Elnätens digitalisering

Maskininlärning, elkvalitet och smarta elnät

ENERYIELD

17 juni 2021

Agenda

1. About Eneryield
2. Project overview and problem outline
3. Outline of work and results
4. Challenges, insights and future work

Eneryield is a startup founded in 2019, based on several years of research within ML/DL applied in power systems

2013 - today

Research: Deep Learning based Prediction, LSTM Deep Learning for Classification of PQ Disturbances, Classification of PD using Machine Learning, Deep learning for Earth Fault Classification and Source Localization

CHALMERS UNIVERSITY OF TECHNOLOGY

MIDDLE EAST TECHNICAL UNIVERSITY

GAZİ ÜNİVERSİTESİ 1926

2018

Innovation project

CHALMERS SCHOOL OF ENTREPRENEURSHIP

2019

Company founded

ENERYIELD

The team possess complimentary knowledge in ML/DL, power systems and business development

Business development

Johan Rådemar

M.Sc Entrepreneurship and Business design

Chalmers University of Technology

Technical development

Karl Bäckström

Ph.D.c Computer Science

Chalmers University of Technology

Ebrahim Balouji

Ph.D Electrical Engineering

Chalmers University of Technology

Matilda Wikström

M.Sc Complex Adaptive Systems

Chalmers University of Technology

Mariam Helmy

M.Sc Physics of Data

University of Padova

Advisory Board

Jonas Bergqvist

RISE

Expert in SaaS products

Özgul Salor

Gazi University

Professor Electrical engineering

David Storek

Ph.D Physics

Business coach at Chalmers Ventures

Project overview and problem outline

Project participants

Project owner

ENERYIELD

Partners and reference group

Göteborg Energi

Skellefteå Kraft

Jämtkraft

ABB

Tekniska verken

e·on

VATTENFALL

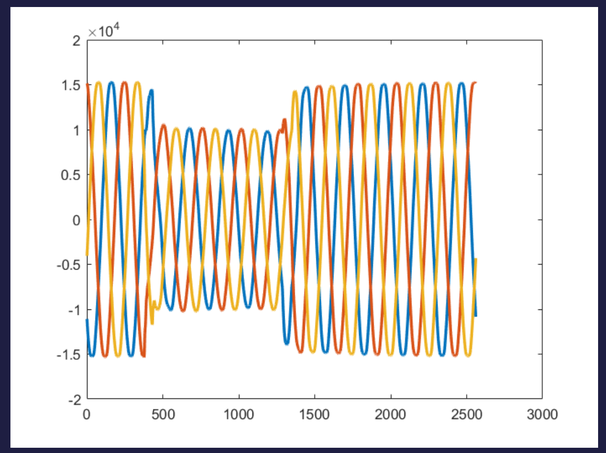
HÄRRYDA ENERGI

UNIPOWER

PQ meters
Event snapshots, RMS values
Comtrade, PQDIF

The project targets challenges with power quality disturbances

Event X



What was the event type?

What was the underlying reason?

Where did it occur?

Minimize manual time consuming fault identification

Provide deeper insights of grids health

The goal of the project

Develop a proof of concept for more in depth analysis of PQ disturbances

- **Accurate and reliable classification of PQ disturbances**
- **Suggest plausible underlying reason of the disturbance**

Present the results in a PQ report

Outline of work and results

Overview work process and detailed level of analysis

High level classification

Sag / Swell / Transient / Earth fault / Interruption

Fine-grained PQ event classification / Root cause analysis

Event is linked to underlying error e.g. phase to ground or motor induction

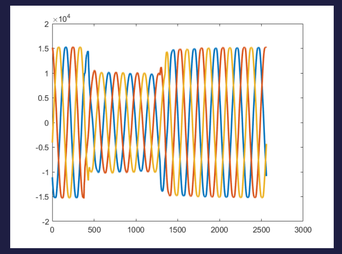
+

Automatic identification of direction

Eg. Determine the direction of events using waveforms & ML

Method - High level classification of PQ Events

PQ-Event X



First level ML-classification

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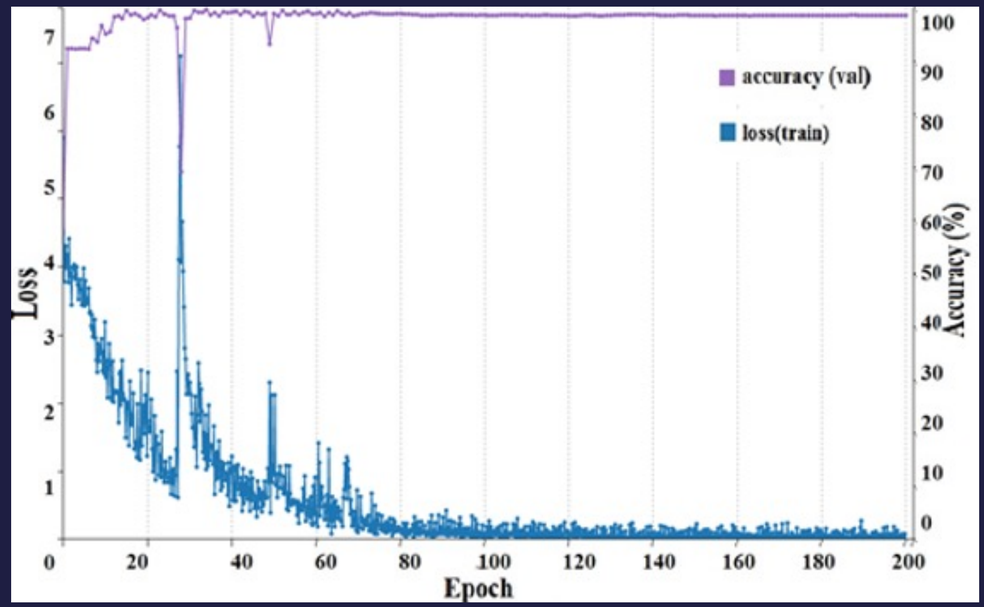
FALSE
Transient

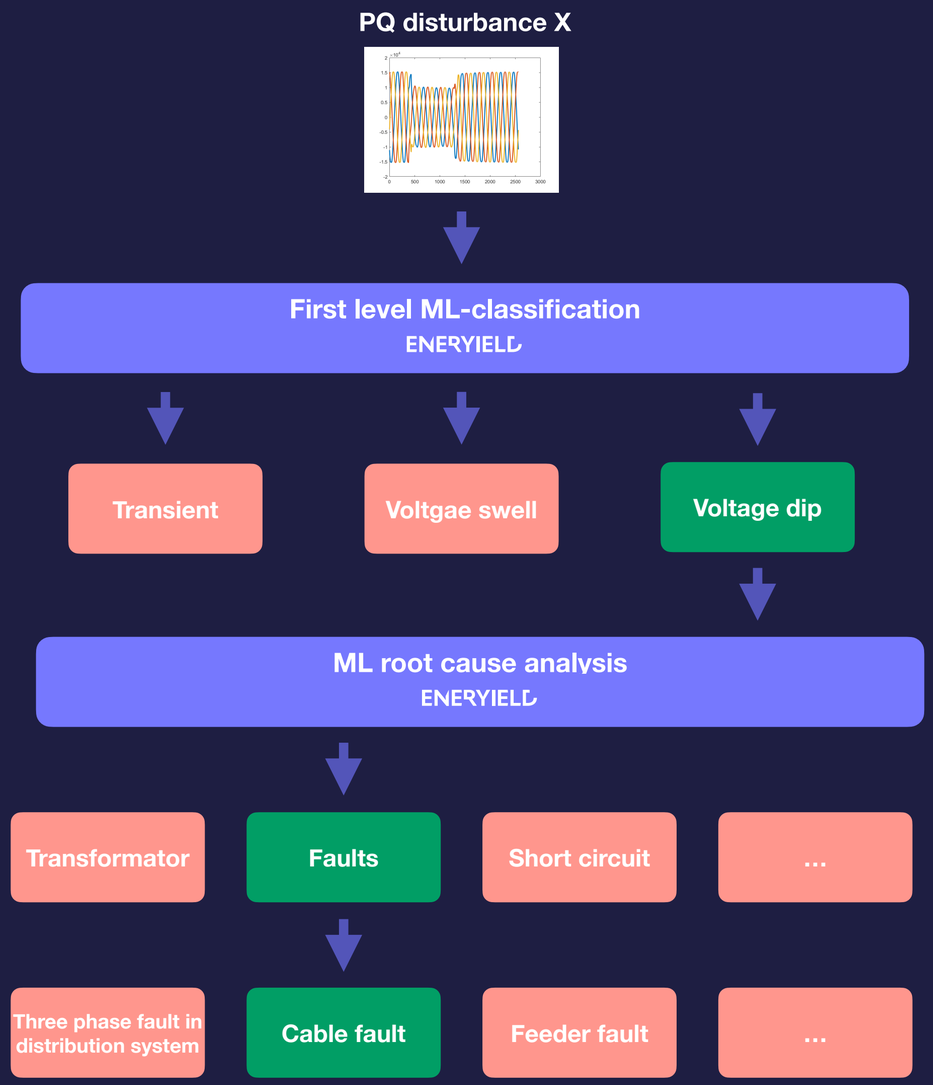
TRUE
Voltage dip

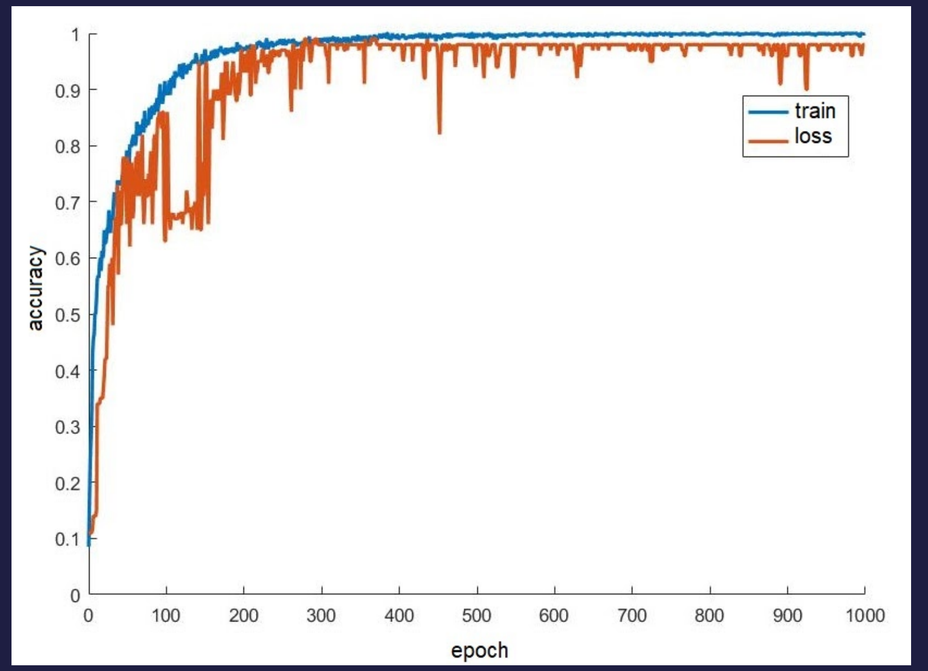
FALSE
...



The system quickly reaches high accuracy of 99% on the test data, and low error, with stable convergence.

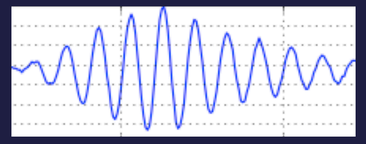
Method - Root cause analysis of voltage dips





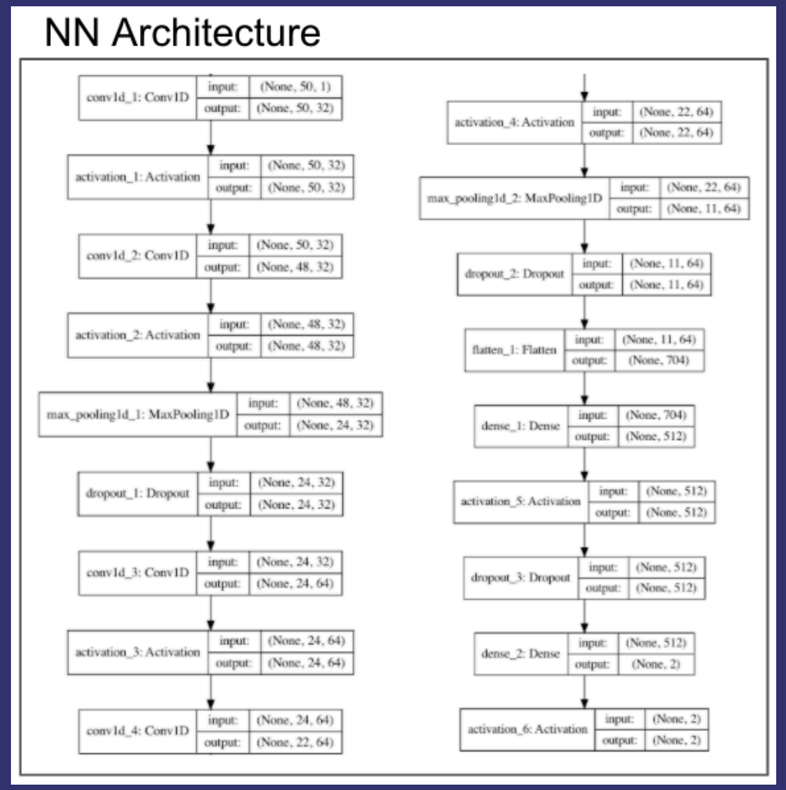
System reaches 95% accuracy on the test data.

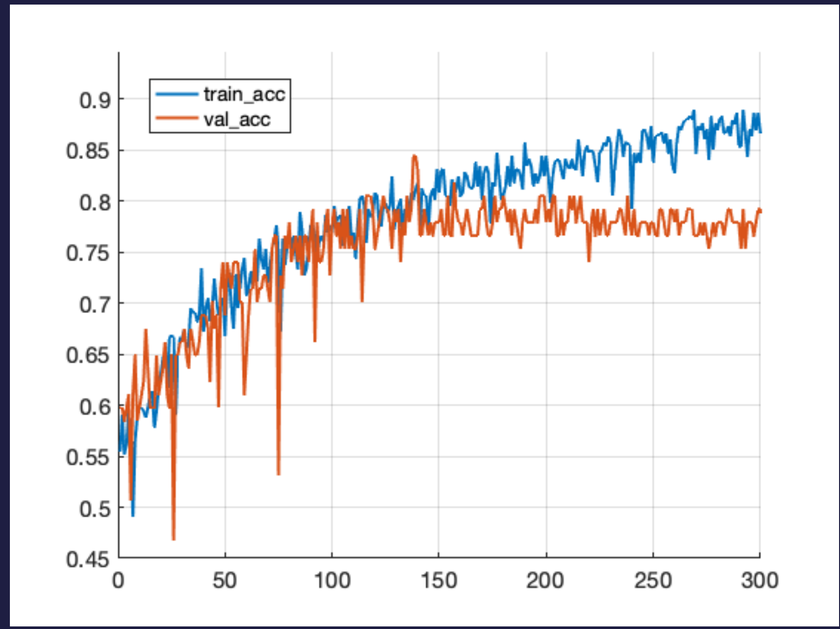
Method - Direction Identification



NN

Up/down stream





Stable training execution. Test performs ~85% at best, but stagnates at ~80%

Machine learning based power quality analytics

Classification, root-cause and direction identification of power quality events

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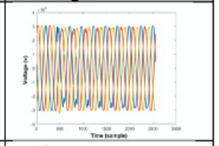
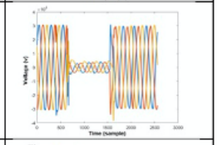
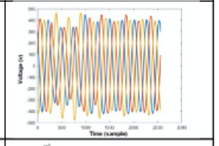
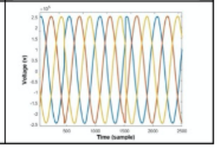
Voltage dips

Date & time	Root-cause	Direction	Event figure
2020-01-05 18:45	Transformer energization	Upstream	
2020-01-07 16:14	Three phase fault in distribution system. Followed by transformer saturation	Upstream	
2020-01-13 01:11	Autoreclosure in distribution feeder	Upstream	
2020-01-24 07:23	Transformer saturation	Downstream	

Challenges, insights and future work

Challenges and insights - Data export

Data aggregation is a bottleneck and it is important to bridge this challenge for large-scale implementation of future data-driven solutions.

Today

1. Copy the entire database (SQL file)
2. Manually export PQ events from PQ software (Excel files)
3. Dedicated export module (Comtrade files)

Future

1. Standardised database with structures for describing meta-information (i.e. frequency, pre-trig time…)
2. Import and export modules that ensure standards are maintained and that the desired recording intervals or batches of data are easily and efficiently exported.

Challenges and insights - Analysis on the edge

1. Digitised power systems will need continuous improvements of higher sampling frequencies

2. Sufficient technology for measurement and communication do exist

3. Combining Machine Learning on the edge and centrally will optimise tomorrows data driven methods

Future work

Developing the root cause analysis further

- Expand with more data, including more type of root causes
- Incorporate in existing software or create API
- Investigate how data can be more efficiently exported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