Extracting Knowledge from Traffic Monitoring and Analysis in the Scope of the Future Internet

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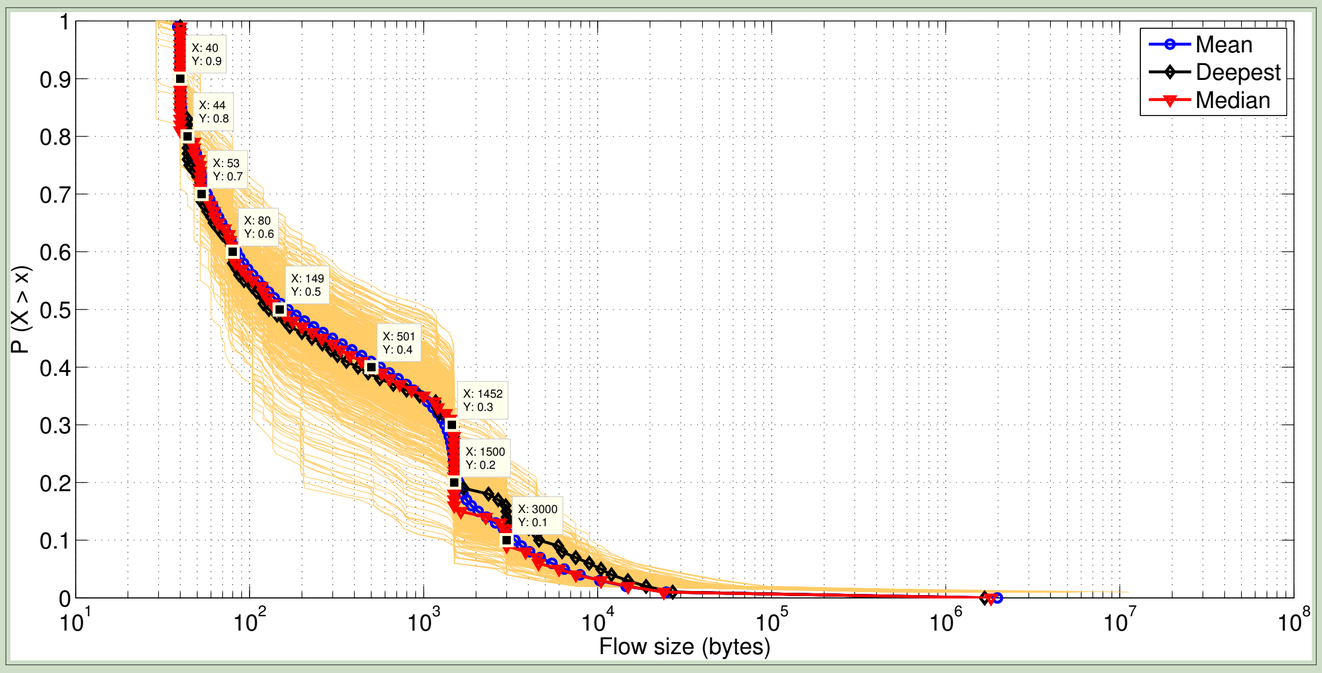
Hypothesis

Traffic Monitoring and Analysis must face new challenges and take advantage of the Future Internet elements. The advances in Data Analysis provide opportunities to lead this evolution:

- Software Defined and Virtualized Networks
- Multitenant infrastructures / Cloud
- Big Data era: growth of data and computing capacities
- More complex data-flows to extract knowledge

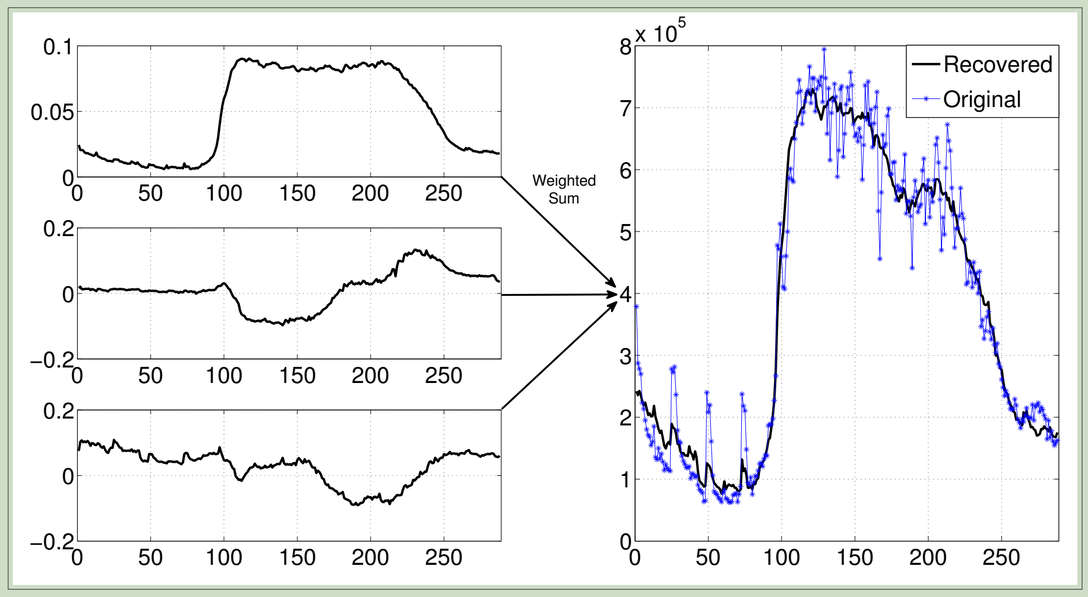
Network Data Mining Using Functional Data Analysis



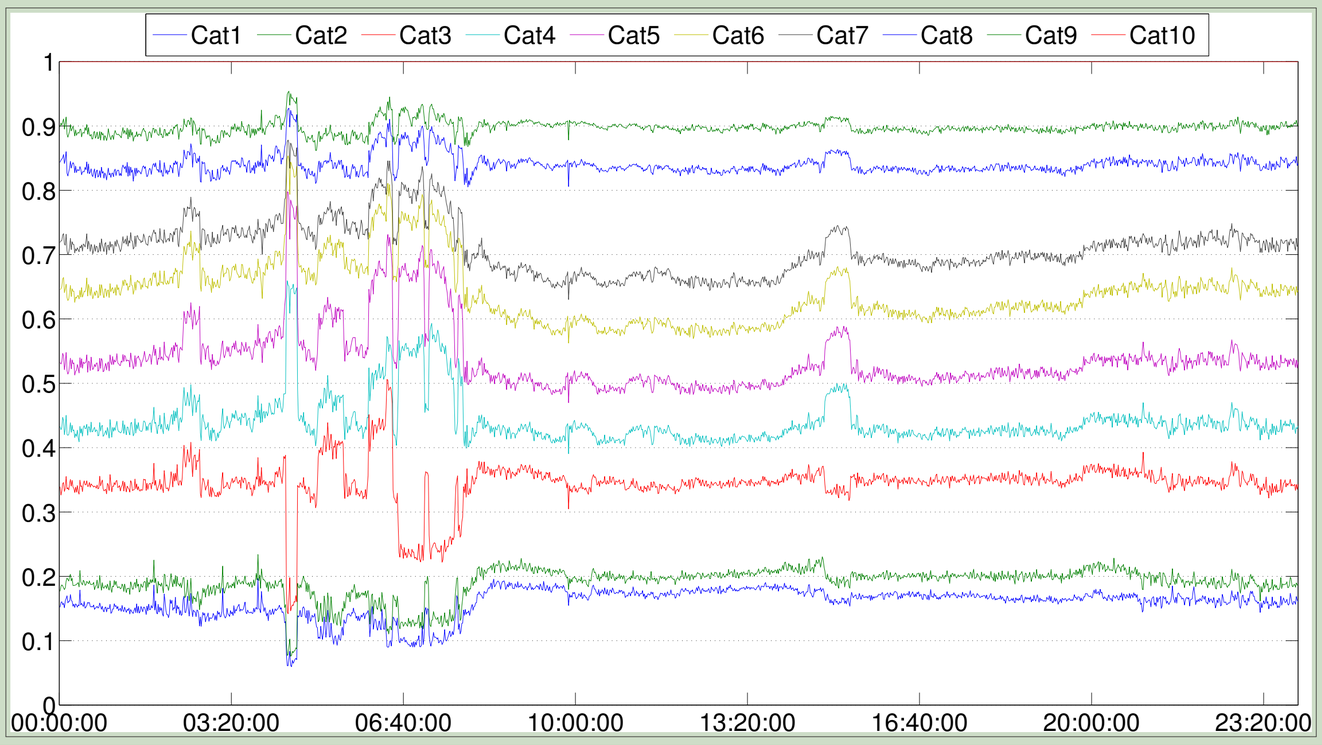
- Network management must suit the heterogeneity and flexibility of emerging technologies.
- In Functional Data Analysis (FDA), random variables are trajectories of stochastic processes.
- By considering functions that represent network state (time series, ECDFs), FDA allows the exploitation of the information in such functions:
  - Many methods do not require hypothesis on the marginal distributions of time series.
  - Analysis is not constrained only to periods where network behavior is stationary.
- Also allows robust analysis of multi-dimensional functions and derivatives of observations.

Network Data Reduction and Feature Selection

- FDA includes feature selection methods that can be applied to Traffic Monitoring and Analysis.
- Functional Principal Components Analysis is one of such methods:
  - Reduces the data volume required to represent network behavior.
  - Detects the components that best explain the variance of the network measurements.
  - Provides a space for data projection that improves classification / clustering of measurements.



Visualization of Network Flow Characteristics



- Big network flow data must be represented to extract knowledge: that is, obtain comprehensive and easy to understand visual summaries.
- The instrument: **Dictyogram** (from *δίκτυο*, network in Greek): Method to graphically trace the network flow behavior versus time. Its graphical results can be like a network electrogram, showing its vital signs.
- The basic idea is to define flow categories using the empirical distribution function of characteristics —*e.g.*, flow size.

Other ongoing research lines

- Application of FDA techniques to network behavior forecasting.
- Exploration of the virtualization of network monitoring and analysis elements.

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