AI and ML – Enablers for Beyond 5G Networks
A view from the 5G PPP

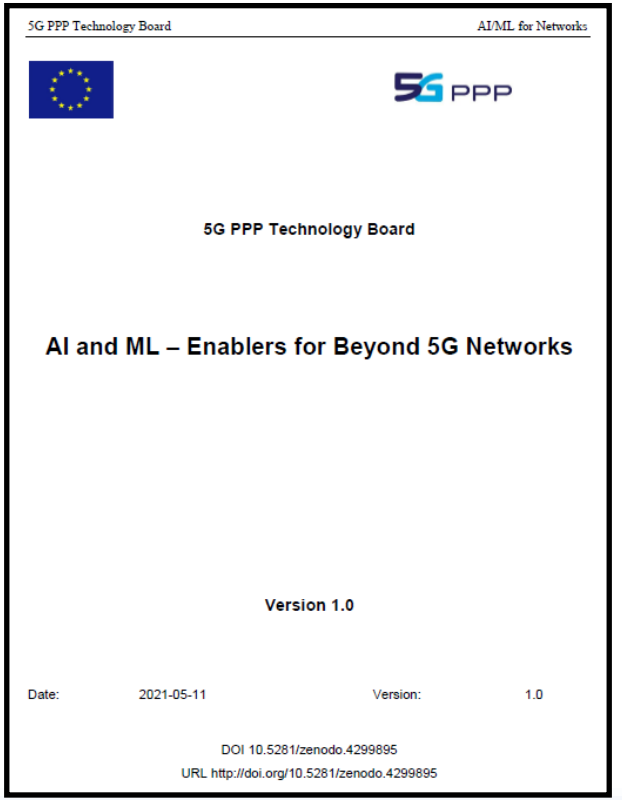
Anastasius Gavras, Eurescom GmbH

Co-editors: Daniel Camps Mur, Mir Ghoraishi, Halid Hrasnica

A white paper

- https://5g-ppp.eu/white-papers/

- Available shortly with a DOI
  - DOI 10.5281/zenodo.4299895
  - URL http://doi.org/10.5281/zenodo.4299895



Motivation

- AI and ML have a long trace in research and development (>50 years)
- Not new in telecoms either
  - Applied in selected areas of telecoms since many years (call centres …)
- Recent advances in tools and skills triggered wide adoption in many application areas
- Many challenges ahead for AI/ML in telecoms
  - Real-time
  - Availability of training data
  - Interoperability
  - Trust

Overview of AI/ML methods

- Neural Networks
  - Feed-forward neural networks
  - Deep neural networks
  - Recurrent neural networks
  - Convolutional neural networks
- Reinforcement Learning
  - Basics/overview
  - Deep Reinforcement Learning
- Hybrid Solutions
  - Combined analytical and Machine Learning modelling
  - Expert knowledge aided Machine Learning
- Further Specific Methods
  - Generative adversarial networks
  - AI enabled network tomography
  - Federated Learning
  - Unsupervised learning

Use case categories

	AI/ML domain		
Network Domain	**Planning**	**Forecast & Diagnostics**	**Optimization and Control**
Radio Access Network			
Non real time	ARIADNE, 5G Complete	ARIADNE, 5GZORRO	5GCLARITY, 5G HEART
Near real-time			5GCLARITY, AFFORDABLE5G
Real-time			LOCUS, ARIADNE
Transport Network			
Fronthaul			5G Complete
Programmable Switches			5GROWTH, 5G Complete
Path computation, Traffic matrix			5GROWTH, TERAWAY
NFV infrastructure			
Dynamic Resource Allocation			5GCLARITY, 5G-VINNI
MEC & NFV			5GZORRO
E2E slicing			
Service assurance, slice config.			5G-VINNI, 5GSOLUTIONS
Admission control & resource allocation			5GSOLUTIONS, MonB5G, 5GZORRO, 5Genesis
Security		5GZORRO	INSPIRE-5Gplus
Application and vertical domain		5GROWTH, 5G-VINNI, 5GCLARITY	5GZORRO, 5GROWTH
Positioning		LOCUS, 5GSOLUTIONS, 5GCLARITY	

Network planning, forecasts and diagnostics

- Network element placement
- Dimensioning C-RAN clusters
- Forecasting traffic characteristics and events
- Forecasting user locations
- Forecasting security incidents

Network Optimization and Control

- Radio
  - RAN slicing, radio resource provisioning, MAC scheduling, traffic steering, channel modelling, channel estimation for RIS optimisation, demand-driven power allocation…
- Transport & NFV
  - Path computation, traffic management, flow scheduling in programmable transport networks, dynamic load balancing, federated learning across MEC & NFV orchestrators, dynamic resource allocation…
- Slicing, Security and Applications
  - E2E service assurance, admission control and resource allocation in E2E slicing, demand prediction, slice isolation, moving target defence, self-protection against DDoS attacks

Architectural aspects

- Management of ML models
  - Model lifecycle management
- Standardization aspects
  - 3GPP network data analytics function (NWDAF)
  - ETSI ENI architecture and use case categories
  - O-RAN ML control loops
- Trust in AI/ML based networks
  - Privacy concerns
  - Trustworthy AI/ML
  - Zero trust management

Summary and recommendations

- AI/ML in telecom has great potential and for enhancing future Return on Investment the following areas need attention:
  - building standardized interfaces to access relevant and actionable data,
  - exploring ways of using AI to optimize customer experience,
  - running early trials with new customer segments to identify AI opportunities,
  - examining use of AI and automation for network operations, including planning and optimization,
  - ensuring early adoption of new solutions for AI and automation to facilitate introduction of new use cases,
  - establish/launch an open repository for network data sets that can be used for training and benchmarking algorithms by all

Questions?