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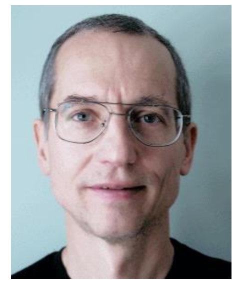

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Research profile:

General interest: numerical methods and optimization, with applications in signal processing. The purpose is always the same: to find efficient algorithms for solving known and new problems. Proving theoretical properties of the algorithms is a bonus. The most relevant recent results fall into the topic of *sparse representations and dictionary learning*.
Specific problems: general-purpose dictionary learning algorithms, algorithms for structured sparse representations, learning with structured dictionaries, dictionary learning applications to time series.

PhD advisor since 2007;
- 4 graduated students
- 3 current students

Scientific publications:
- The monograph Positive trigonometric polynomials and signal processing applications, Springer, 2007 (second edition 2017)
- The monograph Dictionary Learning Algorithms and Applications, Springer, 2018 (with Paul Irofti)
- 50+ papers in journals like IEEE Transactions on Signal Processing (9 articles), IEEE Signal Processing Letters (10), Signal Processing (10), etc.

- 90+ conference papers
- several patents in filter banks design for audio processing

Research projects:

- Sparse representations in signal processing, IDEI 2011-2016
- Convex optimization in signal processing, FiDiPro fellow grant 2010-2013 (Finland)
- Positivity in the analysis and synthesis of multidimensional systems, IDEI 2007-2010
- Filter bank design (Nokia 2008, Microsoft 2015, Huawei 2020)

Leading positions / Membership to scientific organizations and committees, editorial boards

- Associate editor to IEEE Trans. Signal Proc. (2008-2014), Mathematical Problems in Engineering (2015-), Algorithms (2018-)
- Member in the technical program committee at conferences like EUSIPCO, IEEE Statistical Signal Processing, etc.

Proposed PhD research topics:

1. Robust dictionary learning for image processing

Dictionary learning for sparse representation is a versatile model in image processing for simple tasks like denoising or inpainting and more complicated problems like classification. Most dictionary learning methods are based on the assumption of Gaussian representation noise, a fact that is clearly not true for images. The goal is to design algorithms that identify a noise model and design the dictionary appropriately, with many potential applications awaiting.

2. Dictionary learning with nonlinear extensions

Dictionary learning for sparse representation essentially produces a linear model. As such, it has inherent limitations that put its performances behind those of neural networks. However, in terms of complexity, dictionary learning is very convenient. The goal is to explore nonlinear extensions of dictionary learning, starting with those based on typical kernel methods and aiming to mixed structures that combine sparsity and nonlinearity.

3. Anomaly detection in graphs

Anomaly detection deals with abnormal events or signals, attempting to separate them from the “normal” class. A particularly interesting case is that of anomaly detection in graphs, for example in graphs modelling financial transactions. The problem can be approached in many ways, starting from classical graph search algorithms and going to artificial intelligence methods. The goal is to find efficient algorithms that are in between these extremes, for example inspired from dictionary learning. Online algorithms are of special interest.

4. Parallel algorithms on GPU for solving numerical problems that occur in signal processing.

This is a generic topic, which can contain several classes of problems, starting from the standard ones and going to special problems like those related to sparse representations. The goal is to obtain efficient algorithms on graphic processing units or mixed architectures, with OpenCL implementation.