
intel
Software
INNOVATE VISION SOLUTIONS FROM EDGE TO CLOUD
INTEL® DISTRIBUTION OF OPENVINO™ TOOLKIT
(Open Visual Inference & Neural Network Optimization)
Includes Intel® Deep Learning Deployment Toolkit
OpenVINO™
Compute Performance Developer Products
Intel Architecture, Graphics & Software
May 2019

POLLS!!

Do you have a prior experience in inference using traditional computer vision library like OpenCV?

- Yes
- No

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POLLS!!

Were you already aware that CPUs alone can be used for AI (Training & Inference)?

– Yes

– No

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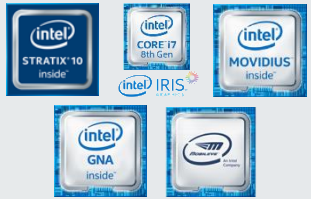
HARDWARE

Multi-purpose to purpose-built
AI compute from cloud to device

intel AI

	MAINSTREAM		INTENSIVE
DEEP LEARNING → TRAINING		+	
DEEP LEARNING → INFERENCE		+	
MOST OTHER AI			

All products, computer systems, dates, and figures are preliminary based on current expectations, and are subject to change without notice.

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ONE SIZE DOES NOT FIT ALL

intel

Intel Computer Vision/AI Portfolio

EXPERIENCES

TOOLS

Intel® Parallel Studio XE
Intel® System Studio
Intel® Media SDK
Intel® Distribution of OpenVINO™ toolkit
Intel® SDK for OpenCL™ Applications
Nauta (Beta)

FRAMEWORKS

Apache Spark MLlib BigDL · TensorFlow · mxnet · neon · Caffe · KALDI · theano · torch · ONNX

LIBRARIES

Intel® Data Analytics Acceleration Library
Intel® Distribution for python
Intel® Math Kernel Library
Intel® nGraph™ Compiler (Beta)
Movidius Stack
saffron TECHNOLOGY

UNLEASH FULL POTENTIAL

HARDWARE

Compute: Intel Atom, Quark, Core i7, Xeon, Arria 10, Movidius

Memory & Storage

Networking

Visual Intelligence: Intel RealSense Technology, Intel Movidius

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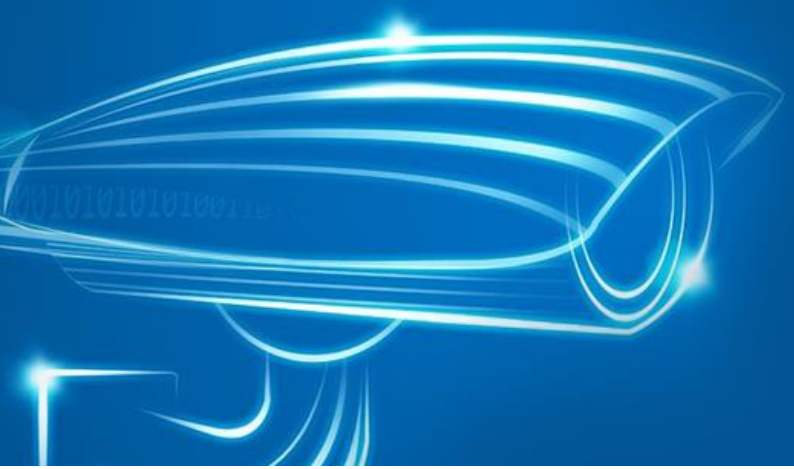
INTEL® DISTRIBUTION OF OPENVINO™ TOOLKIT



Take your computer vision solutions to a new level with deep learning inference intelligence.

What it is

A toolkit to accelerate development of **high performance computer vision** & **deep learning inference into vision/AI applications** used from device to cloud. It enables deep learning on hardware accelerators and easy deployment across multiple types of Intel® platforms.

Who needs this product?

- Computer vision, deep learning software developers
- Data scientists
- OEMs, ISVs, System Integrators

Usages

Security surveillance, robotics, retail, healthcare, AI, office automation, transportation, non-vision use cases (speech, text) & more.

HIGH PERFORMANCE, PERFORM AI AT THE EDGE

STREAMLINED & OPTIMIZED DEEP LEARNING INFERENCE

HETEROGENEOUS, CROSS-PLATFORM FLEXIBILITY

Free Download ▸ software.intel.com/openvino-toolkit

Open Source version ▸ 01.org/openvinotoolkit

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Latest version is 2019 R1

What's Inside Intel® Distribution of OpenVINO™ toolkit

Intel® Deep Learning Deployment Toolkit

Model Optimizer
Convert & Optimize

IR

Inference Engine
Optimized Inference

Open Model Zoo
(30+ Pre-trained Models)

Samples

IR = Intermediate Representation file

Traditional Computer Vision

Optimized Libraries & Code Samples

OpenCV*

OpenVX*

Samples

For Intel® CPU & GPU/Intel® Processor Graphics

Tools & Libraries

Increase Media/Video/Graphics Performance

Intel® Media SDK
Open Source version

OpenCL™ Drivers & Runtimes

For GPU/Intel® Processor Graphics

Optimize Intel® FPGA (Linux* only)

FPGA RunTime Environment
(from Intel® FPGA SDK for OpenCL™)

Bitstreams

OS Support: CentOS* 7.4 (64 bit), Ubuntu* 16.04.3 LTS (64 bit), Microsoft Windows* 10 (64 bit), Yocto Project* version Poky Jethro v2.0.3 (64 bit), macOS* 10.13 & 10.14 (64 bit)

Intel® Architecture-Based Platforms Support

CELERON, ATOM, CORE, XEON, ARRIA 10, MOVIDIUS, IRIS Pro Graphics

Intel® Vision Accelerator Design Products & AI in Production/ Developer Kits

An open source version is available at 01.org/openvinotoolkit (some deep learning functions support Intel CPU/GPU only).

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POLLS!!

Is this the first time you are hearing about Intel OpenVINO tool kit?

– Yes

– No

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Intel® Deep Learning Deployment Toolkit

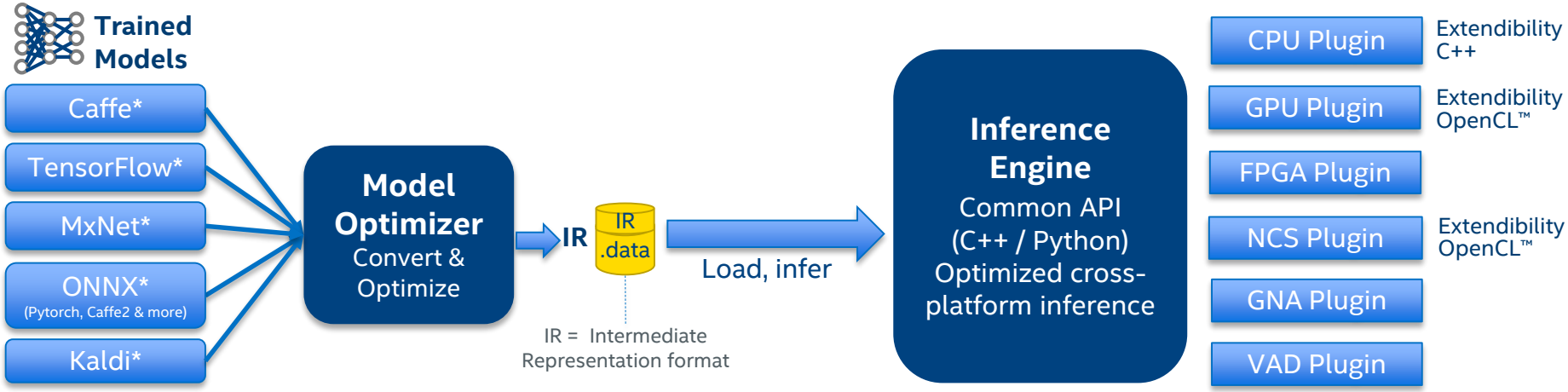
For Deep Learning Inference

Model Optimizer

- **What it is**: A Python*-based tool to import trained models and convert them to Intermediate representation.
- **Why important**: Optimizes for performance/space with conservative topology transformations; biggest boost is from conversion to data types matching hardware.

Inference Engine

- **What it is**: High-level inference API
- **Why important**: Interface is implemented as dynamically loaded plugins for each hardware type. Delivers best performance for each type without requiring users to implement and maintain multiple code pathways.



GPU = Intel CPU with integrated graphics processing unit/Intel® Processor Graphics

VAD = Vision Accelerator Design Products; includes FPGA and 8 MyriadX versions

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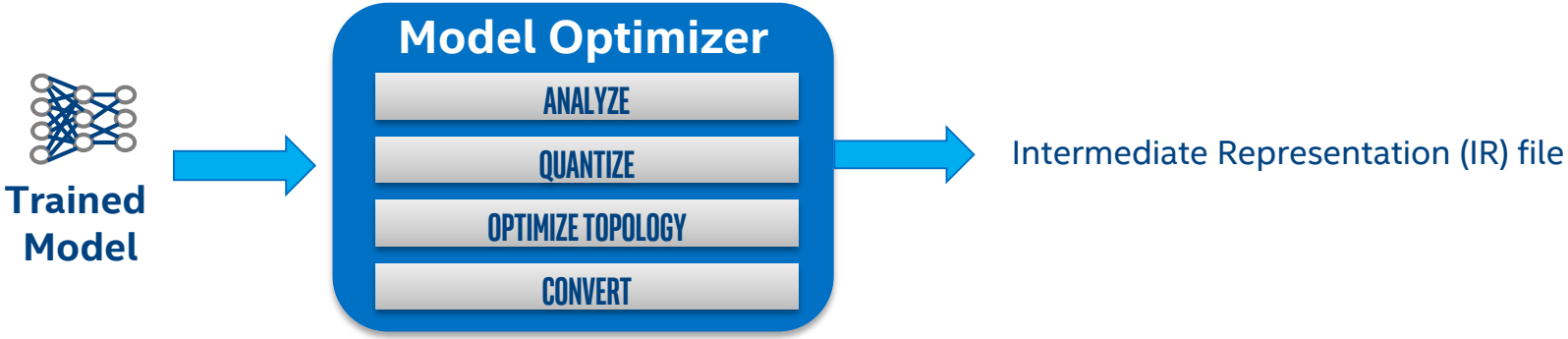
Improve Performance with Model Optimizer



- Easy to use, Python*-based workflow does not require rebuilding frameworks.
- Import Models from many supported frameworks: Caffe*, TensorFlow*, MXNet*, Kaldi*, exchange formats like ONNX* (Pytorch*, Caffe2* and others through ONNX).
- 100+ models for Caffe, MXNet, TensorFlow validated. Supports all ONNX* model zoo public models.
- Extends inferencing for non-vision networks with support of LSTM and 3D Convolutional based networks and Kaldi framework/Kaldi Nnet2*.
- IR files for models using standard layers or user-provided custom layers do not require Caffe.
- Fallback to original framework is possible in cases of unsupported layers, but requires original framework.

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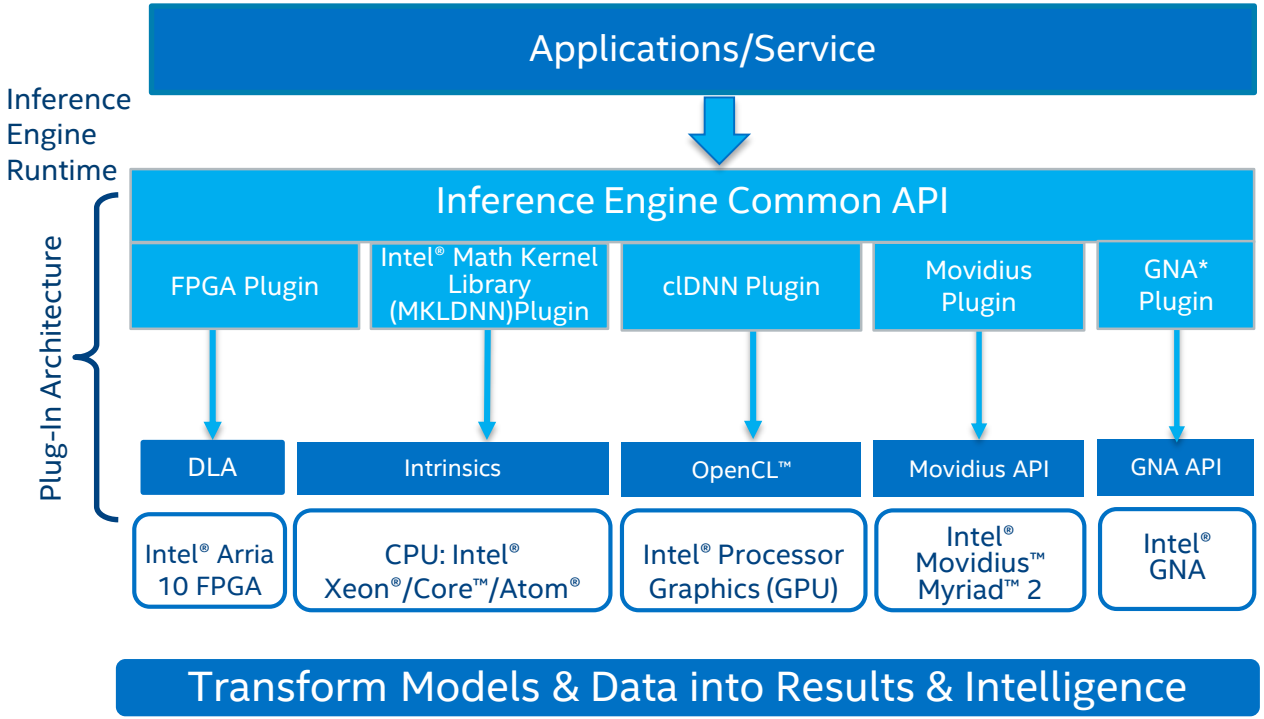
Optimal Model Performance Using the Inference Engine

- Simple & unified API for inference across all Intel® architecture
- Optimized inference on large IA hardware targets (CPU/GEN/FPGA)
- Heterogeneity support allows execution of layers across hardware types
- Asynchronous execution improves performance
- Futureproof/scale your development for future Intel® processors



GPU = Intel CPU with integrated graphics/Intel® Processor Graphics/GEN
GNA = Gaussian mixture model and Neural Network Accelerator

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Speed Deployment with Pre-trained Models & Samples

Expedite development, accelerate deep learning inference performance, and speed production deployment.

Pretrained Models in Intel® Distribution of OpenVINO™ toolkit

- Age & Gender
- Face Detection–standard & enhanced
- Head Position
- Human Detection–eye-level & high-angle detection
- Detect People, Vehicles & Bikes
- License Plate Detection: small & front facing
- Vehicle Metadata
- Human Pose Estimation
- Action recognition – encoder & decoder
- Text Detection & Recognition
- Vehicle Detection
- Retail Environment
- Pedestrian Detection
- Pedestrian & Vehicle Detection
- Person Attributes Recognition Crossroad
- Emotion Recognition
- Identify Someone from Different Videos–standard & enhanced
- Facial Landmarks
- Gaze estimation
- Identify Roadside objects
- Advanced Roadside Identification
- Person Detection & Action Recognition
- Person Re-identification–ultra small/ultra fast
- Face Re-identification
- Landmarks Regression
- Smart Classroom Use Cases
- Single image Super Resolution (3 models)
- Instance segmentation
- and more…

Binary Models

- Face Detection Binary
- Pedestrian Detection Binary
- Vehicle Detection Binary
- ResNet50 Binary

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Save Time with Deep Learning Samples

Use Model Optimizer & Inference Engine for public models & Intel pretrained models

- Object Detection
- Standard & Pipelined Image Classification
- Security Barrier
- Object Detection SSD
- Neural Style Transfer
- Hello Infer Classification
- Interactive Face Detection
- Image Segmentation
- Validation Application
- Multi-channel Face Detection
- Object Detection for Single Shot Multibox Detector using Asynch API+

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Starting with OpenCV* & OpenVX*

- Intel-optimized functions for faster performance on Intel hardware
- Basic building blocks to speed performance, cut development time & allow customization
- All-in-one package

- Well-established, open source, computer vision library
- Wide variety of algorithms and functions available

- Targeted at real time, low power applications
- Graph-based representation, optimization & execution
- 11 samples included

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OpenCV* Samples

- **OpenCV Version** – Print the OpenCV* library version & build configuration
- **People Detection** – Use the built-in feature descriptor (a histogram of oriented gradients) to detect pedestrians
- **Colorization** – Recoloring of grayscale images with DNN
- **Custom OpenCL™ Kernel** – Implement & run this kernel via the Telephony Application Programming Interface (TAPI)
- **Dense Optical Flow** – Run a dense optical flow using TAPI with Fameback & TV-L1 algorithms
- **Facial Recognition** – Develop a detection & recognition solution

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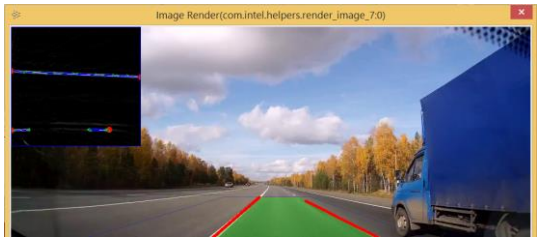
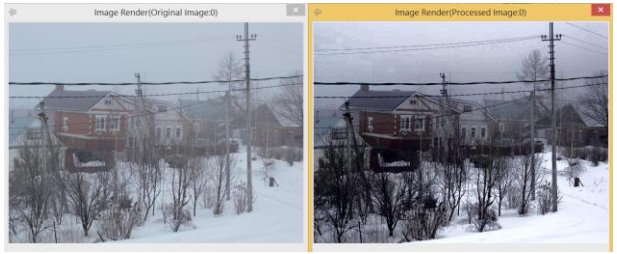
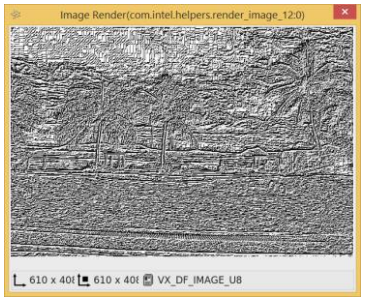
Take Advantage of OpenVX™ Code Samples





- GStreamer Interoperability
- Video Stabilization
- Hetero Basic
- Camera Tampering
- Census Transform
- Custom OpenCL™ Kernel
- Face Detection
- Auto-Contrast
- Lane Detection
- Motion Detection
- Color Copy Pipeline



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Benefits of Intel® Distribution of OpenVINO™ toolkit

Maximize the Power of Intel® Processors: CPU, GPU/Intel® Processor Graphics, FPGA,VPU

ACCELERATE PERFORMANCE

Access Intel computer vision accelerators.
Speed code performance.
Supports heterogeneous execution.

INTEGRATE DEEP LEARNING

Unleash CNN-based deep learning inference using a common API, 30+ pre-trained models, & computer vision algorithms. Validated on more than 100 public/custom models.

SPEED DEVELOPMENT

Reduce time using a library of optimized OpenCV* & OpenVX* functions, & 15+ samples.

Develop once, deploy for current & future Intel-based devices.

INNOVATE & CUSTOMIZE

Use OpenCL™ kernels/tools to add your own unique code. Customize layers without the overhead of frameworks.

Deep learning revenue is estimated to grow from $655M in 2016 to **$35B** by 2025[1].

[1]Tractica 2Q 2017

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Intel as Best Choice for Vision Solutions

Deliver High Performance Computer Vision & Deep Learning
Transform Data & Results into Artificial Intelligence

Intel offers the broadest portfolio of hardware and software that help you

- Accelerate workloads for a wide range of solutions and vertical use cases
- Increase application performance through Intel accelerators and flexible heterogeneous architectures[1] (CPU, CPU w/integrated graphics (GPU), FPGA, and Vision Processing Units (VPU))
- Drive power, cost and development efficiencies to designs and applications for cameras, gateways, network video recorders, and servers
- Enable deep learning capabilities for smarter, faster analytics—transform data into artificial intelligence for competitive advantage

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[1]Certain technical specifications and select processors/skus apply. See product site for more details.

OpenVINO™ Toolkit

Open Source Version

- Provides flexibility and availability to the developer community to extend OpenVINO™ toolkit for custom needs
- Components that are open sourced
  - **Deep Learning Deployment Toolkit** with **CPU, GPU & Heterogeneous** plugins github.com/opencv/dldt
  - **Open Model Zoo** - Includes pre-trained models, model downloader, demos and samples: github.com/opencv/open_model_zoo
- See FAQ and next slide for key differences between the open source and Intel distribution

Learn More ▶ 01.org/openvinotoolkit

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Quick Guide: What's Inside the Intel Distribution vs Open Source version of OpenVINO™ toolkit

Tool/Component	Intel® Distribution of OpenVINO™ toolkit	OpenVINO™ toolkit (open source)	Open Source Directory https://github.com
Installer (including necessary drivers)	✓		
Intel® Deep Learning Deployment toolkit			
Model Optimizer	✓	✓	/opencv/dldt/tree/2018/model-optimizer
Inference Engine	✓	✓	/opencv/dldt/tree/2018/inference-engine
Intel CPU plug-in	✓ Intel® Math Kernel Library (Intel® MKL) only[1]	✓ BLAS, Intel® MKL[1], jit (Intel MKL)	/opencv/dldt/tree/2018/inference-engine
Intel GPU (Intel® Processor Graphics) plug-in	✓	✓	/opencv/dldt/tree/2018/inference-engine
Heterogeneous plug-in	✓	✓	/opencv/dldt/tree/2018/inference-engine
Intel GNA plug-in	✓		
Intel® FPGA plug-in	✓		
Intel® Neural Compute Stick (1 & 2) VPU plug-in	✓		
Intel® Vision Accelerator based on Movidius plug-in	✓		
30+ Pretrained Models - incl. Model Zoo (IR models that run in IE + open sources models)	✓	✓	/opencv/open_model_zoo
Samples (APIs)	✓	✓	/opencv/dldt/tree/2018/inference-engine
Demos	✓	✓	/opencv/open_model_zoo
Traditional Computer Vision			
OpenCV*	✓	✓	/opencv/opencv
OpenVX (with samples)	✓		
Intel® Media SDK	✓	✓[2]	/Intel-Media-SDK/MediaSDK
OpenCL™ Drivers & Runtimes	✓	✓[2]	/intel/compute-runtime
FPGA RunTime Environment, Deep Learning Acceleration & Bitstreams (Linux* only)	✓		

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[1]Intel MKL is not open source but does provide the best performance
[2]Refer to readme file for validated versions

What's New in Intel® Distribution of OpenVINO™ toolkit

2019 R1

- **Supports 2nd generation Intel® Xeon® Scalable Processors** and provides performance acceleration for inference through Intel® AVX512-Deep Learning Boost (VNNI instruction set). **Extends support to macOS*** on Intel CPUs for key components (Model Optimizer, Inference Engine, OpenCV*, and more).
- **Switches parallelism schemes from OpenMP* to Intel Threading Building Blocks (TBB)** to provide increased performance in multinetwork scenarios. The most common deployment pipelines run multiple network combinations, and TBB delivers optimal performance for these use cases.
  - More details: Intel Threading Building Blocks as a Default Parallelization

Deep Learning

- **Supports many new operations** in ONNX*, TensorFlow*, and Apache MXNet* frameworks. Provides optimized inference on topologies like Tiny YOLO* version 3, the full DeepLabs* version 3, and bidirectional long short-term memory (LSTM).
- **Includes 8 pretrained models** for new use cases: gaze estimation, action recognition encoder, action recognition decoder, text recognition, and instance segmentation networks (30+ models are in the package).
- **Introduces support for binary weights** to boost performance, adds 4 binary models: ResNet 50, and face, person, vehicle detection.

Other

- **Updates the FPGA plugin** to Deep Learning Accelerator 2019 R1 with new bitstreams for Intel® Vision Accelerator Designs, Intel® Arria® 10 FPGA Development Kit, and Intel® Programmable Acceleration Card with Intel® Arria® 10 GX FPGA.
  Supports automatic scheduling between multiple FPGA devices.

See release notes for more details.

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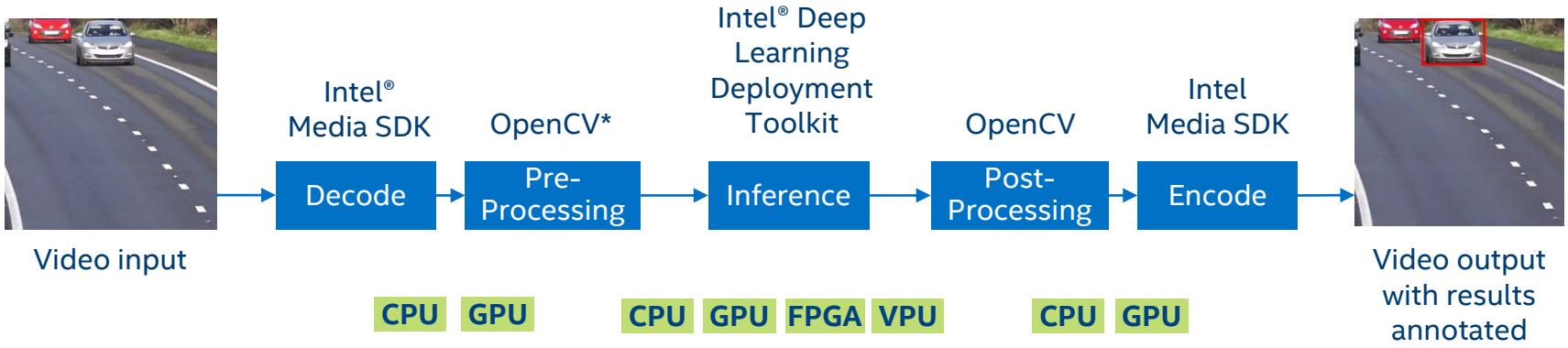
End-to-End Vision Workflow



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Intel® IoT Developer Kits & Accelerators

Get started quickly in designing innovative solutions

Order Here >

PROTOTYPING/COMPUTER VISION/ DEEP LEARNING

[UP Squared* AI Vision X* Developer Kit]

Pre-Installed Intel Software Tools[1]

- OpenVINO™ toolkit
- Intel® System Studio (Eclipse* IDE)

HIGH-PERFORMANCE MULTI-STREAM COMPUTE

[IEI TANK* AIoT Developer Kit]

Commercial production-ready development with deep learning/computer vision/AI

Pre-Installed Intel Software Tools[1]

- Intel® System Studio
- Intel® Media SDK
- Intel® Distribution of OpenVINO™ toolkit

Faster prototyping and path to productization, designed for scalability and extensibility

All kits include the start-up essentials for a bootable development environment

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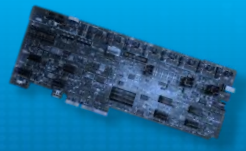
[1]Check developer kit specifications for which software versions are installed.

Examples of Intel® Vision Accelerator Design Products

	Intel® Vision Accelerator Design with Intel® Movidius™ VPU			Intel® Vision Accelerator Design with Intel® Arria® 10 FPGA
EXAMPLE CARD BASED ON VISION ACCELERATOR DESIGNS	 1 Movidius MA2485 VPU	 2 Movidius MA2485 VPUs	 8 Movidius MA2485 VPUs	 Intel® Arria® 10 FPGA 1150GX
INTERFACE	M.2, Key E	miniPCIe	PCIe x4	PCIe x8
CURRENTLY MANUFACTURED BY*	iEi, ADVANTECH, AAEON, ADLINK, NEXCOM	iEi, ADVANTECH, ADLINK, NEXCOM	iEi, NEXCOM, uzei	iEi
SOFTWARE TOOLS	OpenVINO™ TOOLKIT Develop NN Model; Deploy across Intel® CPU, GPU, VPU, FPGA; Leverage common algorithms			

*Please contact Intel representative for complete list of ODM manufacturers. Other names and brands may be claimed as the property of others.

Additional Services & Programs

Intel® IoT Solutions Alliance

Find partner solutions based on Intel® architecture

Learn more >

Community

Accelerate the development of AI-centric applications at the edge

Learn more >

Ready Kits

Get use-case-specific technology offerings that can be easily customized to quickly respond to RFPs

Learn more >

Ready Solutions

Submit use-case-specific IoT solutions and get unique support and scaling opportunities

Learn more >

AI: In Production

Intel® IoT RFP

Intel® IoT Market

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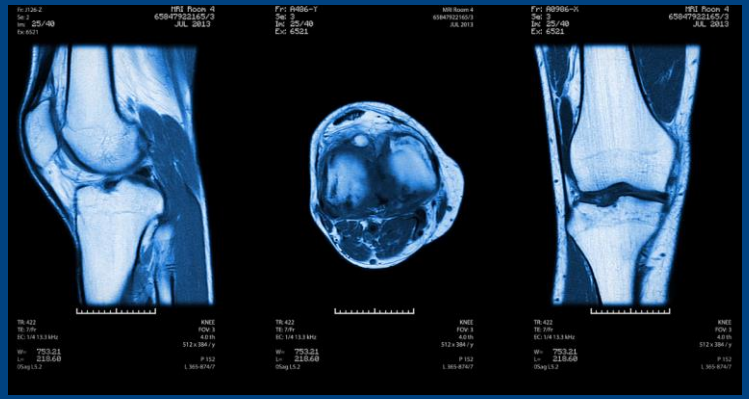
Key Vision Solutions Optimized by Intel® Distribution of OpenVINO™ toolkit



Philips

Intel teamed with Philips to show that servers powered by Intel® Xeon® Scalable processors & Intel® Distribution of OpenVINO™ toolkit can efficiently perform deep learning inference on patients' X-rays & computed tomography (CT) scans, without the need for accelerators. Achieved breakthrough performance for AI inferencing:

- **188x** increase in throughput (images/sec) on Bone-age prediction model.[1]
- **38x** increase in throughput (images/sec) on Lung segmentation model. [1]

"Intel® Xeon® Scalable processors and OpenVINO toolkit appears to be the right solution for medical imaging AI workloads. Our customers can use their existing hardware to its maximum potential, without having to complicate their infrastructure, while still aiming to achieve quality output resolution at exceptional speeds."
— Vijayananda J., chief architect and fellow, Data Science and AI, Philips HealthSuite Insights, India

White Paper

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[1]See white paper for performance details.

Key Vision Solutions Optimized by Intel® Distribution of OpenVINO™ toolkit

GE Healthcare*

The Intel® Distribution of OpenVINO™ toolkit helped GE deliver optimized inferencing to its deep learning image-classification solution. By bringing AI to its clinical diagnostic scanning, GE no longer needed an expensive 3rd party accelerator board, achieving:

- **5.9x** inferencing performance above the target[1]
- **14x** inferencing speed over the baseline solution[1]
- Improved image quality, diagnostic capabilities, and clinical workflows

With the OpenVINO™ toolkit , we are now able to optimize inferencing across Intel® silicon, exceeding our throughput goals by almost 6x," said David Chevalier, Principal Engineer for GE Healthcare.
"We want to not only keep deployment costs down for our customers, but also offer a flexible, high-performance solution for a new era of smarter medical imaging. Our partnership with Intel allows us to bring the power of AI to clinical diagnostic scanning and other healthcare workflows in a cost-effective manner."

Intel-GE Healthcare, Intel® Distribution of OpenVINO™ Optimizes Deep Learning Performance for Healthcare Imaging

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[1]See white paper for performance details.

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Security for Stadiums at the World Cup 2018

RESULT

axxonsoft

9000+ SURVEILLANCE CAMERAS

used to protect

2MILLION+ FANS

The integrated surveillance system connected to cameras at stadiums, which transmitted video data to operational HQ in each city.

Intel® Distribution of OpenVINO™ toolkit allowed Axxonsoft to distribute the neural network video analytics of the video across all available Intel hardware, for zone entry detection, abandoned objects detection, and facial recognition.

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See case study for details.

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Train Safety

RESULT

KLAS TELECOM

IN-TRAIN VISION PLATFORM

Enables pedestrian & vehicle identification at crossroads + on-train empty seat detection

The platform provides multiple functions from onboard Wi-Fi to computer vision applications such as human/vehicle detection at crossroads, onboard empty seat detection and intruder detection.

OpenVINO provides a scalable, high performance common platform across a variety of hardware for greater efficiencies.

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Demonstrated Industry Success

Access Developer Success Stories for details & more examples

NexCOBOT Delivers Robotics with AI for Industry 4.0L

NexCOBOT, a NEXCOM company, offers a flexible, modular robotics solution integrating artificial intelligence (AI) with machine vision, powered by Intel® Vision Accelerator Design products and optimized by Intel® Distribution of OpenVINO™ toolkit.

Philips Performs AI-Driven Medical Imaging Efficiently and Cost-Effectively on Intel® CPU–Based Systems

Philips demonstrates breakthrough performance for AI inferencing of healthcare workloads run on servers powered by Intel® Xeon® Scalable processors and optimized with the OpenVINO™ toolkit.

QNAP/IEI Develop AI Solutions for Healthcare

Together, Intel and QNAP/IEI have come up with a solution that offers developers, data scientists, medical researchers, and students a quick-to-deploy computer vision system combining a workstation, deep learning software development kit (Intel® Distribution of OpenVINO™ toolkit), and powerful NAS.

For Somatic, Deep Learning Brings Touch to Robots

Deep learning algorithms that enable touch as well as vision can create tremendous opportunities for robotics applications. Intel® Software Development Tools can help devs take advantage of enabling technologies that bring touch to the forefront and are fueled by the latest artificial intelligence (AI) advances.

ADLINK and Touch Cloud Deliver AI Solutions Powered by Intel® Vision Products

DLINK, Touch Cloud, and Intel provide a turnkey AI engine to assist in data analytics, detection, classification, and prediction for a wide range of use cases, optimized by Intel Distribution of OpenVINO toolkit.

Advantech Addresses Major Retail Dilemmas with Intel® Vision Products

Advantech deploys a combination of hardware and software including cameras, AI deep learning, and video analysis technology optimized by Intel® Distribution of OpenVINO™ toolkit and Intel® Vision Accelerator Design products.

Agent VI* Delivers the Next Generation of Digital Security and Surveillance Solutions

Intel® Distribution of OpenVINO™ toolkit is the centerpiece of computer Agent VI's next-gen vision solutions.

GeoVision Gets a 24x Deep Learning Algorithm Performance Boost

GeoVision turbo-charges its deep learning facial recognition solution using Intel® System Studio and the OpenVINO™ toolkit.

GE Healthcare and Intel Optimize Deep Learning Performance for Healthcare Imaging

Intel® Math Kernel Library and OpenVINO™ toolkit help bring the power of AI to clinical diagnostic scanning and other healthcare workflows.

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Call to Action, Resources

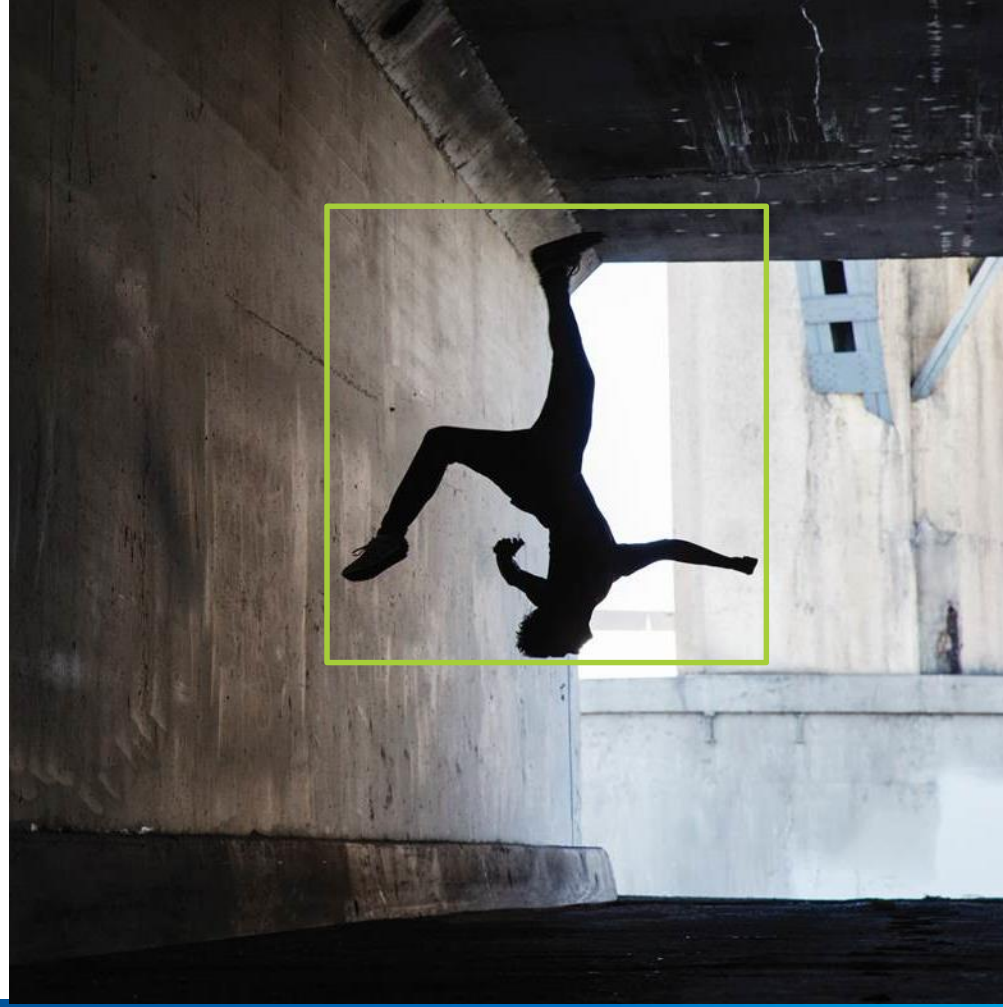
Download ▸
Free Intel® Distribution of OpenVINO™ toolkit

Get started quickly with:

- Developer resources
- Online webinars, tool how-tos & quick tips
- Hands-on developer workshops

Support

- Connect with Intel engineers & computer vision experts at the public Community Forum



Select Intel customers may contact their Intel representative for issues beyond forum support.

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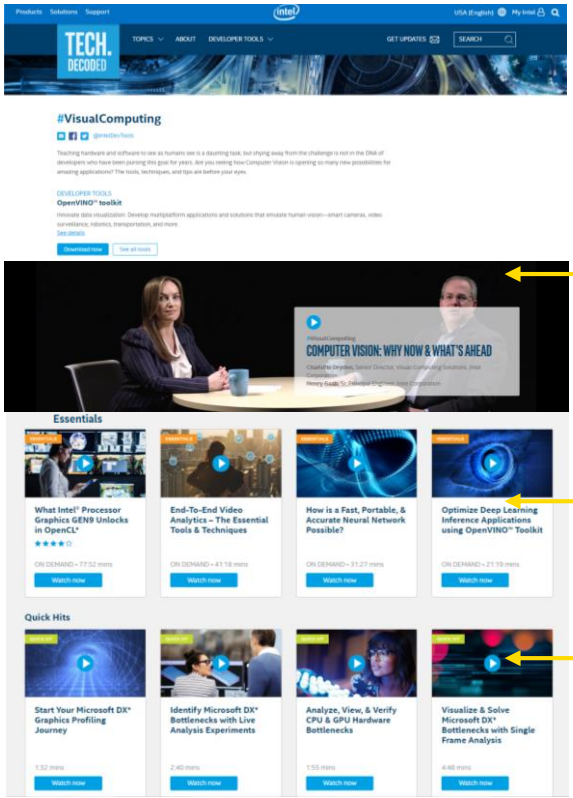
Get the Most from Your Code: Software Tools Training



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Intel® Distribution of OpenVINO™ toolkit

Multiple Visionary videos

6 Webinars

12 How-to videos, articles

OVERALL DEVELOPMENT TOPICS

- **Visual Computing**
- **Code Modernization**
- **Systems & IoT**
- **Data Science**
- **Data Center & Cloud Computing**

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