Smart decimation method applied to real-time monitoring

R. Castro, J. Vega

AI and Visualizing large dataset workshop, Princeton University 11-13 July (2024)

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MOTIVATION

- New long pulse fusion machines
  - Very fast data acquisition signals
  - Data access requests for long time intervals
- Users data access requests
  - Huge number of values
  - Very long response latencies
- Real time data monitoring
  - Distribute a large number of samples over a big number of users

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Offline data visualization

- Screen limitation
  - Limitation in screen size/resolution: about 3K number of points
- User interface must be interactive
  - Locks and big latencies must be avoid
- Top-down approach
  - Quick data access requests with lower resolution
    - Representative set of values of the requested interval: **decimation**
  - Zoom on interesting portion
    - New data access request with higher resolution

Real time data visualization

- Screen limitation
  - Limitation in screen size/resolution: about 3K number of points
- Big number of users monitoring a significant number of signals
  - Fast data acquisition signals
- Data optimization
  - Select and distribute a representative set of values of the signals to be monitored: **decimation**

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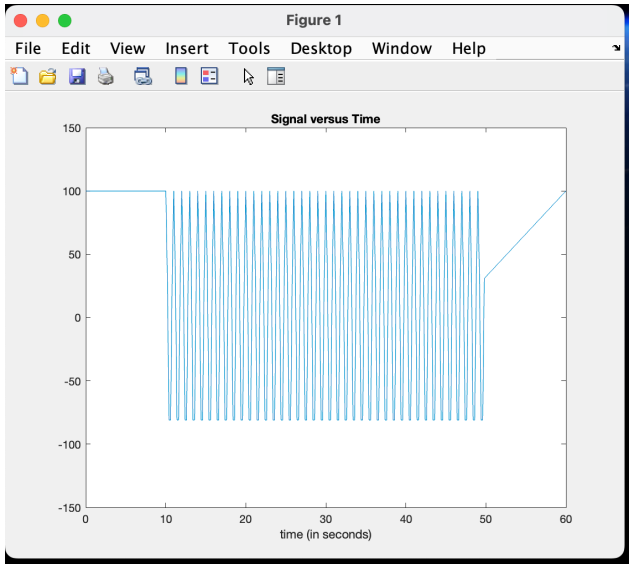
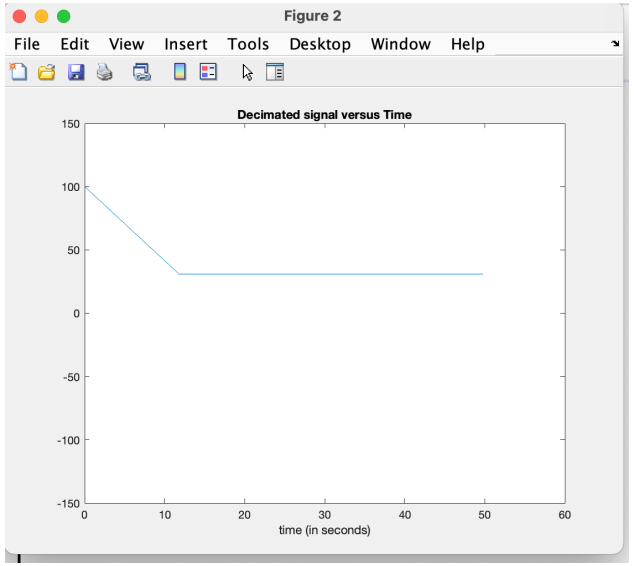
Decimation is the key

- Selection of a representative set of values from original data
- Typical decimation method: 1-of-n
- Data visualization:
  - Aliasing effect: loss of very relevant information for users



1-of-n



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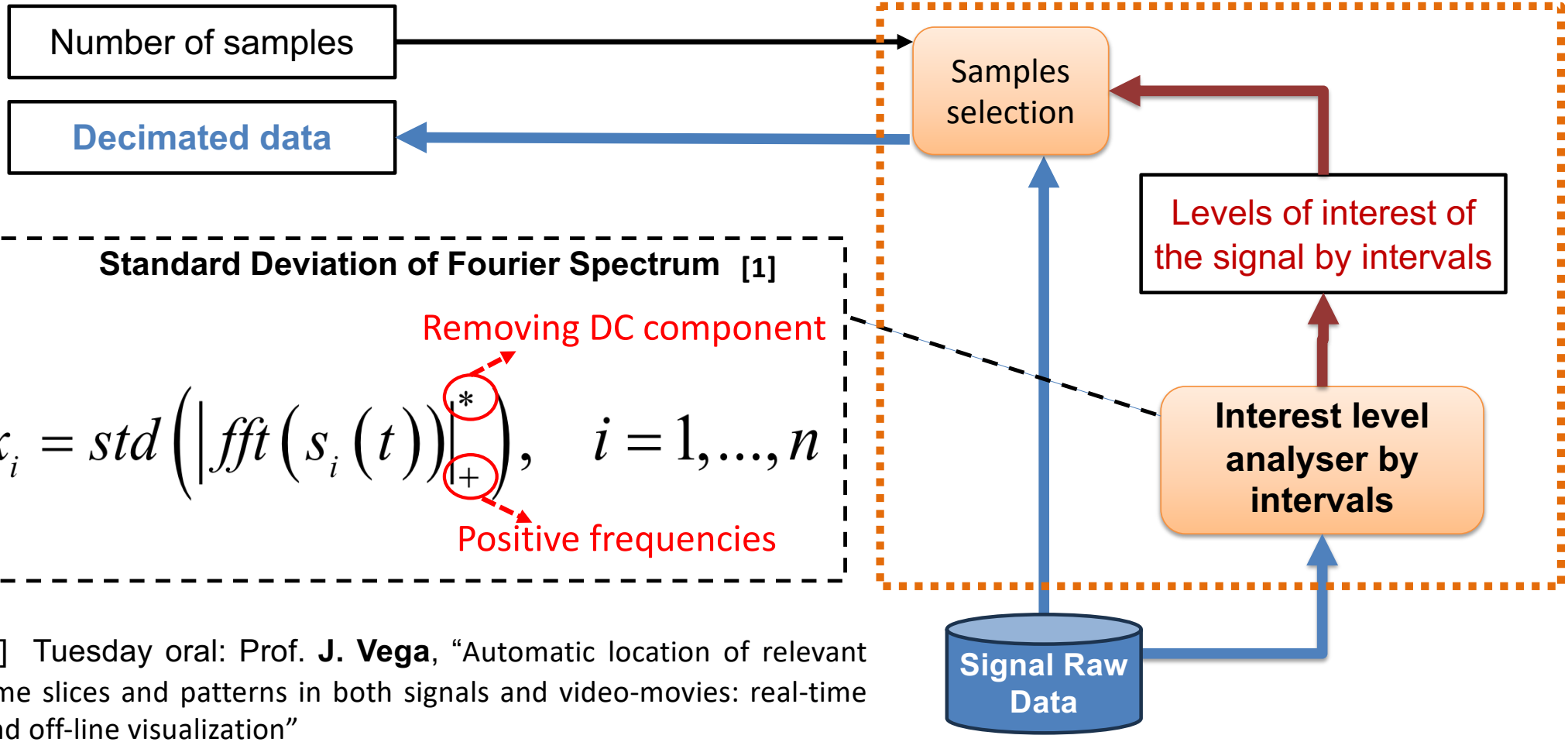
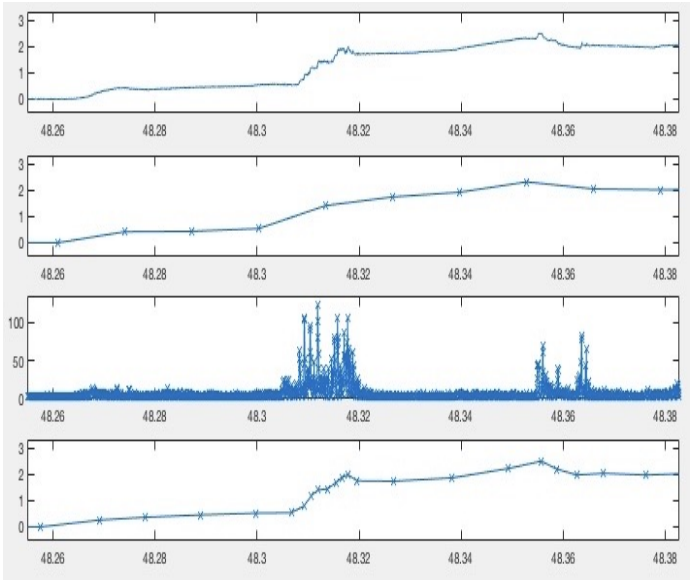
Smart Decimation Method



[1] Tuesday oral: Prof. **J. Vega**, "Automatic location of relevant time slices and patterns in both signals and video-movies: real-time and off-line visualization"

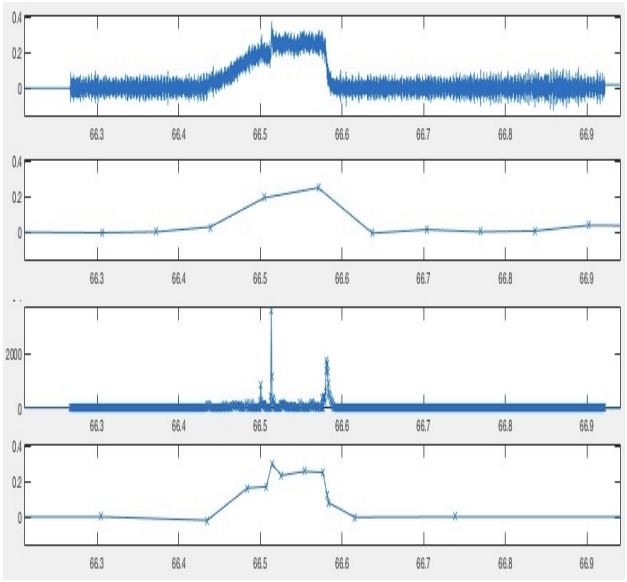
Data visualization results

Signal: DENCM0



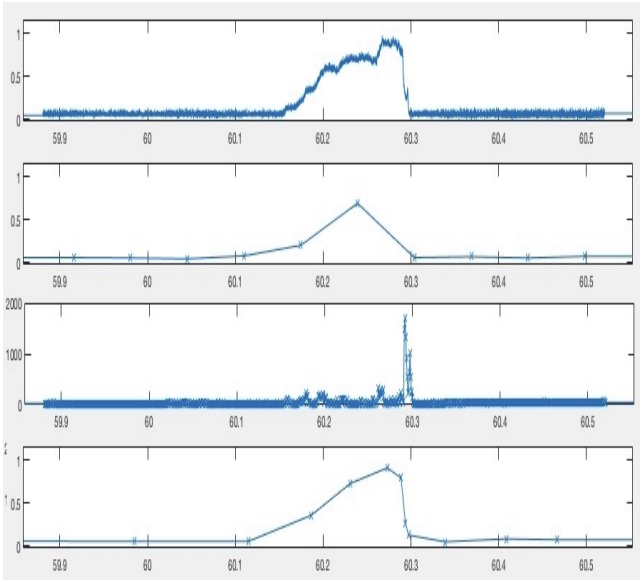
	Step decimation	Smart decimation
Eucl. Distance	161.07	109.73
Coef. Correlation	0.9969	0.9986

Signal: BOL1



	Step decimation	Smart decimation
Eucl. Distance	107.54	67.23
Coef. Correlation	0.6727	0.8914

Signal: RX105



	Step decimation	Smart decimation
Eucl. Distance	187.55	99.06
Coef. Correlation	0.7732	0.9421

12th IAEA Technical Meeting on Control, Data Acquisition and Remote Participation (2019)

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Smart decimation for real time monitoring

- To be a real time algorithm
- To improve the similarity of monitored signal vs the original one
- To reduce the loss of relevant information in data monitoring
- To use equal or less number of points than classical decimation

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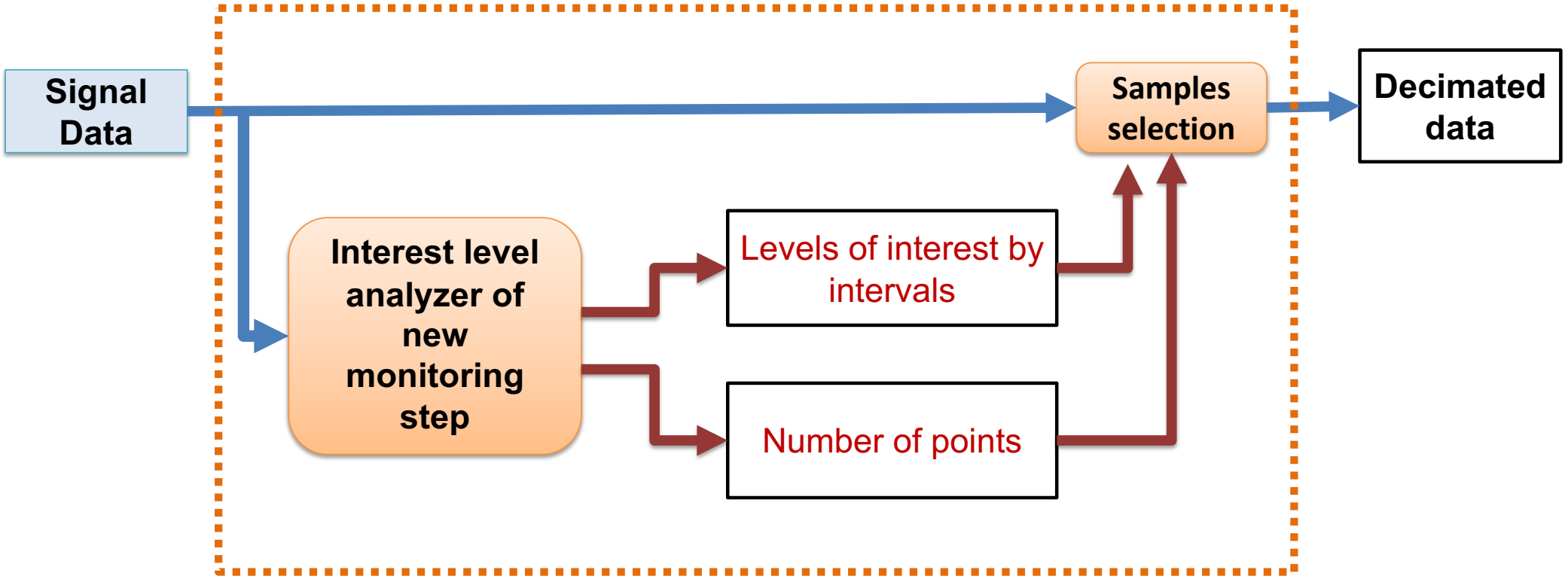
Smart decimation for real time monitoring



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Test setup

- Signals from TJ-II
  - To emulate long pulse -> Concatenation of hundreds of pulses

Signal name	Description	Sampling rate
BOL1	Bolometer signal	100 KHz
DENCM0	Electron density	1 MHz
ECE10	Electron Cyclotron Emission	100 KHz
RX105	Soft Ray-X	78 KHz

- Function to compare the level of similarity of decimated signal vs original signal: Cross correlation ‘xcorr’ Matlab function

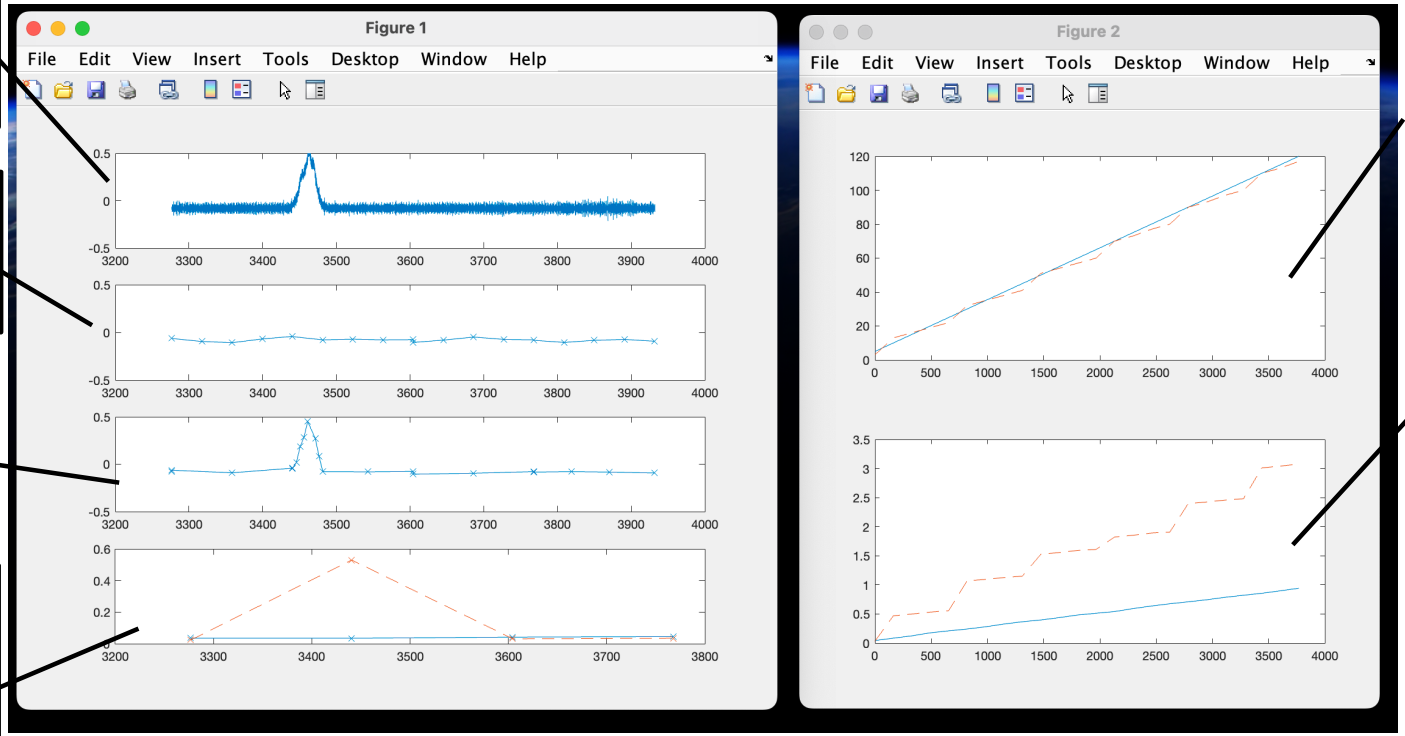
Test

Original signal

1-of-n decimation

Smart decimation

Similarity of decimated vs original



Accumulated number of points

Accumulated similarity

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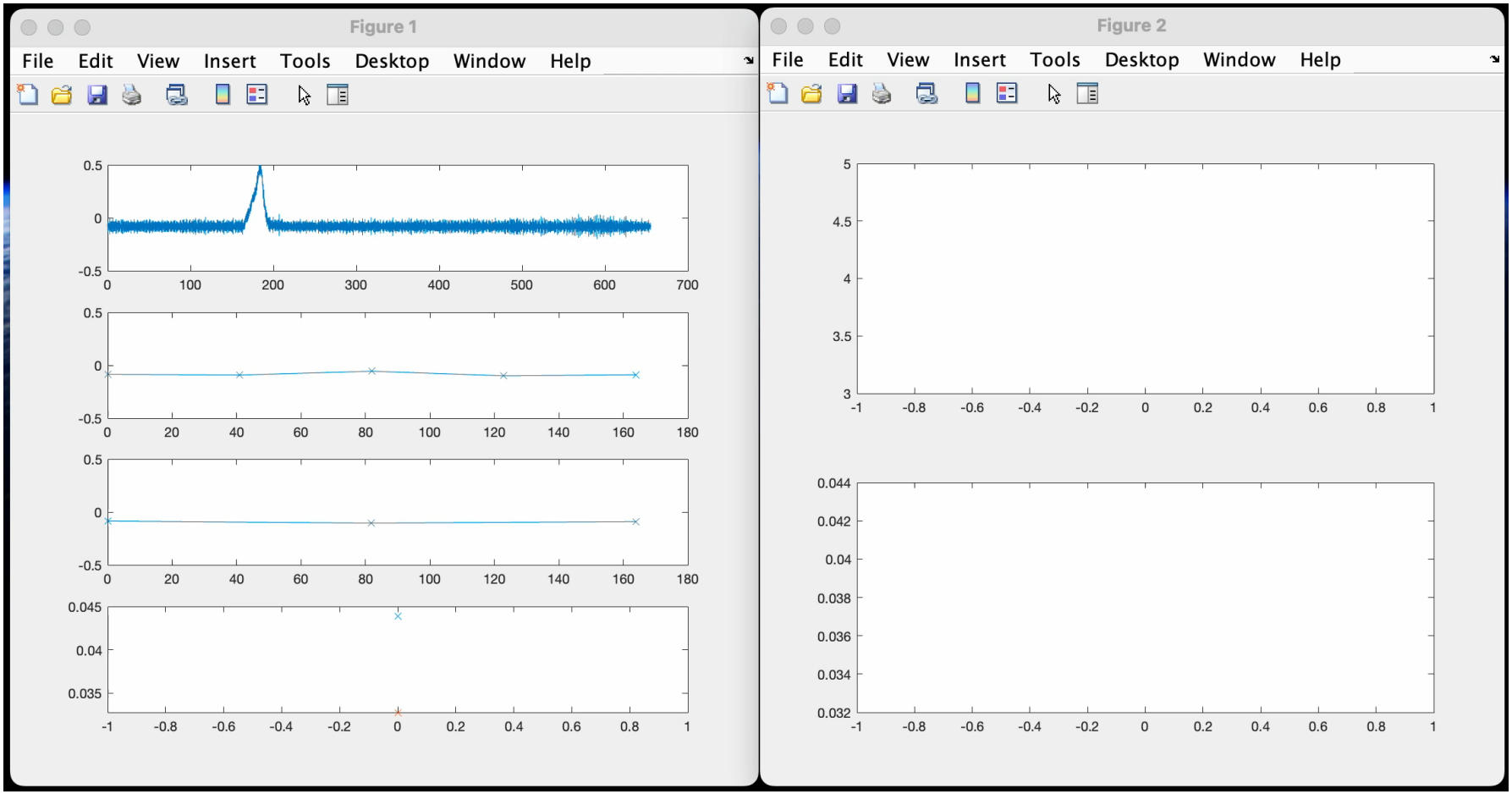
BOL1



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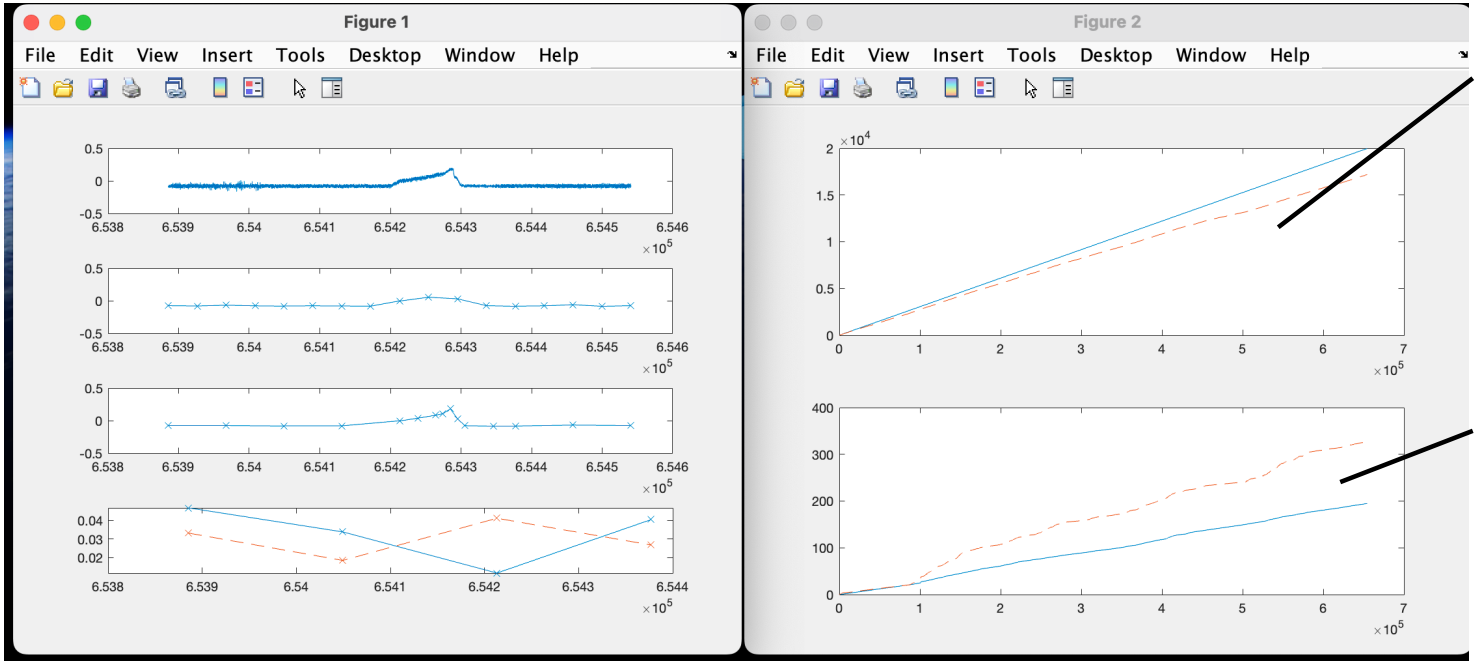
BOL1 final numbers

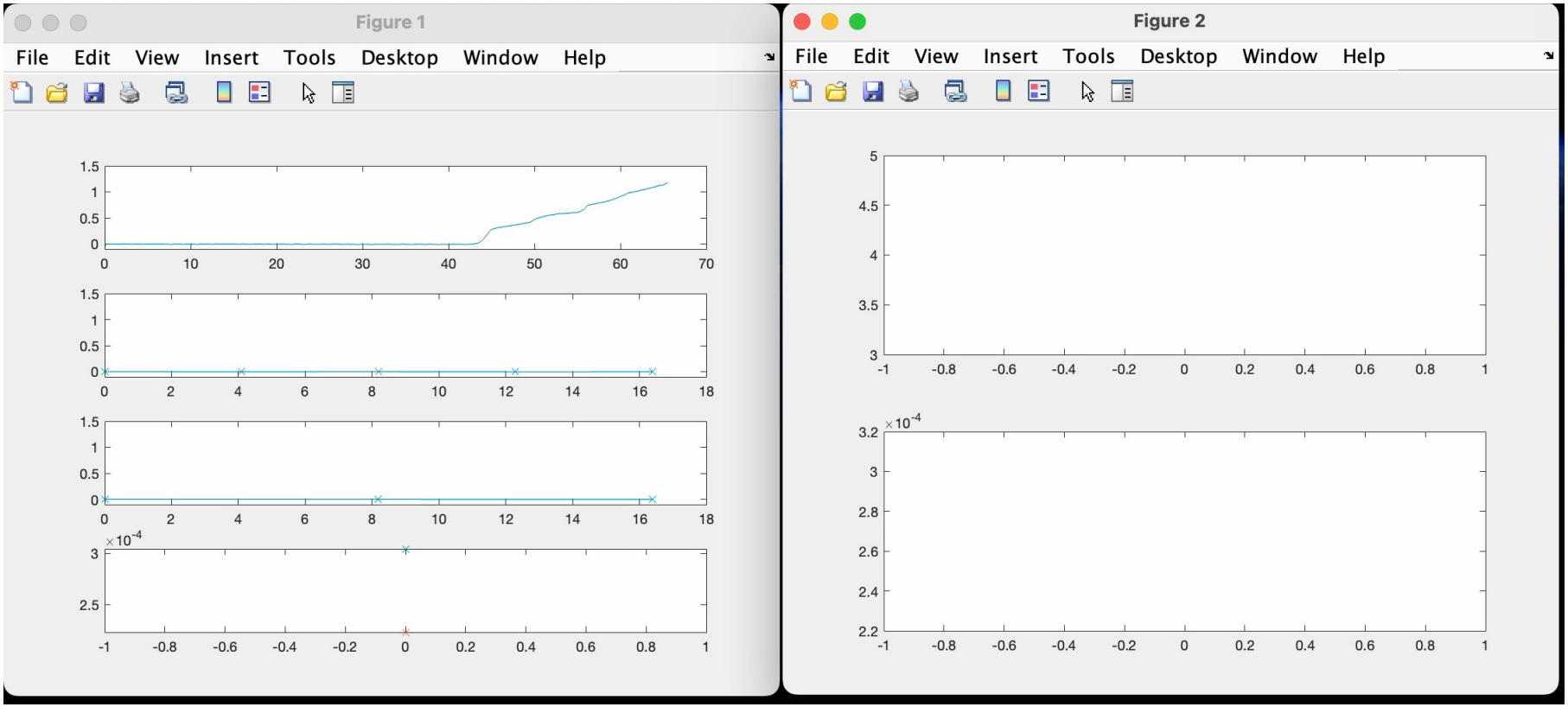


Number of values
- 1-of-n: 19975
- Smart: 17190

Accum. xcorr:
- 1-of-n: 194,63
- Smart: 327,57

Avg. xcorr:
- 1-of-n: 0.0487
- Smart: 0.082

DENCM0



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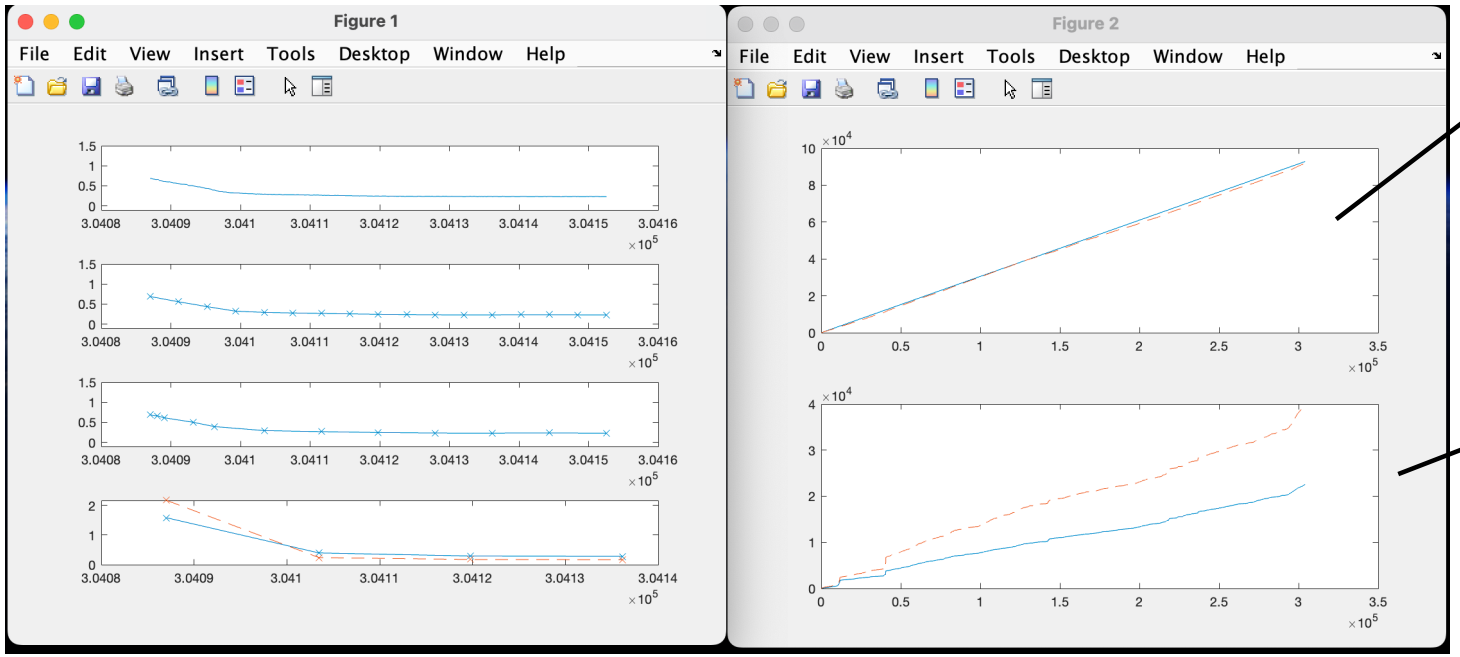
DENCM0 final numbers



Number of values
- 1-of-n: 92820
- Smart: 91817

Accum. xcorr
- 1-of-n: 2.95e4
- Smart: 3.97e4

Avg. xcorr:
- 1-of-n: 1.21
- Smart: 2.14

Comparison

Similarity(avg. xcorr)	1-of-n	Smart
BOL1	0.0487	0.082
DENCM0	1.21	2.14
ECE10	1.131	2.4797
RX105	0.72	3.23

Number of values	1-of-n	Smart
BOL1	19975	17190
DENCM0	92820	91817
ECE10	18670	17288
RX105	12450	12116

Conclusions

- Data decimation is key for massive data access approach
- New methods based on user-oriented concepts such as ”level of interest" can significantly improve the efficiency of user data handling
- A new smart decimation method for real time monitoring has been implemented and tested
- The test results show a clear improvement in the similarity of the monitored signal with respect to the original
- The new method very significantly reduces the loss of relevant information in signal monitoring

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Thank you

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