



Universitatea POLITEHNICA din București
FACULTATEA DE INGINERIE ELECTRICĂ
Departamentul de Măsurări, Aparate
Electrice și Converteoare Statice



Prelucrări digitale de semnal
(Prelucrarea numerică a semnalelor)

- Disciplina opțională -

Anul 4 – Semestrul 2

Titular curs – prof.dr.ing. Mihaela ALBU

Titular laborator – as.drd.ing. Radu Plămănescu



Date despre disciplina

Continuare disciplina "PS", Prelucrarea Semnalelor, anul 2 (semestrul 3)

Necesita cunostinte Matlab /R / Scilab / Octave

Axata pe proiect dezvoltat independent de echipe de studenti (2 studenti/echipa)

- Denumirea disciplinei = Prelucrari digitale [numerice] de semnal / *Prelucrarea numerica a semnalelor*
Digital Signal Processing [DSP]

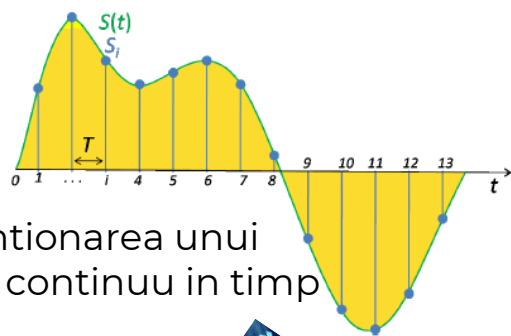
- Numar de ore de **curs** pe saptamana = 2
- Numar de ore de **laborator** pe saptamana = 1
- Numar credite: 3

- Titular activitati de curs = prof. dr. ing. Mihaela Albu
- Titular activitati de laborator = as. drd. Ing. Radu Plămănescu.

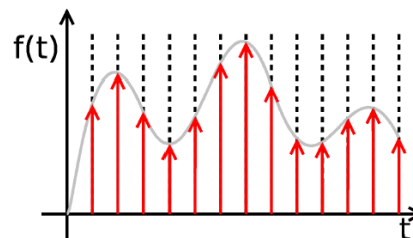
Cunoasterea prin discutii cu final deschis asupra aplicatiilor tehnicilor studiate in telecomunicatii, retele wireless, audio (MP3), multimedia, retele de senzori, masurari, aplicatii din domeniul militar...

Prelucrari digitale de semnal (Prelucrarea numerica a semnalelor)

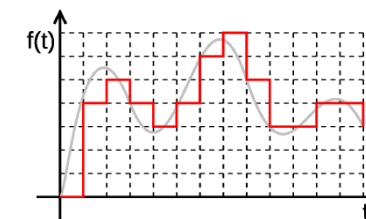
- Disciplina optionala (anul 4, sem 2)



Esantionarea unui semnal continuu in timp



Semnal discret (esantionat)
[rezolutie finita in timp]



Semnal digital
(nr. finit de biti)

Aplicatii in diverse domenii



Economie

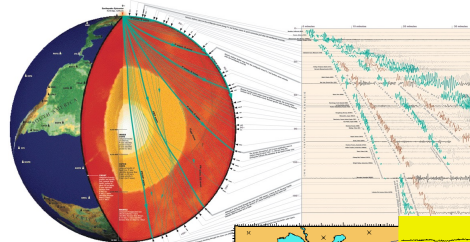


Meteorologie

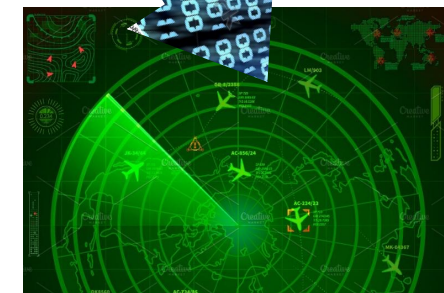
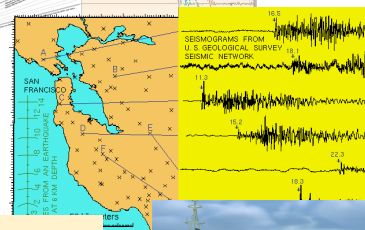


Medicina
Comunicatii
Predictii [politici]
...

Oceanografie

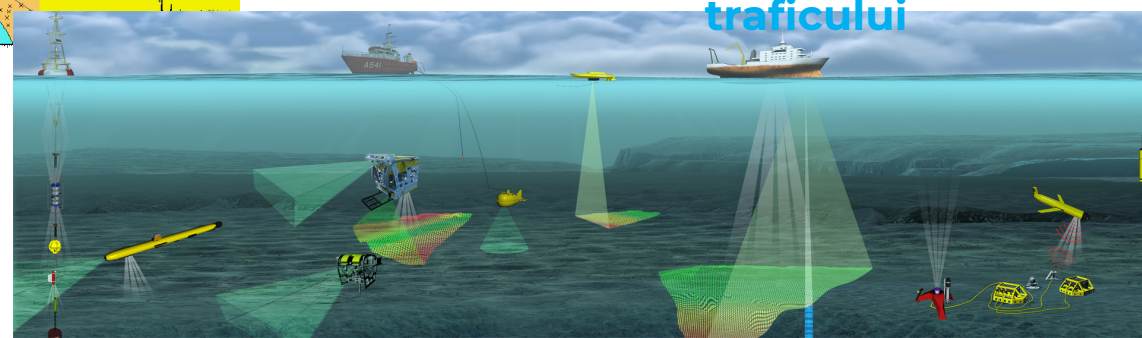


Seismologie



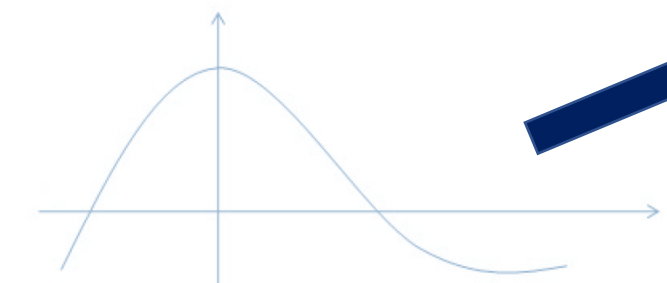
Sisteme de urmarire a traficului

Serii de timp

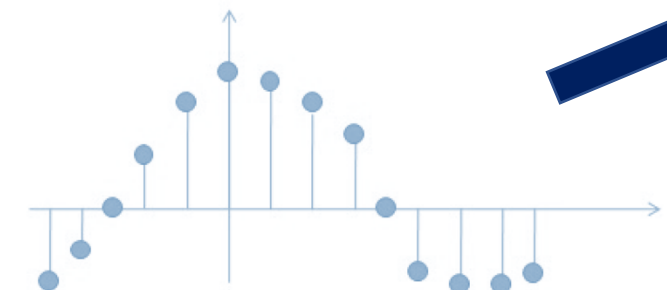


Prelucrari digitale de semnal (Prelucrarea numerica a semnalelor)

- Disciplina optionala (anul 4, sem 2)



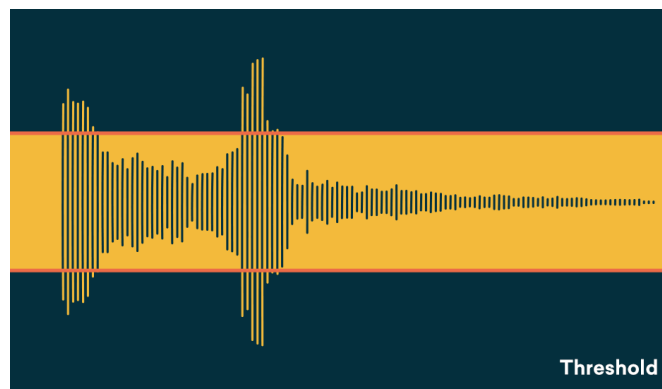
Semnal continuu in timp



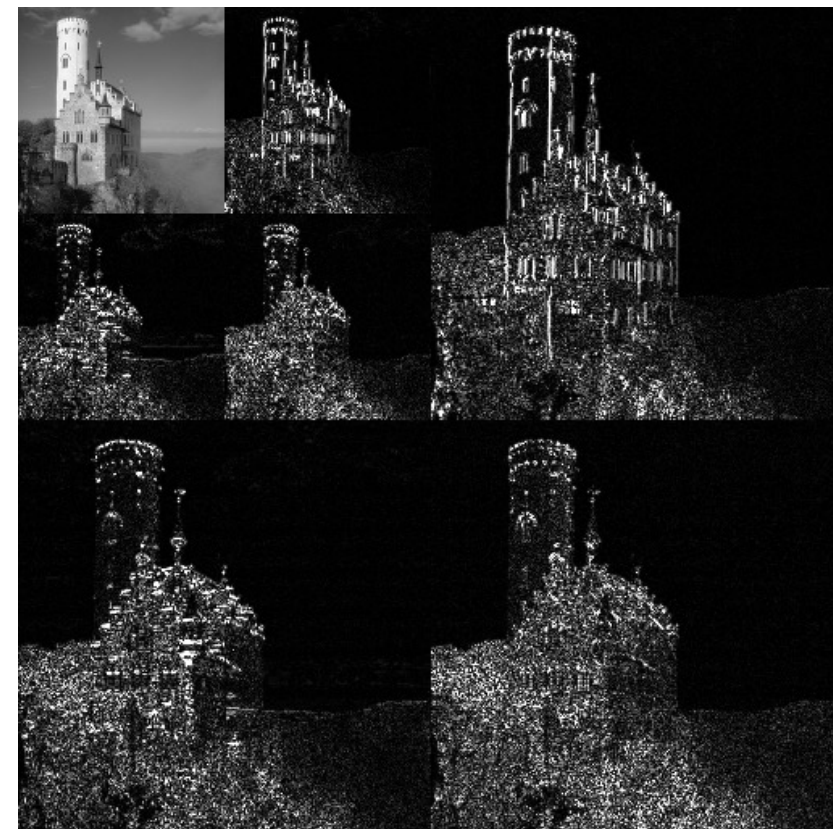
Semnal discret



Analiza si compresie video



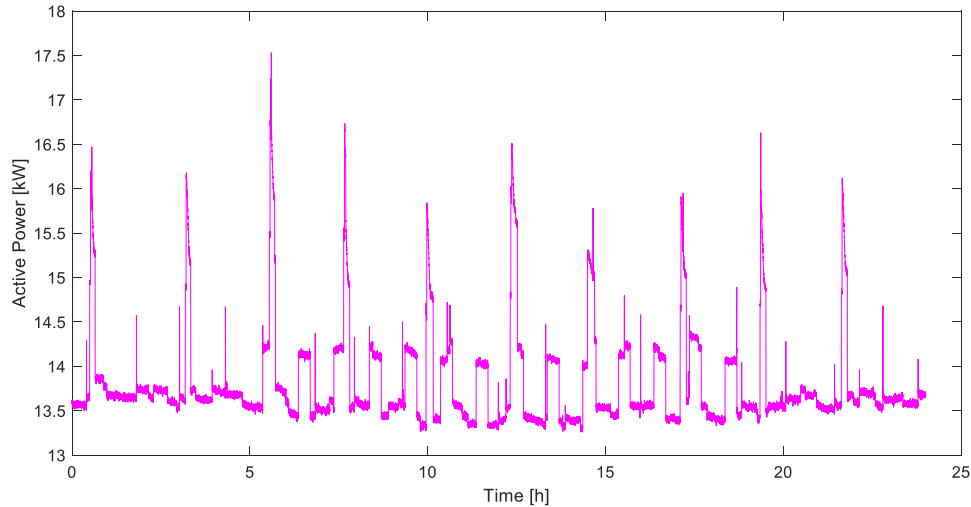
Prelucrare audio



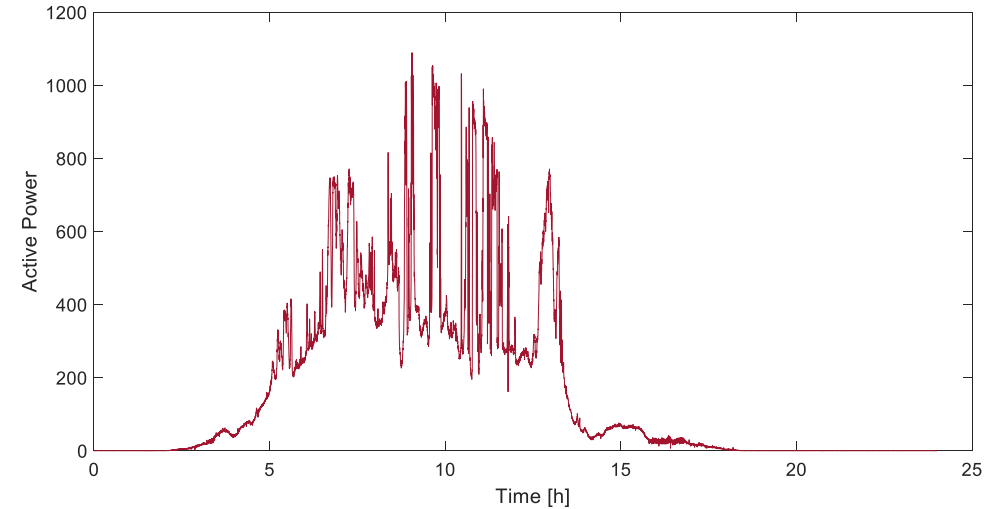
Exemplu DWT folosit la compresia JPEG2000

Axat pe prelucrari semnale unidimensionale (inginerie electrica)

24h – power profile for the heat-agent pumping station



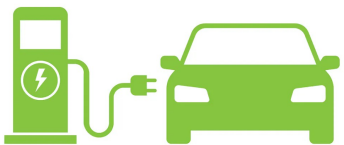
Local PV profile [historical] →



Forecast total PV generation



??? Storage ???



??? EV Charging station ???

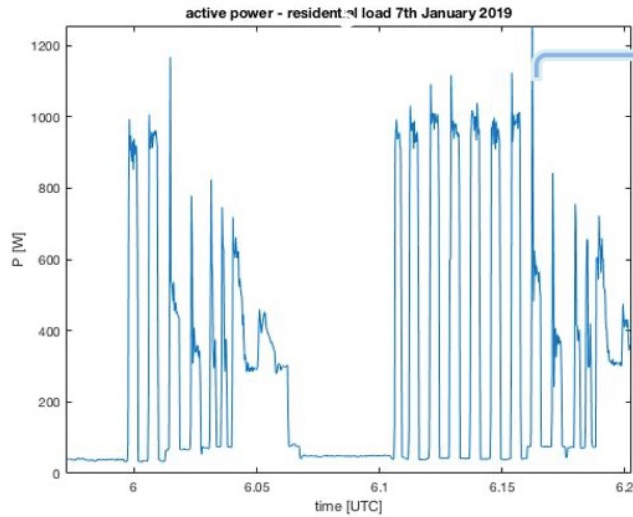
Estimation of load profiles
Planning storage capacity
Estimation PV profiles
Optimal design and investment

Prelucrari digitale de semnal (Prelucrarea numerica a semnalelor)

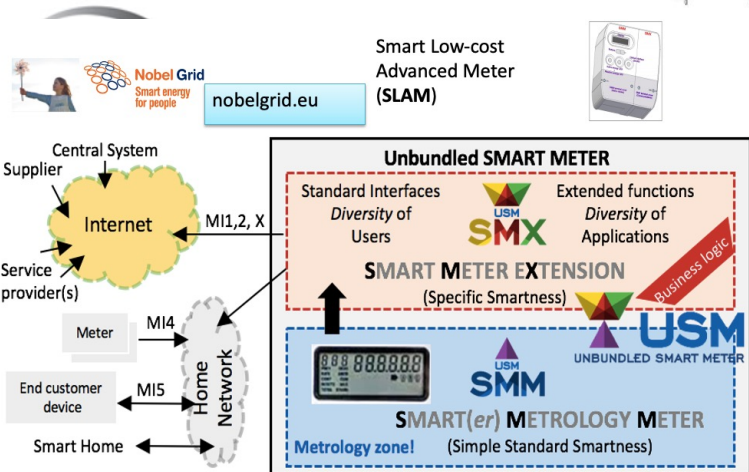
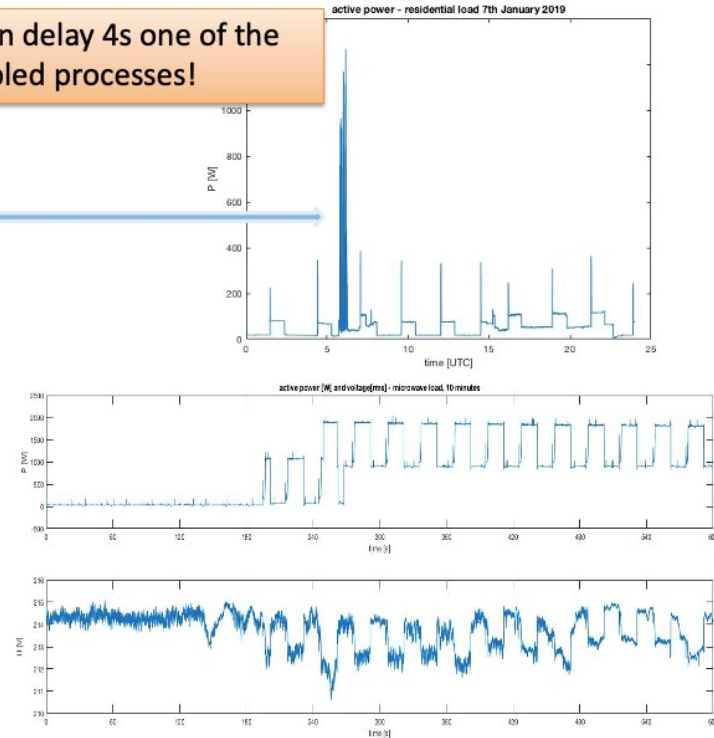
- Disciplina optionala (anul 4, sem 2)



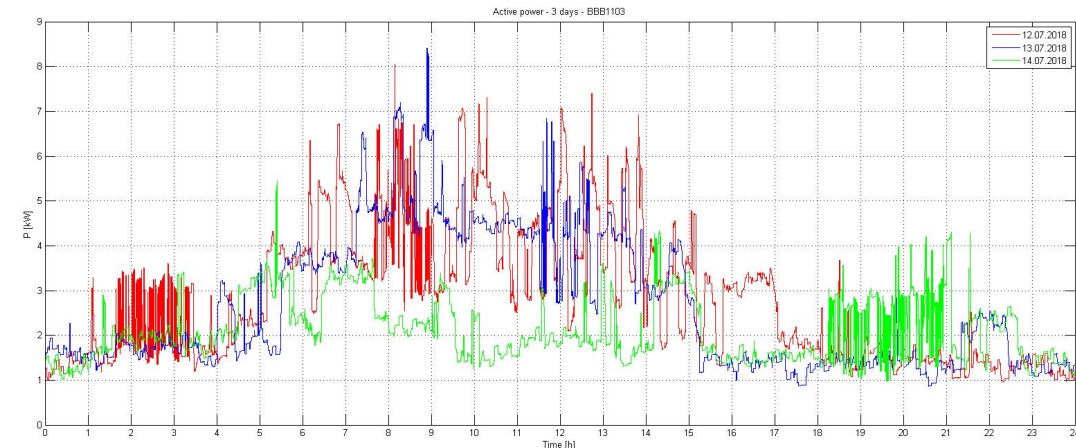
07. 01 2019, 0:00-24:00
UTC, active power @home



One can delay 4s one of the decoupled processes!



Smart Low-cost
Advanced Meter
(SLAM)



Prelucrari digitale de semnal (Prelucrarea numerica a semnalelor)

- Disciplina optionala (anul 4, sem 2)



... cum estimam comportarea in viitor a sistemelor electrice? (curbe de consum, curbe de generare) $\leftarrow \rightarrow$ V2G
... ce inseamna MonteCarlo simulations?

Toate informatiile sunt numerice! Dar realitatea (electrica) este analogica!

**Transformata
Fourier Discreta**

Semnal original (discret)

Laborator

**Analiza multirezolutie.
Filtre. Algoritmi de
compresie si criptare**

**Utilizare modul
SignalAnalyser [Matlab]**

**Serii de timp.
Procedee de
agregare**

**Transformata
Hilbert-Huang**

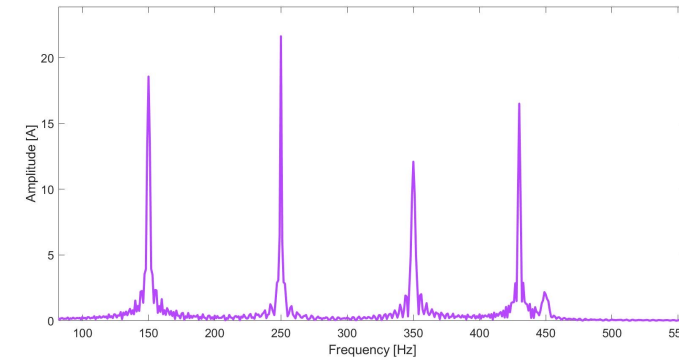
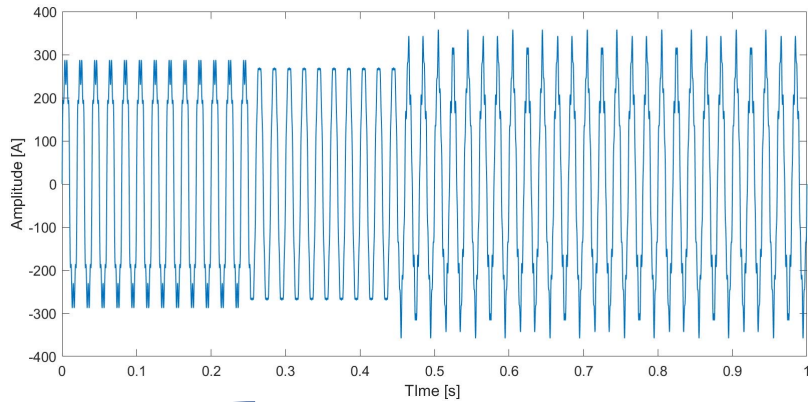
**Analiza in spatii wavelet.
Aplicatii in detectia
regimurilor tranzitorii**

**Autocorelatia semnalelor aleatoare.
Estimare spectrala (periodograma;
modelul AR, modelul ARMA).**

**Analiza spectrala a
semnalelor aleatoare**

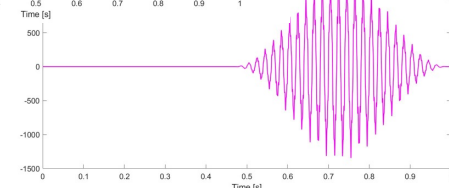
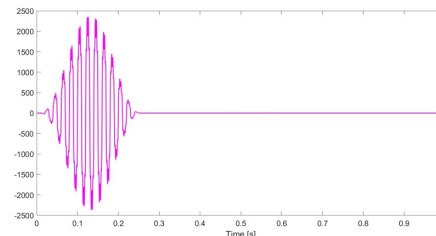
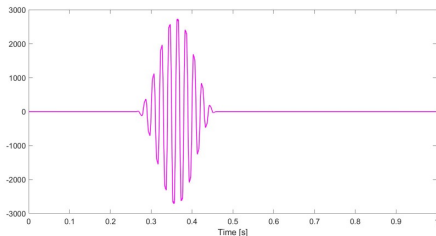
Prelucrari digitale de semnal (Prelucrarea numerica a semnalelor)

- Disciplina optionala (anul 4, sem 2)

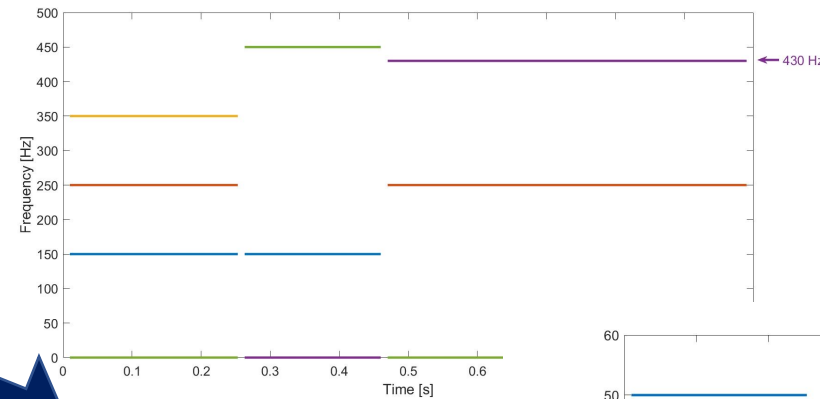


Transformata
Fourier
Discreta

Semnal original (discret)

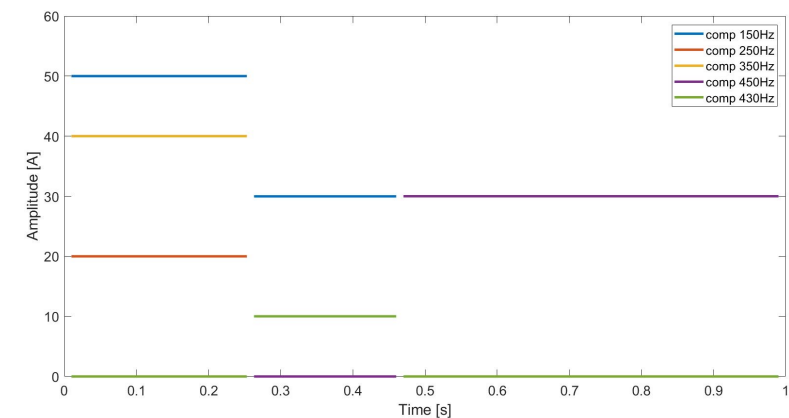


Ferestre



Standarde!
Sample values
PQ [10-100 kHz]

Transformata
Hilbert-Huang



Prelucrari digitale de semnal (Prelucrarea numerica a semnalelor)

- Disciplina optionala (anul 4, sem 2)

Date numerice obtinute din analiza fenomenelor din sisteme electrice reale [Masurari!]

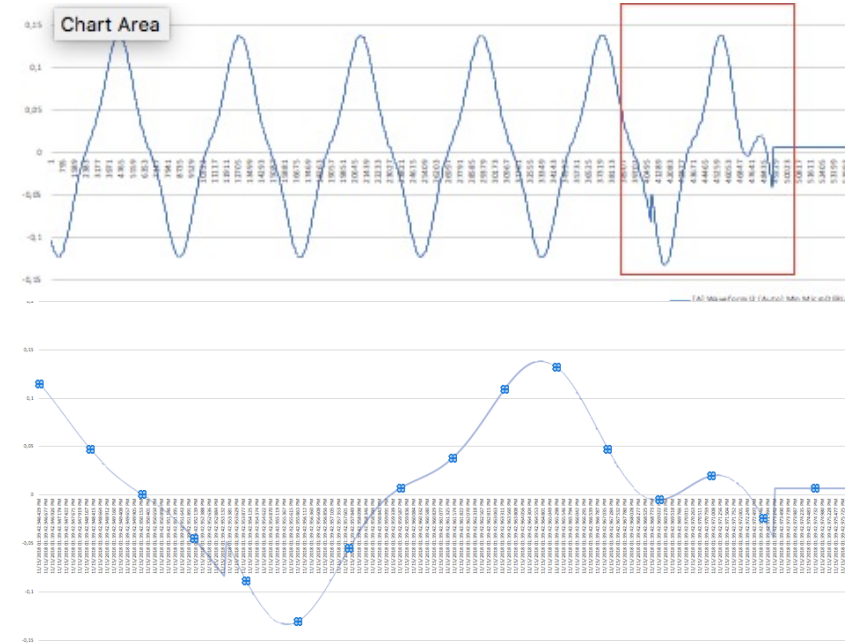


Prelucrari digitale de semnal (Prelucrarea numerica a semnalelor)

- Disciplina optionala (anul 4, sem 2)



Date and Time	[A] Waveform I2 (Auto) Min P
11/15/2018 01:39:42.853833 PM	-0,1038808
11/15/2018 01:39:42.853835 PM	-0,103954
11/15/2018 01:39:42.853837 PM	-0,1040272
11/15/2018 01:39:42.853840 PM	-0,1041004
11/15/2018 01:39:42.853842 PM	-0,1041736
11/15/2018 01:39:42.853845 PM	-0,1042468
11/15/2018 01:39:42.853847 PM	-0,1043201
11/15/2018 01:39:42.853850 PM	-0,1043933
11/15/2018 01:39:42.853852 PM	-0,1044665
11/15/2018 01:39:42.853854 PM	-0,1045397
11/15/2018 01:39:42.853857 PM	-0,1046129
11/15/2018 01:39:42.853859 PM	-0,1046861
11/15/2018 01:39:42.853862 PM	-0,1047594
11/15/2018 01:39:42.853864 PM	-0,1048326
11/15/2018 01:39:42.853867 PM	-0,1049058
11/15/2018 01:39:42.853869 PM	-0,104979
11/15/2018 01:39:42.853871 PM	-0,1050522
11/15/2018 01:39:42.853874 PM	-0,1051254
11/15/2018 01:39:42.853876 PM	-0,1051986

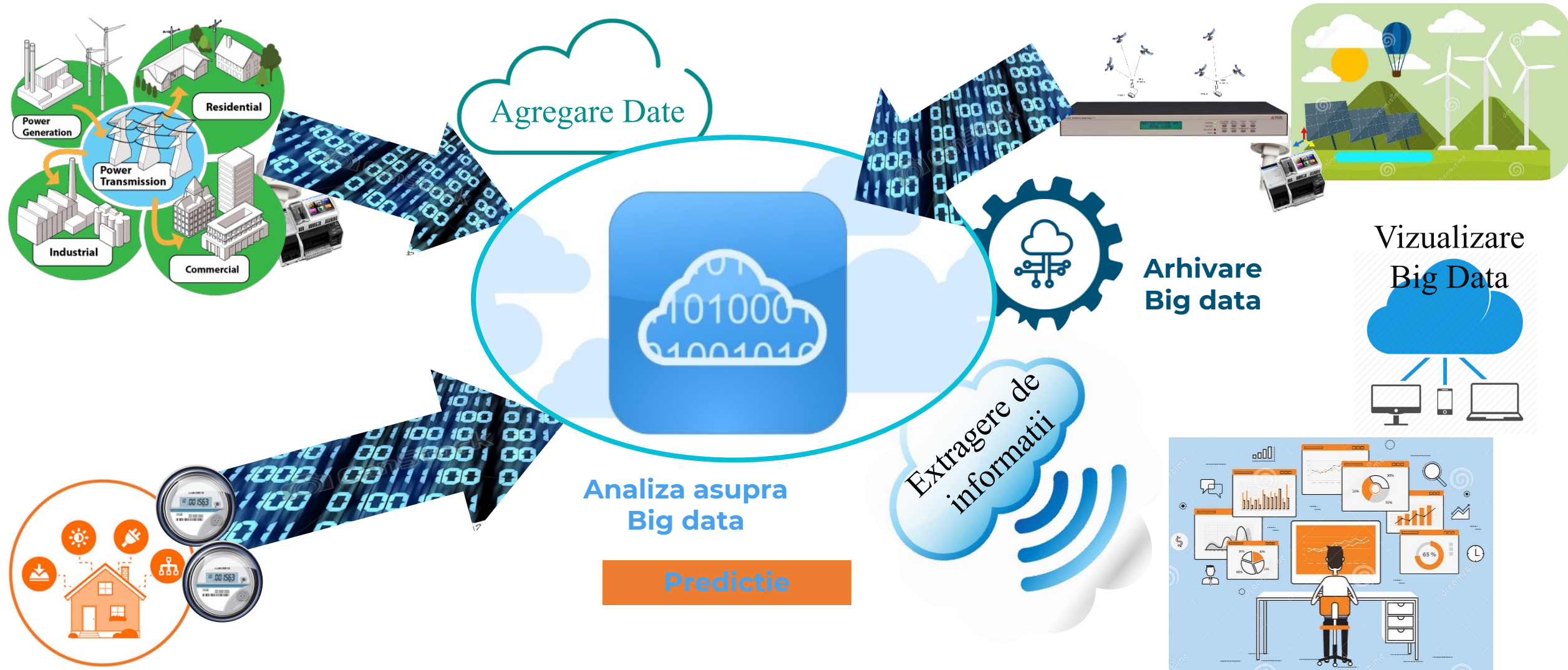


rms:
1 min,
1 canal,
1 masurand: **40 kB**

Tehnici de compresie a datelor / a informatiilor

waveform, sampling 150 kHz
1 min,
1 canal,
1 masurand: **120 MB**

Aplicatii in Inginerie Electrica





MULTI-SCALE DATA ANALYTICS FOR POWER PROFILES

Development of **data driven models** that operate in a robust manner at various timescales

Incorporate domain knowledge at pre-processing and feature engineering stages

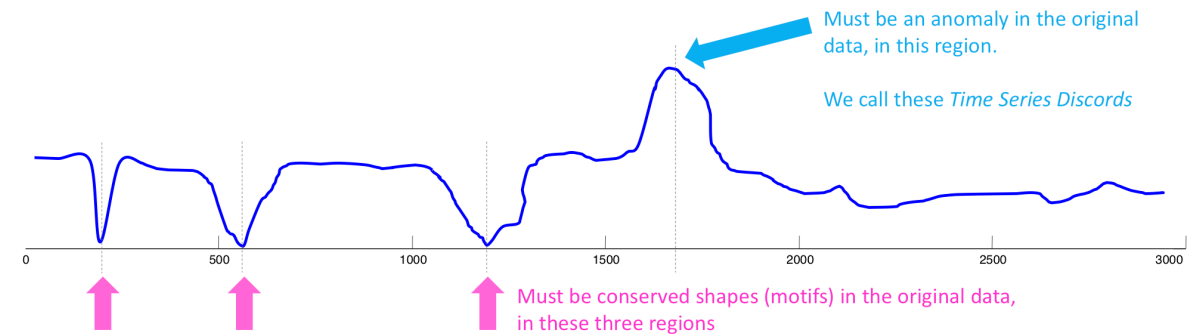
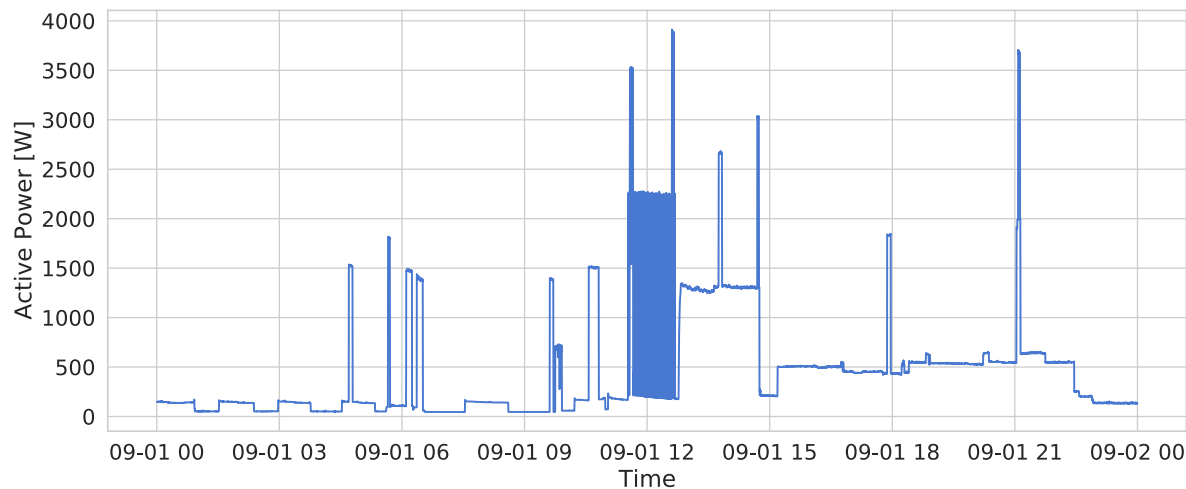
Potential for model compression to run on embedded hardware with resource constraints

Micro-load forecasting and classification e.g. steady state and transients labelling

How do data-driven models perform under varying input reporting rates? Can we keep the same models w/o retraining?

One month of residential energy measurements sampled at 1s; Offline processing of daily text record files

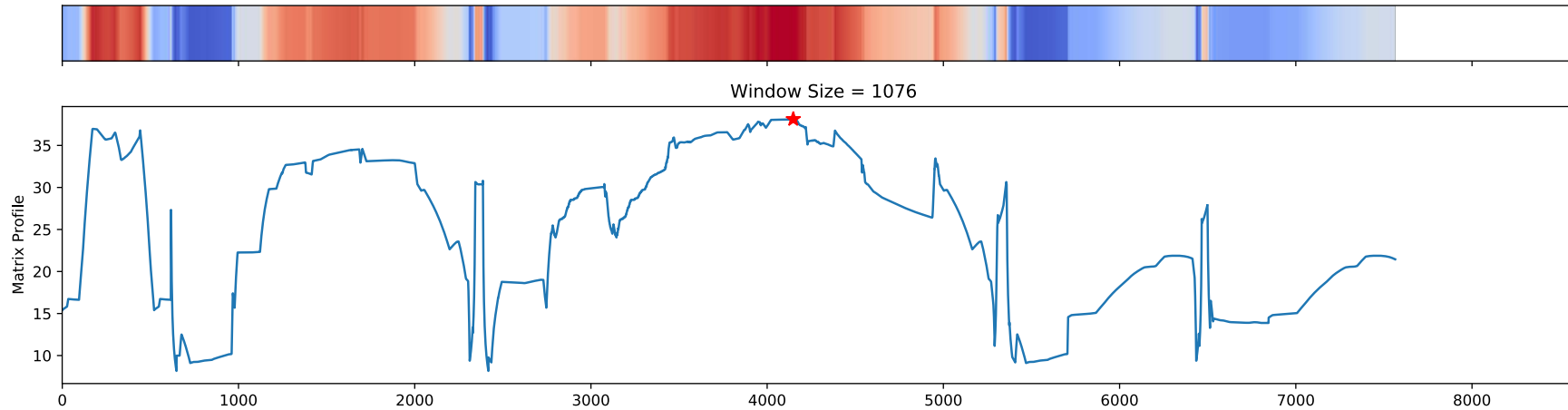
Grigore Stamatescu, et al.,
Reporting Interval Impact on Deep Residential Energy Measurement Prediction,
Proc. of AMPS2021, 2021





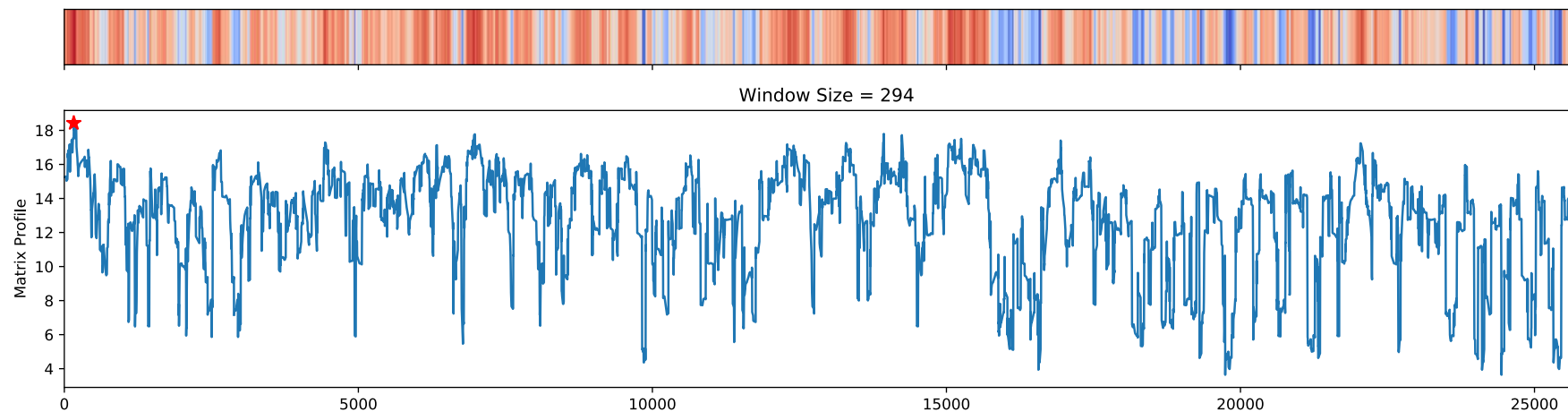
MULTI-SCALE DATA ANALYTICS FOR POWER PROFILES

Matrix Profile to identify most dissimilar sequence in **the daily data (noon)**



Matrix Profile (efficient data mining method) for feature extraction and anomaly detection over large series.

Matrix Profile to identify most dissimilar sequence in **the monthly data (Sept. 1st)**



Grigore Stamatescu, et al., *Reporting Interval Impact on Deep Residential Energy Measurement Prediction*, Proc. of AMPS2021, 2021

- H2020 Flexmeter, 2015-2017
 - H2020 RESERVE, 2016-2019
- H2020 Storage4Grid, 2016-2020
 - H2020 NobelGrid, 2016-2018
- REDESIGN (ERASMUS+), 2016-2019
 - FISMEP (ERA Net Smart Grids Plus), 2017-2020
- ITCity (ERA Net LAC 2016), 2017-2019

- DCNextEve, 2016-2018

- EMERGE, 2021-2023

- I-GRETA Intelligent FIWARE-based Generic Energy Storage Services for Environmentally Responsible Communities and Cities, 2020-2023



Q&A session:

**Ing. Radu Plamanescu
Prof. Mihaela Albu**



www.microderlab.pub.ro

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