Geometry & Learning from Data (Online) 21w5239

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October 24–29, 2021

1 Meeting Overview

The meeting was attended live online on average by between 25 and 60 participants, from 131 confirmed registered people. The online format allowed many participants from Europe, Asia, and the Americas to participate. The rapid availability of videos also made it possible for participants to catch up and participate asynchronously. A conscious distribution of participants was designed to include researchers from different career levels and backgrounds.

Moreover, given that BIRS, and more specifically CMO, are partly funded by CONACyT, there was a dedicated effort to select Mexican speakers and to include Mexican participants. The Mexican speakers were Nancy Arana-Daniel (Universidad de Guadalajara), Benjamin Sanchez-Lengeling (Google Research), and David Alvarez Melis (Microsoft/Harvard). Their high caliber talks were essential to establish representation of the Mexican contributions to the developments in robotics, chemistry, and linguistics coming from the applications of computer vision, graph neural networks, and optimal transport (all in the same order). The underlying glue to these disparate directions is, of course, Geometry.

Furthermore, we included five more Mexican participants as panelists in three different panels. These were the following:

- Panel 1: AI & Public Institutions – Dr. Eduardo Ulises Moya (Jalisco Government), Dra. Paola Villareal (CONACyT), and Dra. Yalbi Itzel Balderas Martinez (INER).
- Panel 2 : Professional Development – Prof. Tina Eliassi-Rad (Northeastern), and Prof. Jesús de Loera (UC Davis).
- Panel 3 : AI & Industry – Dr Juan Carlos Catana (HP Labs), Dr Ilke Dermir (Intel), and Dr David Alvares Melis (Microsoft/Harvard).

On top of these Mexican speakers and panelists, the following 26 Mexican participants registered and were involved in the meeting's activities: Arizmendi, Gerardo (Universidad de las Américas Puebla), Barahona, Igor (UNAM), Barcenas, Noe (UNAM), Contreras Peruyero, Adriana Haydee (Instituto Tecnológico Superior de Martínez de la Torre), de la Iglesia, Manuel D. (Universidad Nacional Autonoma de Mexico), De Loera, Javier (UNAM), Evangelista Alvarado, Miguel Angel (Instituto de Matemáticas UNAM), Fritz, Rodrigo (UNAM), Gomez-Mont, Xavier (CIMAT), Gonzalez Casanova, Adrian (Instituto de Matemáticas UNAM), Hernandez Torres, Sarai (Technion - Israel Institute of Technology), Hernández Dueñas, Gerardo

(Universidad Nacional Autonoma de Mexico), López Pérez, Mario (UNAM), Martin del Campo, Abraham (CIMAT at Guanajuato), Martinez, Anayanzi (UNAM)Martínez Aguilar, Carlos Eduardo (Posgrado en Ciencias Matemáticas), Membrillo Solis, Ingrid Amaranta (University of Southampton), Mijangos de la Cruz, Victor (UNAM), Moya, Luis (National University of Engineering), Ortiz, Claudia (UNAM), Perales, Raquel (UNAM, Oaxaca), Rieser, Antonio (CONACYT-CIMAT), Rodriguez Viorato, Jesus (CONACyT-CIMAT), Roldan Roa, Erika (Technical University Munich and EPFL), Ruíz, José (Universidad de Sonora), Treviño, Erick (UNAM).

It cannot be stressed enough that given the dearth of research funding and investment in Mexico over the last three decades (by several administrations), opportunities like this are significant for the Mexican community. More importantly, given that CONACyT partly funds both BIRS and CMO, there have to be visible, tangible, and real benefits created by the activities that CMO carries out for Mexican taxpayers to appreciate and for Mexican society to truly profit from. Otherwise, this funding might be better spent directly by Mexican researchers, who are at an unfair disadvantage with colleagues from the USA, Canada, and elsewhere where research funding is more readily available.

Apart from the panels, there were 26 talks, each 45 minutes long, with 15 minutes break in between each. This format gave ample time for rest and interactions between sessions, needed in a fully online format. In addition, a lively poster session, with 16 posters, was held on the Gathertown platform to complement these activities and provide space for students and early career researchers. It provided a lovely opportunity for interaction and socialization beyond the Zoom chat boxes, breakout rooms, and discussion rooms. Mexican participants, at Masters, Ph.D., and Postdoc levels, had three posters in this space.

2 Recent Developments and Open Problems

This meeting brought together several allied fields, all of which intersect in their use of Geometry to study data. These include Optimal Transport, Information Geometry, Geometric Processing, and Geometric Deep Learning. Professors Jost, Curto, Memoli, and Otter presented applications and developments from applied topology. Michael Bronstein explained novel developments in the use of differential geometry techniques, where geometric flows are now being used to analyze complex networks in Twitter. Techniques that have been successful for surface meshes and points clouds, with a review of the areas up to the latest developments, were included in the talks by Maks Ovsjanikov and Ron Kimmel. An open question in this direction, and also related to the tensor results of Chris Connell and Joe Kileel, is to what extent these methods' computational complexity depends on the genus of the underlying surface? This fundamental geometric question has not yet been addressed in the available databases for point clouds and surfaces, where the genus distribution is not uniform or even considered.

Given the online nature of the meeting, it is hard to pinpoint specific signs of progress. These will happen in the future as more people see the archived videos and make connections between their research and the meeting presentations. However, fruitful interactions can and did occur in the continued conversations between theorists and applied scientists.

3 Outcome of the Meeting

The relevance of different geometric techniques in collecting, analyzing, and learning from data is obvious from the different activities held in our meeting. We foresee a continued use of Differential Geometry, Algebraic Geometry, Metric Geometry, Algebraic Topology, Optimal Transport, Information Geometry, and its implementations towards successful applications in learning theory and practice. These span from the academic production of new knowledge right to the deployment of industrial and commercial products (made clear in the presentations from colleagues at Google, Intel, HP Labs, Microsoft, and Twitter). As more 3D data becomes available and used, these mathematical areas and their applications will continue to gain prominence. We expect more interactions and collaborations to carry on shortly.