Virtual XCU Calibration with Neural Networks
NARX/Sequential Neural Networks for Dynamical Systems
# Agenda

1. Classical ECU Functions
2. Deep Dynamical Systems
3. Deploying AI As Virtual Testbench
Classical ECU Functions
What is an ECU Function?

› Mapping Input Signals to Output signals

- Pedal value
- Engine speed
- Temperature
- Fuel Mass
Classical ECU Functions
Advantages/Disadvantages

**Advantages**
- Physically motivated
- High understanding of what's going on (intermediate signals have typically physical units)
- Enabling “transfer learning” for single HW change

**Disadvantage**
- Require development (modelling + coding)
- Require methodology development for calibration = training
- Require tooling for the training (backpropagation)
- Require very special measurements from engine test bench
Deep Dynamical Systems
Network overview

› No LSTM (Long Short-Term Model)
› NARX (Nonlinear autoregressive neural network)
Deep Dynamical Systems
Temperature example 40min of driving (validation)
Deep Dynamical Systems
Training at AWS

AWS Cloud

API Gateway

Trigger
Sagemaker

Measurement
file

Hyperparameter
Training
Sagemaker

Trained Model

Amazon ECR
NARX Training

Engineer

MATLAB

Codebuild
Deep Dynamical Systems
Applications

1. Deploy to ECU
2. Virtual Testbench
3. Calibrate Controller for Dynamical System
4. Reinforcement Learning
Deploying Artificial Intelligence As Virtual Testbench
Matlab/Simulink Workflow

- Measurement
- Train Neural Network
- Gensim
- Simulink Embedded Coder
  - Compile with ASAP Interface and external mode
  - A2L
- Model.exe
- XCP over TCP/IP
- Engineer

Electrification & Data Analytics
Internal

11.04.19
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Deploying Artificial Intelligence As Virtual Testbench
Measure Neural Network with INCA

Test Bench

measure

A2L

Neuronal Network

Virtual A2L

XCP over TCP/IP
Q & A