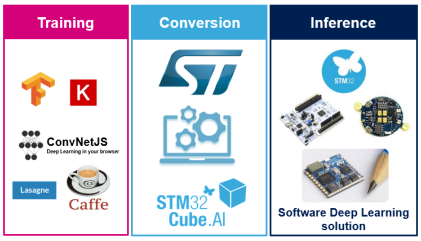
X-CUBE-AI

Data brief

Artificial intelligence (AI) software expansion for STM32Cube



Features

- Generation of an STM32-optimized library from pre-trained Neural Network models
- Support various Deep Learning frameworks such as Keras, Caffe, ConvnetJS, and Lasagne
- Easy portability across different STM32 microcontrollers series through STM32Cube™ integration
- Free, user-friendly license terms

Description

X-CUBE-AI is an STM32Cube™ Expansion Package part of the STM32Cube.AI ecosystem and extending STM32CubeMX capabilities with automatic conversion of pre-trained Neural Network and integration of generated optimized library into the user's project. The easiest way to use it is to download it inside the STM32CubeMX tool (version 5.0.1 or newer) as described in user manual *Getting started with X-CUBE-AI Expansion Package for artificial intelligence (AI)*.

The X-CUBE-AI Expansion Package offers also several means to validate Neural Network models both on desktop PC and STM32, as well as measure performance on STM32 devices without user handmade ad hoc C code.

Product status link
X-CUBE-AI

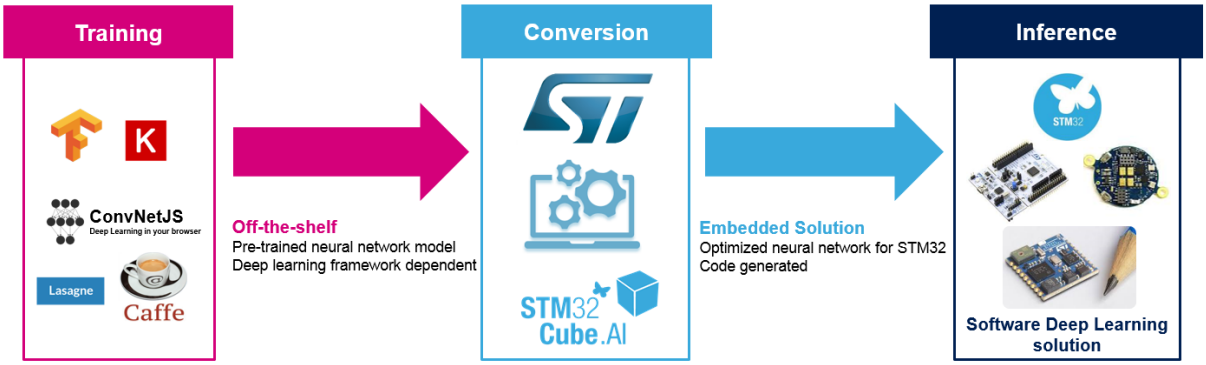
1 Ordering information

X-CUBE-AI is available for free download from the *www.st.com* website.

2 Detailed description

Figure 1 sketches the integration of X-CUBE-AI in STM32 AI environment.

Figure 1. X-CUBE-AI overview



2.1 What is STM32Cube™?

STM32Cube™ is an STMicroelectronics original initiative to significantly improve designer's productivity by reducing development effort, time and cost. STM32Cube™ covers the whole STM32 portfolio.

STM32Cube™ includes:

- A set of user-friendly software development tools to cover project development from the conception to the realization, among which:
  - STM32CubeMX, a graphical software configuration tool that allows the automatic generation of C initialization code using graphical wizards.
  - STM32CubeProgrammer (STM32CubeProg), a programming tool available in graphical and command-line versions.
  - STM32CubeMonitor-Power (STM32CubeMonPwr), a monitoring tool to measure and help in the optimization of the power consumption of the MCU.
- STM32Cube™ MCU Packages, comprehensive embedded-software platforms specific to each microcontroller series (such as STM32CubeF4 for the STM32F4 Series), which include:
  - STM32Cube™ hardware abstraction layer (HAL), ensuring maximized portability across the STM32 portfolio.
  - STM32Cube™ low-layer APIs, ensuring the best performance and footprints with a high degree of user control over the HW
  - A consistent set of middleware components such as RTOS, USB, TCP/IP, and graphics.
  - All embedded software utilities with full sets of peripheral and applicative examples.

2.2 How does this package complement STM32Cube™?

The X-CUBE-AI Expansion Package extends STM32CubeMX by providing an automatic neural network library generator optimized in computation and memory (RAM and Flash) that converts pre-trained Neural Networks from most used Deep Learning frameworks (such as Caffe, Keras, Lasagne, and ConvnetJS) into a library that is automatically integrated in the final user project. The project is automatically setup, ready for compilation and execution on the STM32 microcontroller.

X-CUBE-AI also extends STM32CubeMX by adding, for the project creation, specific MCU and board filtering to select the right devices that fit specific criteria requirements (such as RAM or Flash size) for a user's Neural Network.

The X-CUBE-AI tool can generate three kinds of projects:

- system performance project running on the STM32 MCU allowing the accurate measurement of the Neural Network inference CPU load and memory usage
- validation project that validates incrementally the results returned by the Neural Network, stimulated by either random or user test data, on both desktop PC and STM32 Arm® Cortex®-M-based MCU embedded environment
- application template project allowing the building of an application including multi-network support

Note: Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

3 License

X-CUBE-AI is delivered under the *Mix Ultimate Liberty+OSS+3rd-party V1* software license agreement (SLA0048).
The software components provided in this package come with different license schemes as shown in Table 1.

Table 1. Software component license agreements

Software component	Owner	License
h5py	Copyright (c) 2008 Andrew Collette and contributors http://h5py.alven.org (see note). All rights reserved. *Note: refer to http://docs.h5py.org/en/stable/licenses.html.*	3-Clause BSD
Keras	All contributions by François Chollet: Copyright (c) 2015 - 2018, François Chollet. All rights reserved. All contributions by Google: Copyright (c) 2015 - 2018, Google, Inc. All rights reserved. All contributions by Microsoft: Copyright (c) 2017 - 2018, Microsoft, Inc. All rights reserved. All other contributions: Copyright (c) 2015 - 2018, the respective contributors. All rights reserved.	The MIT License
matplotlib	Copyright (c) 2012-2013 Matplotlib Development Team; All Rights Reserved	PSF(1)
numpy	Copyright © 2005-2018, NumPy Developers. All rights reserved.	3-Clause BSD
scikit-learn	Copyright (c) 2007–2018 The scikit-learn developers. All rights reserved.	
scikit-image	Copyright (C) 2011, the scikit-image team All rights reserved.	
scipy	Copyright © 2003-2013 SciPy Developers. All rights reserved.	
six	Copyright (c) 2010-2018 Benjamin Peterson	The MIT License
tensorflow	Copyright 2018 The TensorFlow Authors. All rights reserved.	Apache® License, Version 2.0

Software component	Owner	License
Theano	Copyright (c) 2008–2017, Theano Development Team All rights reserved. Contains code from NumPy, Copyright (c) 2005-2016, NumPy Developers. All rights reserved. Contains CnMeM under the same license with this copyright: Copyright (c) 2015, NVIDIA CORPORATION. All rights reserved. Contains frozendict code from slezica's python-frozendict (https://github.com/slezica/python-frozendict/blob/master/frozendict/__init__.py), Copyright (c) 2012 Santiago Lezica. All rights reserved.	3-Clause BSD
typing	Copyright (c) 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014 Python Software Foundation; All Rights Reserved	Python Software Foundation, Version 2
Lasagne	Copyright (c) 2014-2015 Lasagne contributors	The MIT License
Jinja2	Copyright (c) 2009 by the Jinja Team	3-Clause BSD
networkx	Copyright (C) 2004-2012, NetworkX Developers Aric Hagberg <hagberg@lanl.gov> Dan Schult <dschult@colgate.edu> Pieter Swart <swart@lanl.gov> All rights reserved.	Open source BSD

1. *Matplotlib only uses BSD-compatible code, and its license is based on the PSF license.*

Revision history

Table 2. Document revision history

Date	Version	Changes
17-Dec-2018	1	Initial release.
3-Jan-2019	2	Updated Description.