



ERCIM "ALAIN BENSOUSSAN"  
FELLOWSHIP PROGRAMME



## Scientific Report

First name / Family name

Nikolas TAPIA

Nationality

Chilean

Name of the *Host Organisation*

NTNU

First Name / family name  
of the *Scientific Coordinator*

Kurusch EBRAHIMI-FARD

Period of the fellowship

01/10/2018 to 31/05/2019

### I – SCIENTIFIC ACTIVITY DURING YOUR FELLOWSHIP

The main line of investigation focused on the role that certain algebraic structures (shuffle and quasi-shuffle algebras, Lie algebras, Hopf algebras, etc.) play in the combinatorial description of stochastic integration both in commutative and non-commutative settings.

Building on previous work by Prof. K. Ebrahimi-Fard and Prof. F. Patras (U. Nice, France) we extended the results of a previous joint publication (with Prof. F. Patras and Prof. L. Zambotti) on the combinatorics of Wick polynomials to the setting of non-commutative probability.

It was observed that the same structures also describe well some aspects of “path signatures” introduced by Chen and studied by Lyons and others. These signatures provide a concise and accurate descriptions on paths in Euclidean space and allow for efficient feature extraction of time series. However, this method has some limitations in current applications. In this respect, a join project with Joscha Diehl (U. Griefswald, Germany) was initiated in order to refine the existing techniques, and to better adapt them to discrete data.

A project to include signatures in shape analysis with applications to gesture identification in computerized motion capture was started, jointly with Prof. E. Celledoni (NTNU) and P. E. Lystad (NTNU). This led to the study of an extension of the currently available methods to the settings of curves evolving on Lie groups.

## II – PUBLICATION(S) DURING YOUR FELLOWSHIP

1. Celledoni, E., Lystad, P.E., Tapia, N. *Signatures in Shape Analysis: an efficient approach to motion identification*. Accepted in “Geometric Science of Information” (2019). To appear.
2. Ebrahimi-Fard, K., Patras, F., Tapia, N., Zambotti, L. *Wick polynomials in Noncommutative Probability*. In preparation.
3. Diehl, J., Ebrahimi-Fard, K., Pfeffer, M., Tapia, N. *On the discrete-time signature in time series analysis*. In preparation.

## III – ATTENDED SEMINARS, WORKHOPS, CONFERENCES

### *Workshops and conferences:*

1. Rencontres du GDR Renormalisation. Clermont-Ferrand, France. 12–16 Nov, 2018.
2. 10<sup>th</sup> Oxford-Berlin meeting for young researchers. Oxford, UK. 29–30 Nov & 1 Dec, 2018.
3. MAGiC 2019. Lillehammer, Norway. Feb. 25 & Mar. 1, 2019.
4. New Directions in Stochastic Analysis: Rough Paths, SPDEs and related topics. Berlin, Germany. 18–22 Mar, 2019.
5. Noncommutative Stochastic Analysis 2019. Trondheim, Norway. 8–10 May, 2019.

I also organized the seminar “Mathematical Perspectives on Machine Learning” at my Host Organization, which was held weekly during my stay.

I attended the seminar of the DNA group regularly and occasionally the seminar held by the topology group at NTNU.

## IV – RESEARCH EXCHANGE PROGRAMME (REP)