand, first-order algorithms can fail if the factorization rank is smaller than predicted by current theory.

**Thursday, Dec. 3, 11:00-12:15. Learning Methods**

Chair: Clément Elvira

- 11:00-11:15. Paul Irofti and Andra Băltoiu, *Unsupervised Dictionary Learning for Anomaly Detection*, #14
- 11:15-11:30. Mickael Tardy and Diana Mateus, *Lightweight U-Net for High-Resolution Breast Imaging*, #30
- 11:30-11:45. Nicolas Vercheval, Aleksandra Pizurica and Hendrik De Bie, *On Variational Auto-Encoders for Fixed Graph Mesh Learning*, #41
- 11:45-12:00. Amelia Jiménez-Sánchez, Diana Mateus, Miguel A. González Ballester and Gemma Piella, *Curriculum Learning to Deal with Noisy Labels*, # 39
- 12:00-12:15. François Orieux and Raphael Chinchilla, *Fast Bayesian Convex Unsupervised Deconvolution*, #35

## Thursday, Dec. 3, 14:00-15:00. Sensing Theory and Methods (II)

Chair: Samuel Vaiter

- 14:00-14:15. Laurent Jacques and Thomas Feuillen, *Keep the phase! Signal recovery in phase-only compressive sensing*, # 25
- 14:15-14:30. Thomas Feuillen, Mike Davies, Luc Vandendorpe and Laurent Jacques, *One Bit to Rule Them All: Binarizing the Reconstruction in 1-bit Compressive Sensing*, # 26
- 14:30-14:45. Martin Genzel, Maximilian März and Robert Seidel, *Compressed Sensing with 1D Total Variation: Breaking Sample Complexity Barriers via Non-Uniform Recovery*, #37
- 14:45-15:00. Alexander Stollenwerk, Hans Christian Jung, Johannes Maly and Lars Palzer, *Quantized Compressed Sensing by Rectified Linear Units*, # 42

## Thursday, Dec. 3, 15:00-15:45. Microscopy Imaging

Chair: Caroline Chauv

- 15:00-15:15. Marc Allain, Virginie Chamard and Stephan Hruszkewycz, *High-resolution three-dimensional crystalline microscopy*, # 20
- 15:15-15:30. Stephan Kunne, Guillaume Potier, Jean Mérot and Perrine Paul-Gilloteaux, *Cross-modal registration using point clouds and graph-matching in the context of correlative microscopies*, # 22
- 15:30-15:45. Simon Labouesse, Jérôme Idier, Anne Sentenac and Thomas Mangeat, *Uniqueness of the Random Illumination Microscopy Variance Equation*, #38

## Thursday, Dec. 3, 16:00-17:00. Christopher Rozell (Georgia Institute of Technology, USA)

### Leveraging low-dimensional models for human-in-the-loop machine learning tasks

Chair: Laurent Jacques

While modern machine learning has made significant gains in focused tasks such as object recognition from images, it is clear that future advances in machine learning for more complex and subtle tasks will require richer human-machine interactions that must be as efficient and effective as possible. In this talk we will examine ways that the low-dimensional structure of natural data can be leveraged to enable performance improvements in three human-in-the-loop machine learning tasks. First, we will highlight work developing active learning approaches to posing relational queries to humans for tasks such as similarity learning and preference search. Second, we will demonstrate new manifold learning approaches based on generative models where a human input is used to specify data invariances to learn as identity preserving transformations. Finally, we will show how dimensionality reduction in deep generative models can be used to explain to humans the behavior of black-box machine learning classifiers. Taken together, these examples will demonstrate the power of low-dimensional models in emerging human-in-the-loop machine learning tasks.

## Thursday, Dec. 3, 17:00-18:00. Non-negative Matrix Factorization

Chair: Jérôme Bobin

- 17:00-17:15. Afef Cherni, Sandrine Anthoine and Caroline Chaux, *Unmixing 2D HSQC NMR mixtures with  $\ell_1$ -NMF and sparsity*, #10
- 17:15-17:30. Christophe Kervazo, Nicolas Gillis and Nicolas Dobigeon, *Successive Nonnegative Projection Algorithm for Linear Quadratic Mixtures*, # 15
- 17:30-17:45. Sixin Zhang, Emmanuel Soubies and Cedric Fevotte, *Analysis of Short-Time Orthogonal Transform Learning for NMF*, #16
- 17:45-18:00. Nicolas Nadisic, Arnaud Vandaele, Jeremy Cohen and Nicolas Gillis, *Sparse Separable Nonnegative Matrix Factorization*, #24

## 6. Workshop program, Friday, Dec. 4

Schedules are given in local (French) time, GMT +1.

Zoom link for all sessions: <https://ec-nantes.zoom.us/j/93155141457>

**Friday, Dec. 4, 9:00-10:00. Vincent Duval (INRIA Paris, France)**

**The BLASSO: continuous dictionaries for sparser reconstructions**

Chair: Pierre Weiss

In this talk, I will give an overview of the main properties of the Beurling LASSO (BLASSO), a sparse reconstruction method which has drawn a lot of attention since the pioneering works of De Castro and Gamboa, Bredies and Pikkarainen, Candès and Fernandez-Granda? The method consists in performing an analogue of the  $\ell_1$  minimization in the space of Radon measures. Using this continuous framework instead of introducing an artificial finite grid for sparse recovery is not only relevant when modelling many physical problems, but it also provides interesting properties such as support stability, sparsity of the solutions, and efficient minimization algorithms.

**Friday, Dec. 4, 10:00-11:15. Off-the-grid Sparsity**

Chair: Hervé Carfantan

- 10:00-10:15. Yann Traonmilin, Jean-François Aujol and Arthur Leclaire, *An algorithm for non-convex off-the-grid sparse spike estimation with a minimum separation constraint*, #7
- 10:15-10:30. Jean-Baptiste Courbot and Bruno Colicchio, *Boosting the Sliding Frank-Wolfe solver for 3D deconvolution*, #13
- 10:30-10:45. Clément Elvira, Jérémy Cohen, Cédric Herzet and Rémi Gribonval, *Continuous dictionaries meet low-rank tensor approximations*, #28
- 10:45-11:00. Gilles Monnoyer de Galland, Luc Vandendorpe and Laurent Jacques, *Factorization over interpolation: A fast continuous orthogonal matching pursuit*, # 45
- 11:00-11:15. Frédéric Champagnat and Cédric Herzet, *Translation-invariant interpolation of parametric dictionaries*, #49

## Friday, Dec. 4, 11:30-12:30. Clustering and Source Separation

Chair: Nicolas Gillis

- 11:30-11:45. Rémi Carloni Gertosio and Jérôme Bobin, *Joint deconvolution and blind source separation on the sphere with an application to radio-astronomy*, # 8
- 11:45-12:00. Nicolas Keriven and Samuel Vaiter, *Sparse and Smooth: Spectral Clustering in the Dynamic SBM*, # 12
- 12:00-12:15. David Mary, Sébastien Bourguignon, Etienne Roquain, Sophia Sulis and Marie Perrot-Dockes, *Some detection tests for low complexity data models and unknown background distribution*, #34
- 12:15-12:30. Shaoguang Huang and Aleksandra Pizurica, *Multi-view Subspace Clustering for Hyperspectral Images*, #43

## Friday, Dec. 4, 14:00-15:00. Karin Schnass (University of Innsbruck, Austria)

### The landscape of dictionary learning

Chair: Emmanuel Soubies

In this talk we will visit the landscape of dictionary learning via iterative thresholding and K residual means. For a given generating dictionary we will have a look at the basin of attraction, the regions of contraction, and spurious attractive points. Time permitting we will also discuss heuristics how to use escape from spurious attractive points and jump directly into the basin of attraction.

## Friday, Dec. 4, 15:00-16:00. Computational Imaging

Chair: Marc Allain

- 15:00-15:15. Maël Millardet, Saïd Moussaoui, Diana Mateus, Jérôme Idier and Thomas Carlier, *Local-mean preserving post-processing step for non-negativity enforcement in PET imaging: application to 90Y-PET*, #32
- 15:15-15:30. Ludivine Morvan, Thomas Carlier, Bastien Jamet, Clément Bailly, Caroline Bodet-Milin, Philippe Moreau, Françoise Kraeber-Bodéré and Diana Mateus, *Leveraging RSF and PET images for prognosis of Multiple Myeloma at diagnosis*, #33
- 15:30-15:45. Benoît Pairet, Faustine Cantalloube and Laurent Jacques, *Morphological components analysis for circumstellar disks imaging*, #44
- 15:45-16:00. Iman Marivani, Evaggelia Tsiligianni, Bruno Cornelis and Nikos Deligiannis, *Interpretable Deep Multimodal Image Super-Resolution*, #46

## Friday, Dec. 4, 16:00-16:30. Closing words

## 7. Scientific and organizing committees

### **Organizing Committee for iTWIST'20**

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## 8. Sponsors

The iTWIST'20 organizing committee thanks the following sponsors for their support.

