

New and not-so-new applications of low-rank matrix and tensor completion to seismic data processing



Mauricio D. Sacchi
2016 CSEG Distinguished Lecturer

Abstract

In recent years, the development of recommendation systems has become an important area of research for data scientists. A recommendation system (or recommender system) is an algorithm that attempts to predict the rating that a user or customer will give to an item. Recommendation systems are becoming quite popular in the field of e-commerce for predicting ratings of movies, books, news, research articles etc. Research in the area of data analytics and recommendation systems has led to important efforts toward solving the so-called matrix completion problem. The latter entails estimating the missing elements of a matrix containing customer ratings. The aforementioned problem can be extended to the recovery of the missing elements of a multilinear array or tensor. Prestack seismic data in midpoint-offset domain can be represented by a 5th order tensor. Therefore, tensor completion methods can be applied to the recovery of unrecorded traces. Furthermore, tensor completion methodologies can also be applied to multidimensional signal-to-noise-ratio enhancement, simultaneous source separation, interpretative attribute analysis etc. In this presentation, I will review matrix and tensor completion methods and discuss their implementation to reconstruct, process and enhance seismic volumes. I will also discuss the successful application of tensor completion techniques to the reconstruction of industrial data sets.

The talk is intended for senior undergraduate and graduate students in Geophysics but I expect that it might also be of interest to applied mathematicians, computer and data scientists.

Biography

Mauricio D. Sacchi received a diploma in geophysics from The National University of La Plata, Argentina, in 1988 and a PhD in geophysics from UBC, Canada, in 1996. He joined the Department of Physics at the University of Alberta (Edmonton, Canada) in 1997. He was promoted to full professor in 2006 and became chairman of the Department of Physics in 2010. His research interests are in the area of signal analysis and imaging methods. He directs the Signal Analysis and Imaging Group, an industry-sponsored initiative for advanced research in signal processing and imaging. He has developed and taught short courses for the industry and for SEG, CSEG, and EAGE in the area of seismic signal theory, transform methods for signal enhancement, seismic inversion, and multidimensional data reconstruction. In collaboration with students, he introduced 5D reconstruction methods, sparse signal representation theory and tensor reconstruction methods to the seismic processing community. With Tad Ulrych he wrote the book *Information-based processing and inversion with applications* (Elsevier). He is the recipient of the 2012 CSEG Medal, the highest award that the Canadian Society of Exploration Geophysicists bestows. He was also SEG's 2014 Honorary Lecturer for Latin America. He is also the Editor of the journal *Geophysics* for 2015-2017.

2015 / 2016 CDL Tour Tentative Schedule (to be updated)

Date	Universities or Institutions Included	City
October 6, 2015	Earth Sciences, University of Toronto	Toronto, ON
October 8, 2015	Earth Sciences, Dalhousie University	Halifax, NS
October 9, 2015	Department of Earth Sciences, Memorial University of Newfoundland	St John's, NL
January 28, 2016	Earth and Ocean Sciences, UBC	Vancouver, BC
February 9, 2016	Department of Geological Sciences and Geological Engineering, Queen's University	Kingston, ON
February 10, 2016	Department of Earth Sciences, Western University	London, ON
February 11, 2016	Earth and Environmental Sciences, University of Waterloo	Waterloo, ON
February 29, 2016	University of Calgary, 4pm Room SB142	Calgary, AB
March 1, 2016	University of Saskatchewan, 4 pm	Saskatoon, SK
March 2, 2016	University of Alberta, 3pm	Edmonton, AB