

# AlfES® – The TinyML Software-Framework for Edge Devices

**Open Source Software-Framework**  
**»AI for Embedded Systems« (AlfES®)**

AlfES is a standalone, open source, high-efficiency AI framework completely programmed in language C, which allows training and running artificial neural networks (ANN) even on the smallest microcontrollers.

## Benefits

- Inference and training on the device
- Load and reconfigure ANNs at runtime
- Approx. 50% less flash memory than TensorFlow for microcontrollers
- Does not require Python
- Does not require additional software
- Completely stand alone
- Runs on almost any hardware
- Import trained models from PyTorch® and TensorFlow®
- Open Source (GNU AGPL)
- Can be used in all C/C++ IDEs
- Arm® CMSIS support
- Arduino® library with many examples

## Functions until now

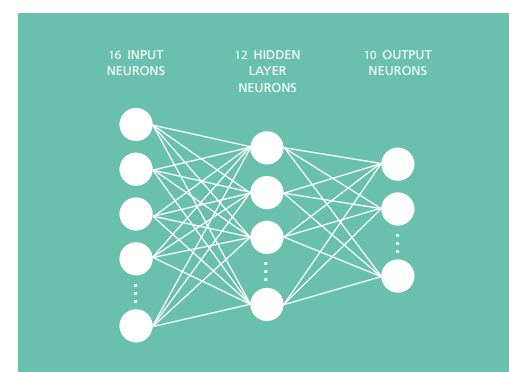
- Feedforward neural network inference
  - F32, Q31 and Q7 support
  - Freely configurable
  - Q7 weight quantization
  - Many activation functions
- Feedforward neural network Training
  - Full SGD and ADAM algorithm
  - Online, Batch, Minibatch
  - Various loss functions
- CNN support follows soon
  - Inference and Training



## TinyML as a Solution for Resource-limited Systems

Decentralized, highly integrated AI at the point of data generation (Sensor, component, product, device) has the following advantages:

- **Fast processing**
  - No transmission delays
- **Increased security**
  - Only preprocessed and protected data is transmitted
- **Increased reliability**
  - Decentralized architecture
- **Saving resources**
  - Reduced data volumes, reduced overall processor performance
- **Saving energy**
  - Small and resource-saving systems like microcontrollers
- **Personalizable AI**
  - Optimizes itself autonomously to the application or user



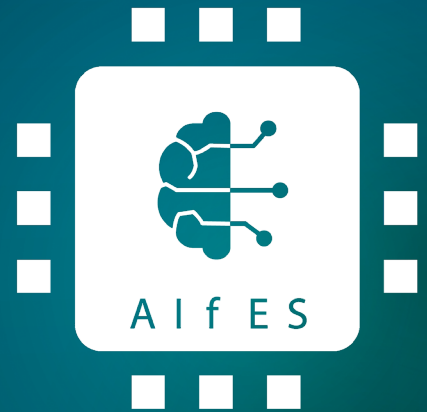
*Example ANN*

# From the Idea to the Product

We support you from the first brainstorming to the integration into your system. Often the hardware does not even have to be changed for this. We develop individual AI models for you and port it to your system. Furthermore, we provide the service to be your contact for verification and validation.

Consulting in the AI environment and in workshops is also a part of our offer.

Of course, we gladly arrange special AlfES® workshops for your team, where we show you how to use AI practically and how to handle the tool.



## Sensors and Applications

### Acceleration Sensors

- Gesture recognition for human machine interfaces
- Vibration recognition for condition monitoring and predictive maintenance
- Predictive maintenance for ball bearing
- Condition monitoring of machining processes
- Condition monitoring of vibratory bowl feeders

### Gas Sensors

- Detection of smells, gases, and mixture of gases

### Structure-Borne Sound Sensors

- Condition monitoring of filling machines in the food industry to detect contamination of food

### Cameras

- Recognize multiple people in images without the need to detect a face

### Current Sensors

- Condition Monitoring due to the current consumption

### RGB and brightness Sensors

- Recognize objects by color

### ECG Sensors

- Detection of atrial fibrillation on

### PPG (PhotoPlethysmoGram) Sensors

- Virtual sensor for blood pressure measurement

## Contact

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