



PostDoctoral and Doctoral positions at the Department of Mathematics of the Technical University of Munich

Dear Colleague,

we are advertising **2 PostDoctoral** and **1 Doctoral** positions for a term of up to 5 years at the Department of Mathematics of the Technical University of Munich within the ERC-Starting Grant project *High-Dimensional Sparse Optimal Control*.

Our research

We perform mathematical research oriented to applications in data analysis and time dependent phenomena (e.g., image processing, fracture simulation, remote satellite sensing for Earth observation, data analysis and modelling of pulsating stars, social dynamics and control of multiagent interactions), employing several related methods in variational calculus, nonlinear PDEs, optimization and optimal control, functional and harmonic analysis, numerical analysis. A short description of the scientific plan of the ERC-Starting Grant project *High-Dimensional Sparse Optimal Control* is reported below.

Environment

Our unit in Applied Numerical Analysis is a very active research group with a strong international profile (<http://www-m15.ma.tum.de/>). The Department of Mathematics of the Technical University of Munich is a young, stimulating, and dynamical environment, offering excellent working conditions. It is composed of 15 research units representing all the relevant fields of applied and numerical mathematics (<http://www.ma.tum.de/Mathematik/Einheiten>), qualifying itself as one of the strongest centers of applied mathematics in Germany. The Technical University of Munich has been recently confirmed as a *University of Excellence* in Germany, and in the next years will be subjected to further relevant developments, in particular with a very new and competitive *tenure track career system* (<http://www.exzellenz.tum.de/1/homepage/>) .

We offer

To the successful candidates will be offered research positions up to 5 years with competitive salaries depending on qualification. The work is additionally supported with individual research funding (c.a. 10.000,00 EUR/year for each researcher). No teaching duties are requested. We provide both individual supervision and independent career promotion. The starting date is currently planned on **December 1, 2012** (negotiable). **Application deadline: September 30, 2012**, or until filled.

We search

Interested candidates with a strong background in one or more of the following

Prof. Dr.
Massimo Fornasier

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Technische Universität München



Fakultät für Mathematik
Lehrstuhl für Angewandte
Numerische Analysis

fields - *functional analysis, calculus of variation and geometric measure theory, applied harmonic analysis, optimization and optimal control, numerical analysis,*

are invited to apply, by electronically submitting a motivation letter, curriculum, including publication list, a description of research interests, up to 3 letters of recommendation in pdf format. Doctoral candidates should specify their final master grades.

Enquiries regarding the positions and the applications should be directed to Massimo Fornasier (massimo.fornasier@ma.tum.de).

Sincerely yours

Massimo Fornasier

Summary of the project *High-Dimensional Sparse Optimal Control*

We are addressing the analysis and numerical methods for the tractable simulation and the optimal control of dynamical systems which are modeling the behavior of a large number N of complex interacting agents described by a large amount of parameters (high-dimension). We are facing fundamental challenges:

- **Random projections and recovery for high-dimensional dynamical systems:** we shall explore how concepts of data compression via Johnson-Lindenstrauss random embeddings onto lower-dimensional spaces can be applied for tractable simulation of complex dynamical interactions. As a fundamental subtask for the recovery of high-dimensional trajectories from low-dimensional simulated ones, we will address the efficient recovery of point clouds defined on embedded manifolds from random projections.
- **Mean field equations:** for the limit of the number N of agents to infinity, we shall further explore how the concepts of compression can be generalized to work for associated mean field equations.
- **Approximating functions in high-dimension:** differently from purely physical problems, in the real life the social forces which are ruling the dynamics are actually not known. Hence we will address the problem of automatic learning from collected data the fundamental functions governing the dynamics.
- **Homogenization of multibody systems:** while the emphasis of our modeling is on social dynamics, we will also investigate methods to recast multibody systems into our high-dimensional framework in order to achieve nonstandard homogenization by random projections.
- **Sparse optimal control in high-dimension and mean field optimal control:** while self-organization of such dynamical systems has been so far a mainstream, we will focus on their sparse optimal control in high-dimension. We will investigate L_1 -minimization to design sparse optimal controls. We will learn high-dimensional (sparse) controls by random projections to lower dimension spaces and their mean field limit.