SS27: F-transforms: bridging theory and applications

Irina Perfilieva
University of Ostrava, IRAFM
Dvorakova 7, Ostrava 1
Czech Republic
Irina.Perfilieva@osu.cz

Vilém Novák
University of Ostrava, IRAFM
Dvorakova 7, Ostrava 1
Czech Republic
Vilem.Novak@osu.cz

1 Description of the session

The theory of fuzzy transform (F-transform) is one of seldom examples where a well elaborated theory has many real-life applications. This theory appeared as a functional model of fuzzy IF-THEN rules and collected all principal features of the latter.

The F-transform successfully links classical mathematics with modern and extensively developing soft computing theories: integral transformations and approximating operators in fuzzy rough theory, fuzzy relation compositions and discrete convolutions, topological categories, and functional spaces. It has many applications in computer vision and image processing, signal processing, time series analysis, numerical analysis and differential equations, data mining, etc.

In the recent ten years, the theory of F-transform became an important constituent in the field of computational intelligence. The exceptional feature of the F-transform is that it successfully and efficiently copes with classical problems as well as with problems that are affected by uncertainty or vagueness.

In image and signal processing, the F-transform effectively solves problems connected with the up- (down-) scaling, reconstruction, edge detection, fusion, registration, etc. In time series analysis, the F-transform is used for trend extraction and reduction of noise. In the big data area, it works as a successful method of pattern recognition.

The F-transform is one of the most distinguished examples that justify the claim: "fuzzy methods are useful and effective on all levels of data processing!"

2 Section Papers and Their Contribution to the Topic

The contributions are focused on recent developments and trends in various soft-computing theories and applications of the F-transform. Besides theoretical aspects, they develop advanced applications in data analysis including handling big data. All the contributions extend traditional ways of the data analysis and suggest adequate methods for various kinds of data processing. Below we give a short description of their main achievements.

T. Afanasieva, N. Yarushkina and I. Sibirev: Time Series Clustering using Numerical and Fuzzy Representations

This paper addresses combination of fuzzy techniques with the well-known clustering algorithm to the analysis of time series. First, one time series model based clustering using the techniques of the F-transform and a general fuzzy tendency is proposed. On the basis of that, quantitative and qualitative representations of the time series are derived. This makes it possible to group time series with similar patterns of their additive model and, therefore, with the same type of behavior.

N. Yarushkina, A. Filippov, A. Romanov, V. Moshkin and E. Egov: Developing a system for time series data mining on the basis of F-transform and the domain-specific ontology

The paper is focused on data mining with the goal to improve quality of the financial management of a commercial organization. The following is addressed: (a) Modelling and forecasting of the organization activity indicators according to the data from the previous reporting periods. (b) Recommendations of the management decision-making based on the gained knowledge and the experience of experts. Estimation of the financial state of the organization is based on forecast of trend using the F-transform.

J. H. Yoon, D. Kyeong, K. Seo and I. Á. Harmati: M-estimators using optimization algorithm based on F-transform

The paper addresses robust estimation technique called M-estimators that is insensitive to small departures from the idealized assumptions (insensitivity to outliers). A new algorithm based on the combination of the F-transform and a modified genetic algorithm is suggested. Such combination improves accuracy of the results.

V. Novák: Tectogrammatical Trees and Fuzzy Natural Logic in Linguistic Characterization of Processes

This paper is a contribution to the applications of mathematical fuzzy logic in modeling of linguistic semantics. The technique of linguistic theory called *tectogrammatical trees* is employed. Using it, linguists characterize semantics of sentences. Such a tree is assigned a formula of *fuzzy natural logic* which construes semantics of the given sentence. Thus, if a model is constructed, we obtain semantical content of the given sentence which, in general, is a fuzzy relation and a truth value. The method is demonstrated on the task to characterize course of trend of time series. To be able to do it, the trend is estimated using the technique of fuzzy transform.

A. P. Singh, S. P. Tiwari: On residuated lattice based fuzzy variable precision F-transform

The authors introduce the notion of *fuzzy variable precision F-transform* by incorporating the L-fuzzy transform with the theory of variable precision. The main idea is to apply the lattice-based F-transform technique to a parametrized "trancation" of a function. This allows to select the "most important" parts of the function. The main claim is that the new F-transform is more general than the existing F-transform concepts.

M. Vajgl, P. Hurtík, P. Števuliáková: Drone real-time control based on pattern matching

In this contribution, the algorithm for detecting an object in an image and tracking it in movie frames is proposed. The idea is adopted from the image pattern matching algorithm which is based on the F-transform. The original pattern matching algorithm based on the F-transform was firstly developed for string matching and later extended for image matching. The main goal of this paper is to modify the general F-transform-based pattern matching algorithm and to combine it with the Bebop drone navigation software.

I. Perfilieva, P. Števuliáková, R. Valášek: Shooting Method Based on Higher Degree F-transform

This paper is a contribution to the F-transform-based approach to ordinary differential equations. The framework of the shooting method for nonlinear second-order ordinary differential equations with boundary conditions has been utilized. The numerical scheme, based on the second degree F-transform for solving the corresponding initial value problem, was proposed. In particular, the inverse F-transform of the zero and first degrees was applied in order to extend the numerical solution to the initial domain. The effectiveness of the proposed method in the class of second order numerical methods was demonstrated.