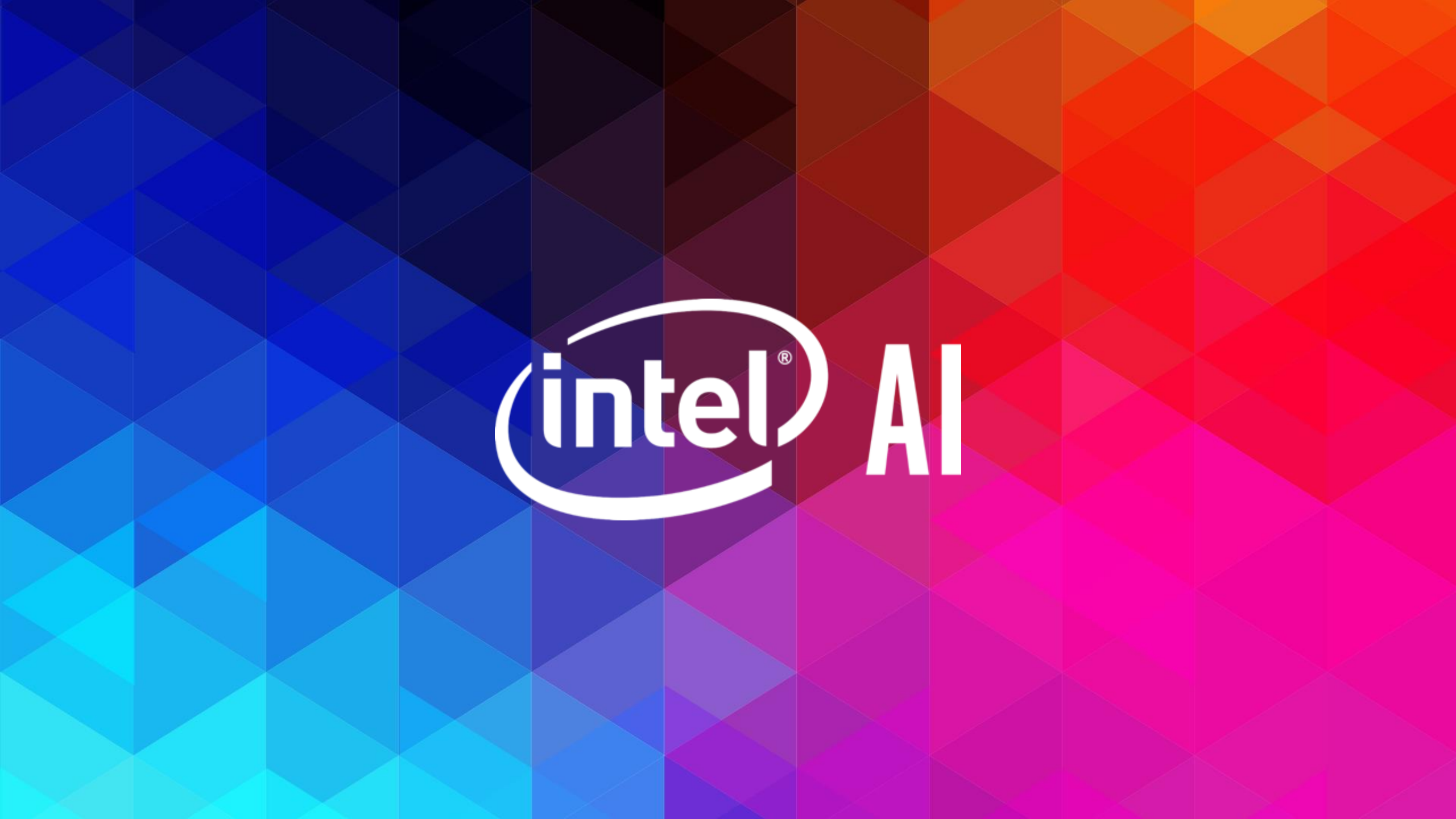
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SUPERCHARGE YOUR DEEP LEARNING ALGORITHMS WITH OPTIMIZED SOFTWARE (CASE-STUDY)

Shailen Sobhee
AI Specialist @ Intel
Compute Performance Developer Products (CPDP)

10 July 2019, EuroPython 2019

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CASE STUDY: BRAIN TUMOUR SEGMENTATION USING DEEP LEARNING

10 July 2019, EuroPython 2019

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ABOUT THE SPEAKER

- Shailen Sobhee
- AI Software Technical Consulting Engineer @ Intel
- Computer Science and Electrical Engineering (Jacobs University Bremen)
- Computational Science and Engineering (Technische Universität München)

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TALK AGENDA

- Problem statement
- Solution to the problem with AI
- Peek at the deep learning algorithm used
- Frameworks and software stack used for best performance

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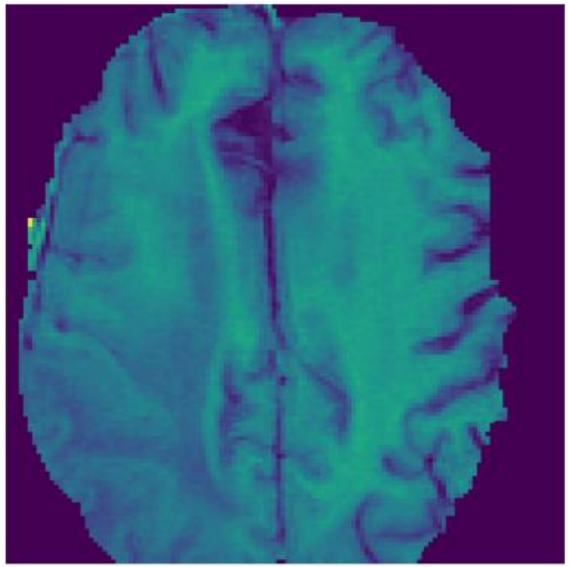
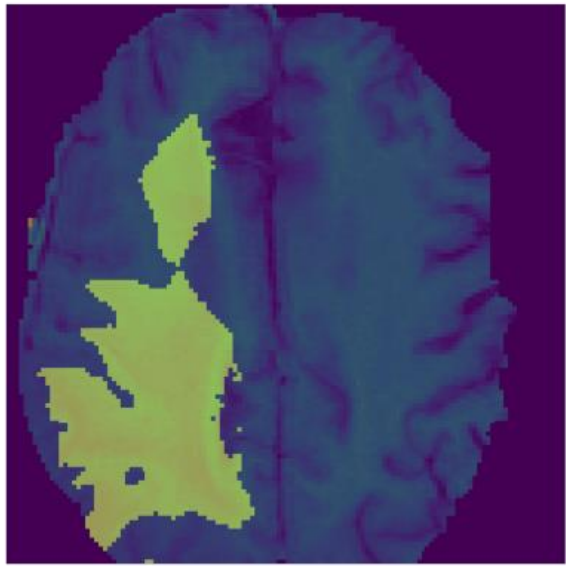
A BIT OF STATISTICS

As per Globocan 2018 (Global Cancer statistics):

- there were **18.1** million new cancer cases, worldwide
- and **9.6** million cancer deaths
- in **2018**





Statistics source:
https://onlinelibrary.wiley.com/doi/full/10.3322/caac.21492
(36 cancers in 185 countries)

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INTRODUCTION

- **Gliomas** are the most commonly occurring type of **brain tumors**
  - and are potentially very dangerous
  - with about 90% of Gliomas belonging to a highly aggressive class of cancerous tumors
- Multi-sequence **Magnetic Resonance Imaging (MRI)** is the primary method of screening and diagnosis for Gliomas

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SEGMENTING THE BRAIN TUMOR

- To assess the severity/for treatment of the tumour, segmentation is important for:
  - focusing on the tumour areas during radiotherapy
  - navigation during surgery

Image sources: Brainlab

THE MEDICAL CHALLENGE

- Not enough expert doctors to analyze all the medical data[1]
- Tumor regions segmentation is time-consuming and expensive

- Sources:
- [1] https://www.diagnosticimaging.com/residents/physician-shortage-too-many-radiologists
- [2]Corbin K. How CIOs Can Prepare for Healthcare “Data Tsunami” [Internet]. CIO. 2014 [cited 8 FEB 2019].
- [3] Fenton SH, Low S, Abrams KJ, Butler-Henderson K. Health Information Management: Changing with Time. IMIA Yearbook of Medical Informatics 2017.
- [4]Stanford Medicine. 2017 Health Trends Report: Harnessing the Power of Data in Health. Accessed online 8 FEB 2019.

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BUT...

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...MACHINES CAN HELP!

- Automating the process:
  - helps gain of time for the radiologist
  - gives time back to the patient and surgeon
  - improves segmentation quality
- Nearly 153 exabytes of healthcare-related data were generated in 2013
  - amount to increase by 48% annually
  - expected to reach 2,314 exabytes in 2020 [1], [2], [3]

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One exabyte is one billion gigabytes
or
250 000 000 DVDs worth of information.

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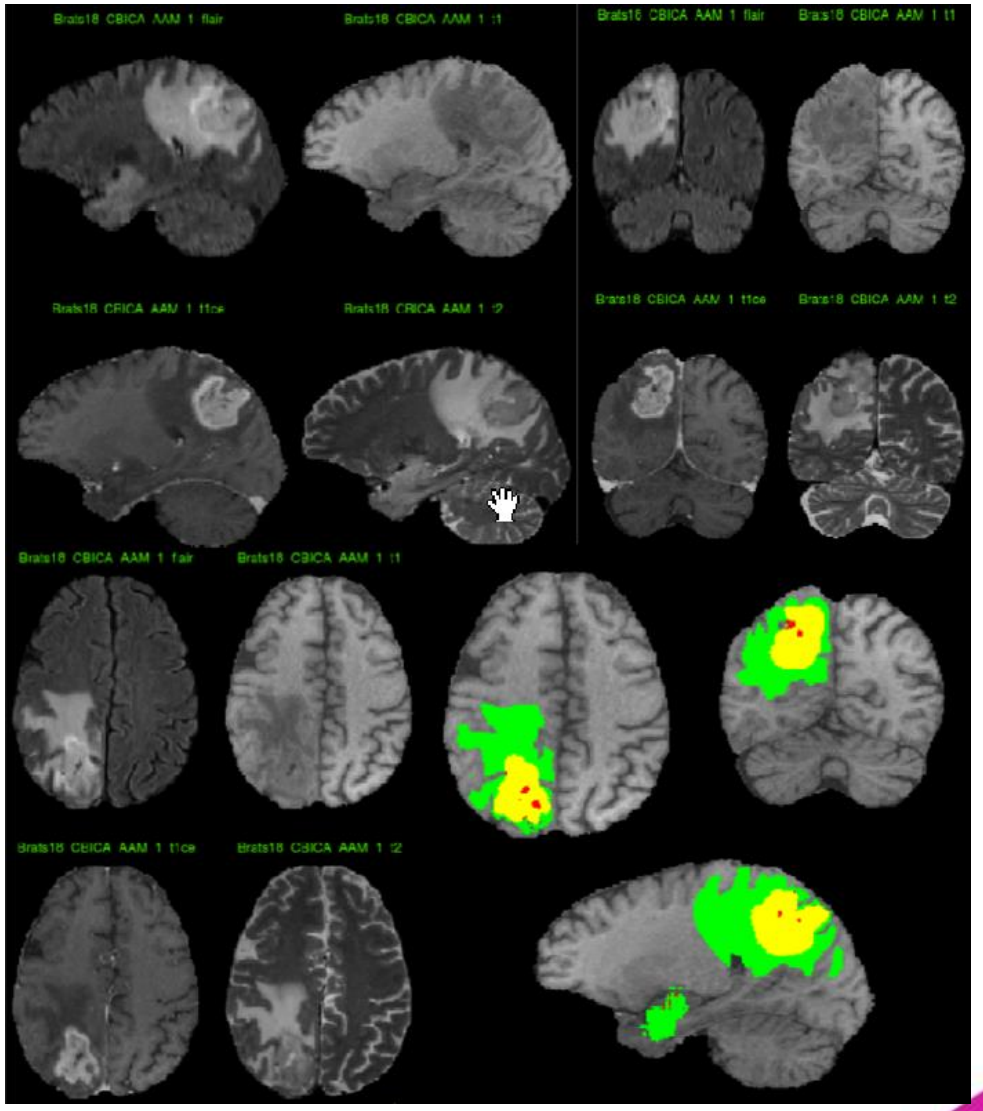
THE DATASET FOR THE DEEP LEARNING ALGORITHM

- Brain Tumor Segmentation (BraTS) Challenge 2018 dataset
- **Goal**: classify every **voxel** in the image as either
  i. healthy tissue
  ii. necrosis or non-enhancing (red)
  iii. edema (green) or
  iv. enhancing tumor (yellow)



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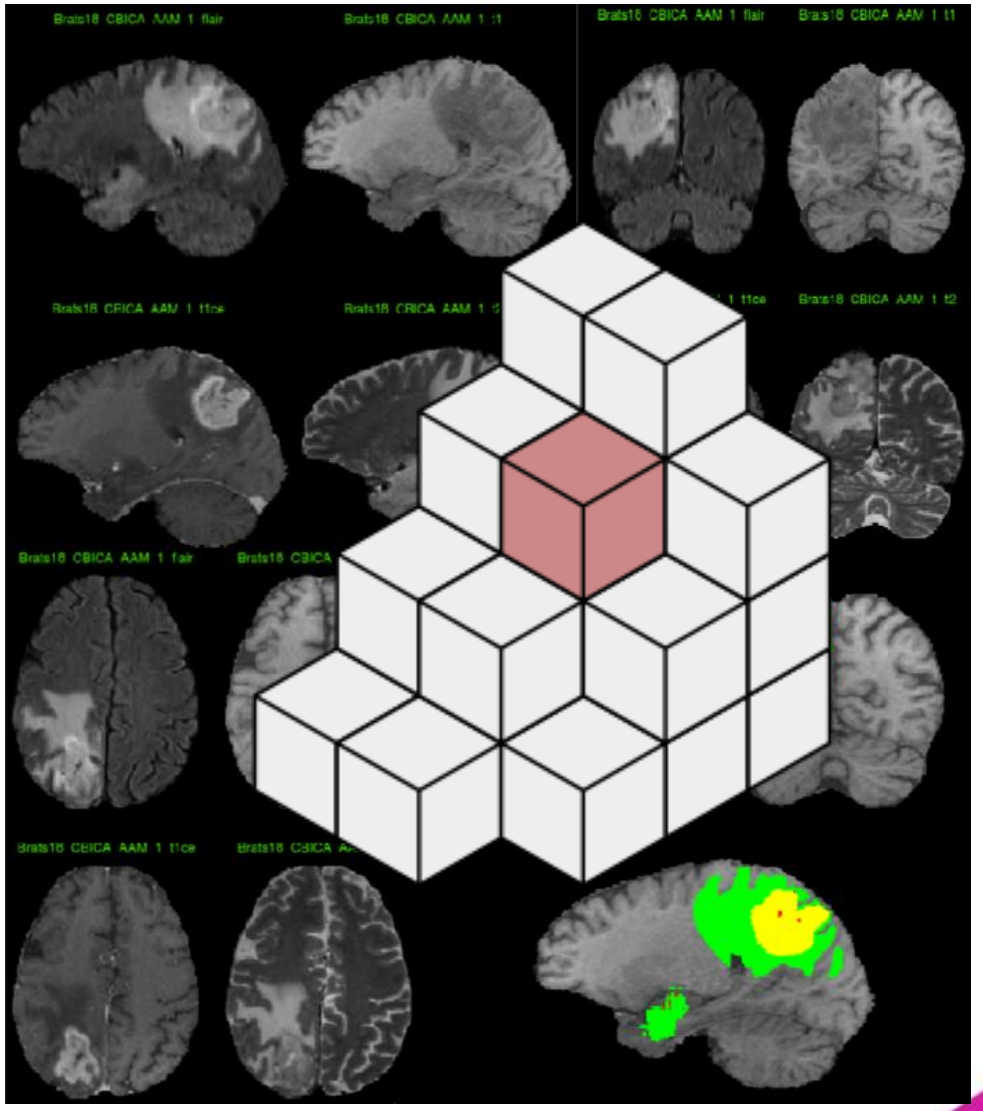

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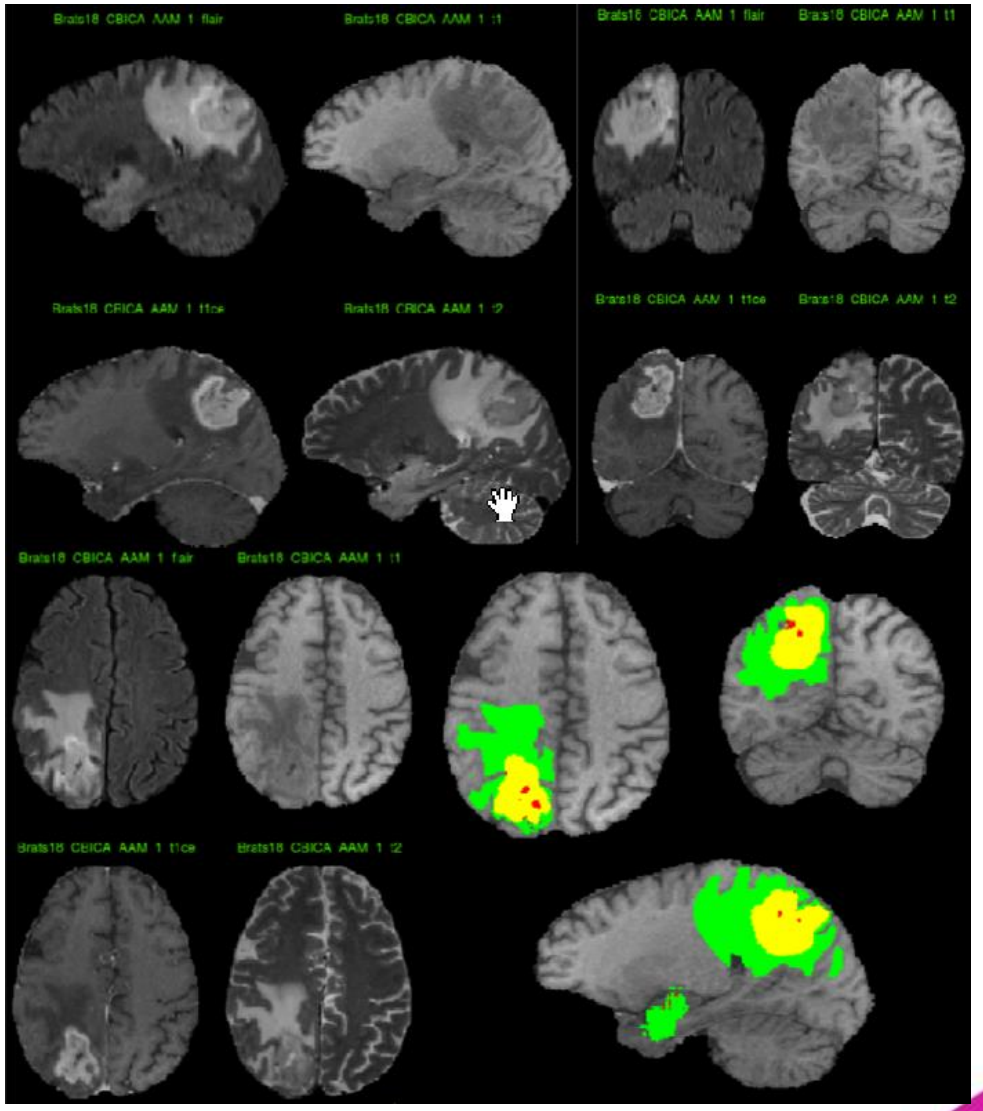

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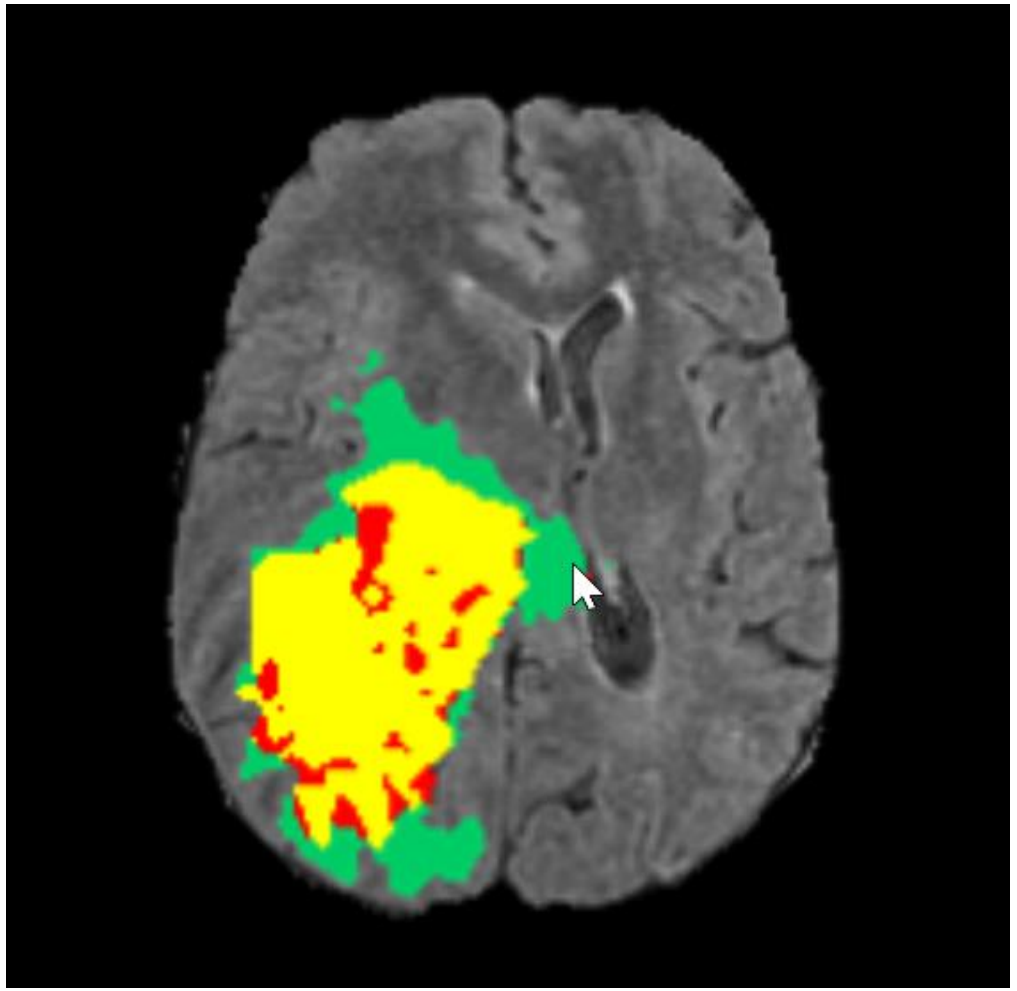

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THE RESULT OF OUR DEEP LEARNING ALGORITHM

- Example segmentation has been prepared for to compare with target (expert's) segmentation.

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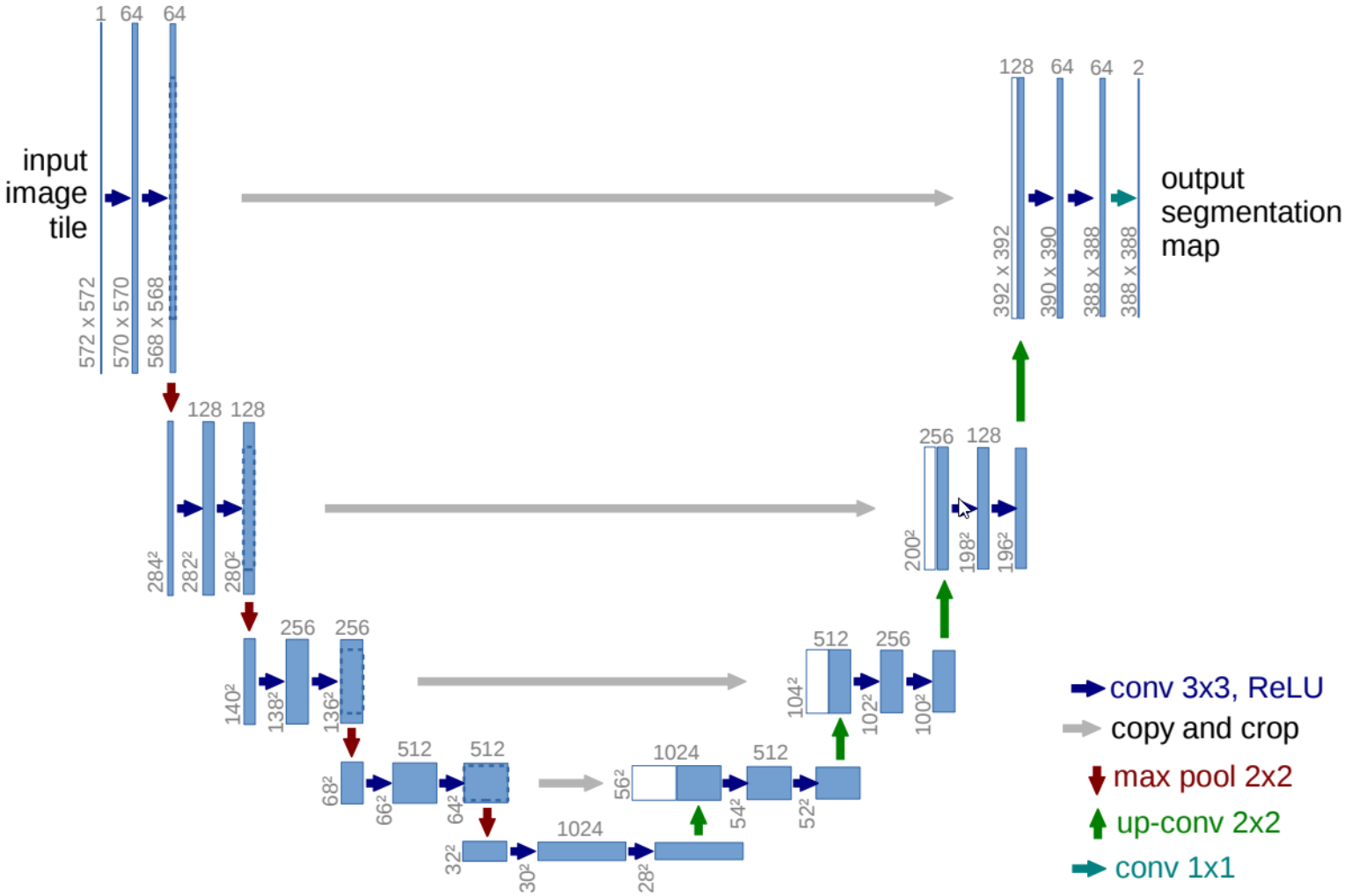
THE ALGORITHM USED (U-NET NEURAL NETWORK)

- Has an **encoding path** (“contracting”) paired with a **decoding path** (“expanding”)
- For each pixel in the original image, it asks the question: **“To which class does this voxel belong?”**



https://lmb.informatik.uni-freiburg.de/people/ronneber/u-net/

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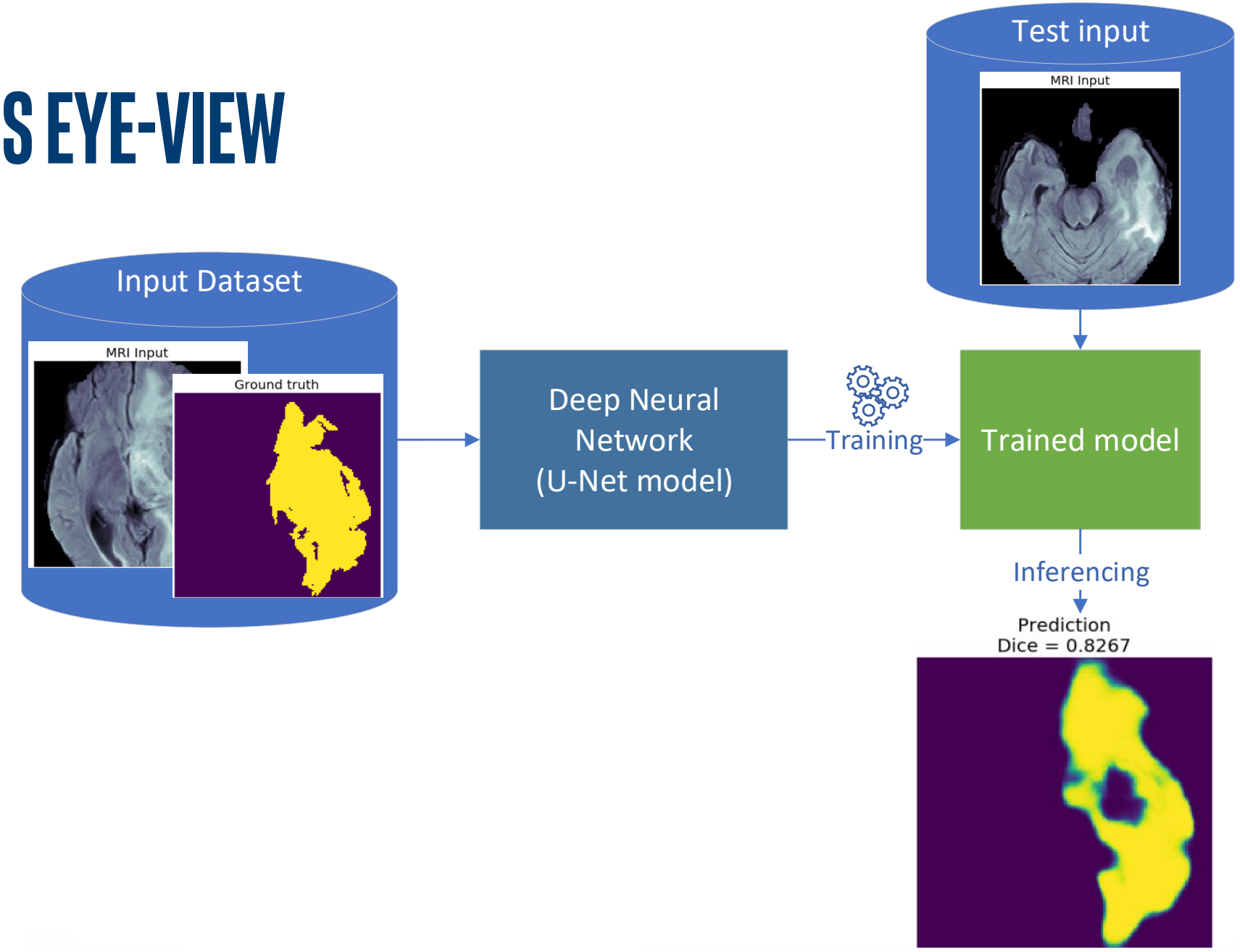
FROM A BIRD'S EYE-VIEW



WHAT SOFTWARE TOOLS DID WE USE IN THIS PROJECT?

Intel® Distribution for Python

Frameworks and Software Stack

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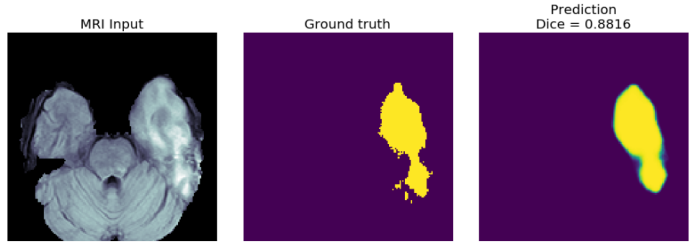
HOW DID WE BOOST THE PERFORMANCE OF THE ALGORITHM?

Thanks to Intel® Technologies:



Python-based Deep Learning Demo application

Intel® Distribution for Python

python™

Keras

TensorFlow

HOROVOD

OpenVINO™

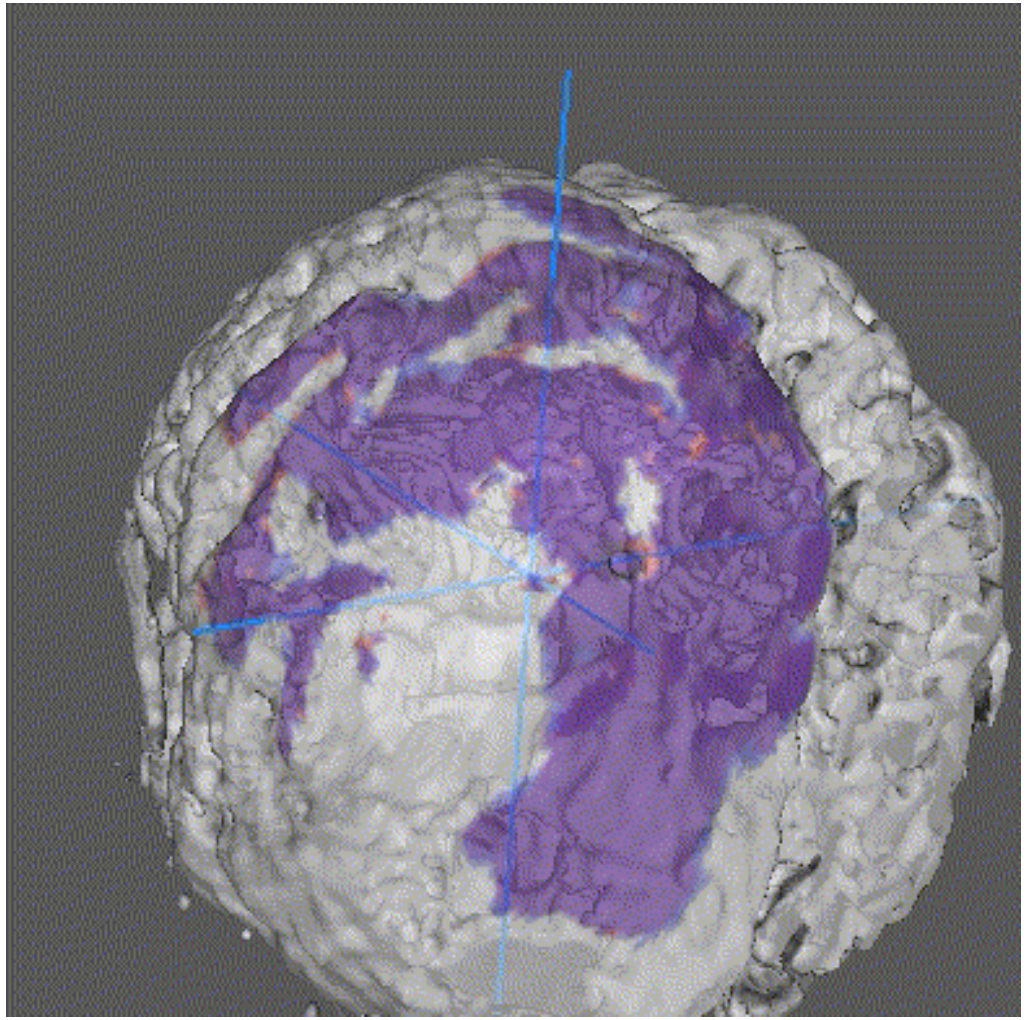
Frameworks and Software Stack

Intel® Math Kernel Library – Deep Neural Network (Intel® MKL-DNN)

The base hardware

intel XEON PLATINUM inside™

VISUALIZATION OF THE END RESULT IN 3D



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SOURCE CODE

https://github.com/shailensobhee/medical-decathlon

From the GitHub link:

- source code
- instructions on how to get the medical dataset

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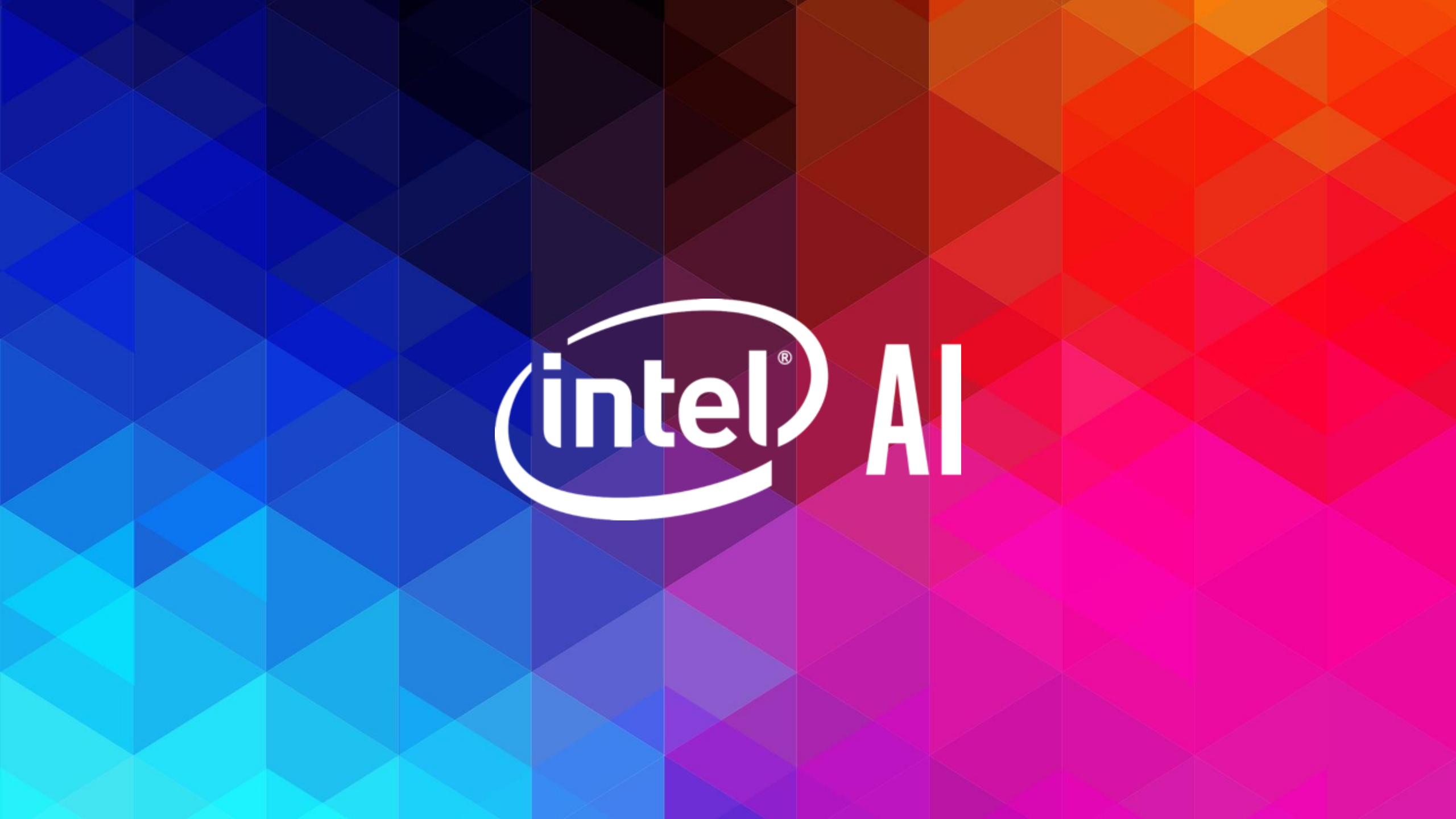
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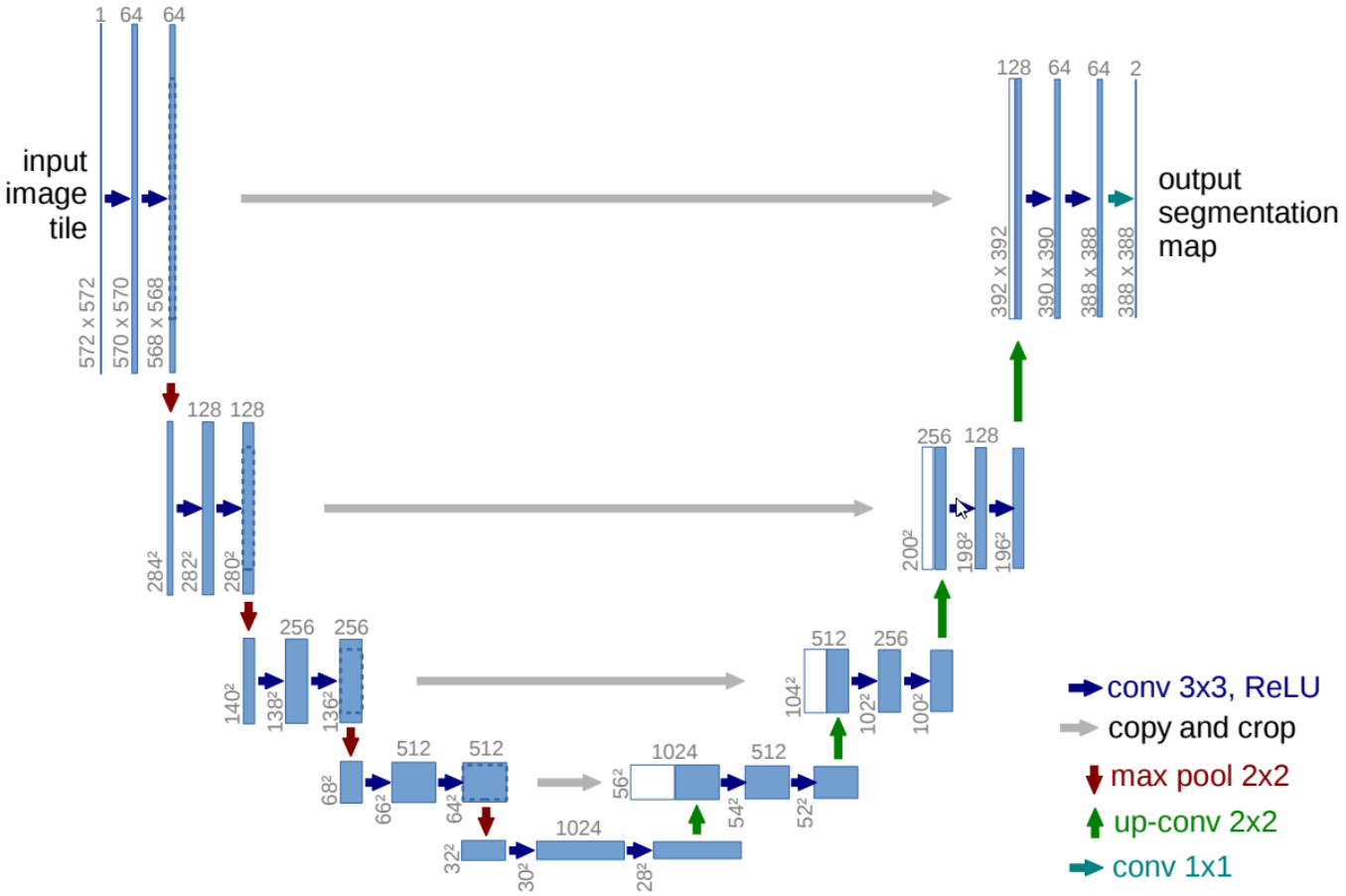
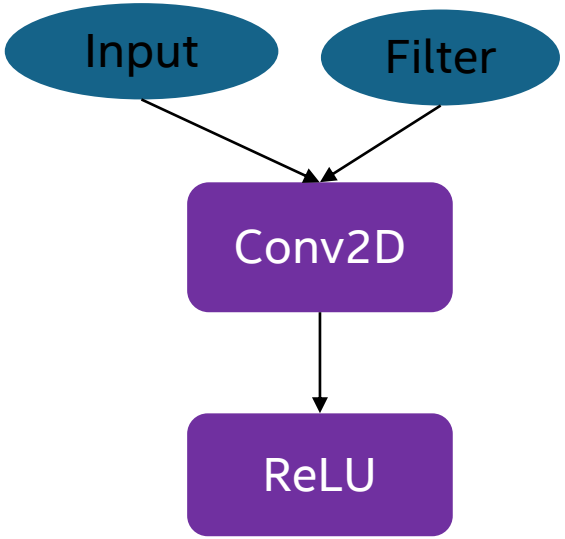
BACKUP

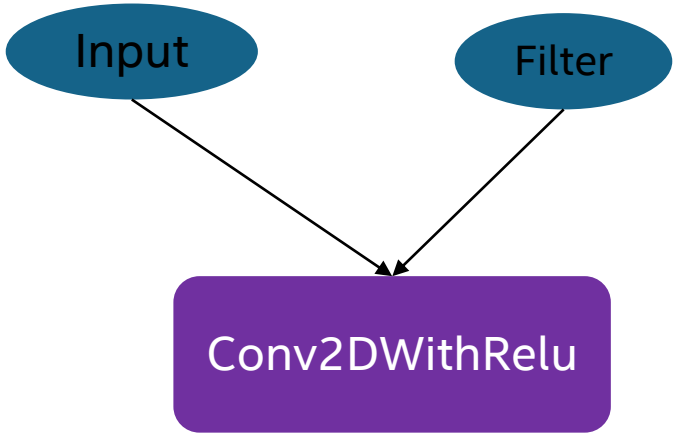
OPTIMIZATIONS - REVISITED



GRAPH OPTIMIZATIONS: FUSION



Before Merge



After Merge

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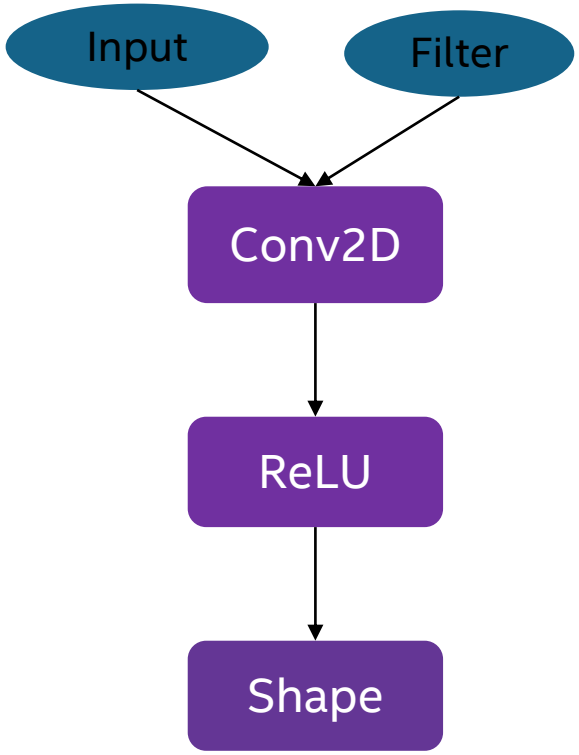
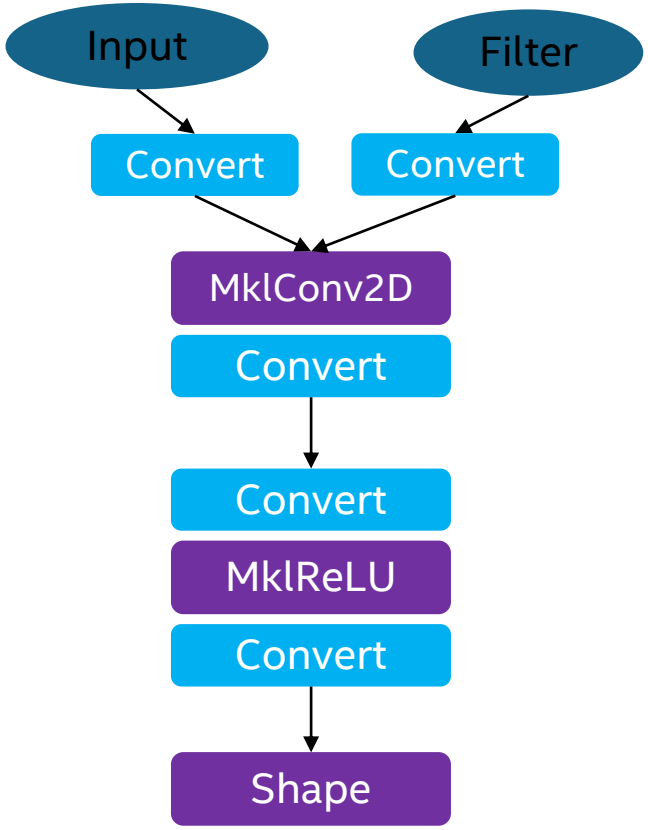
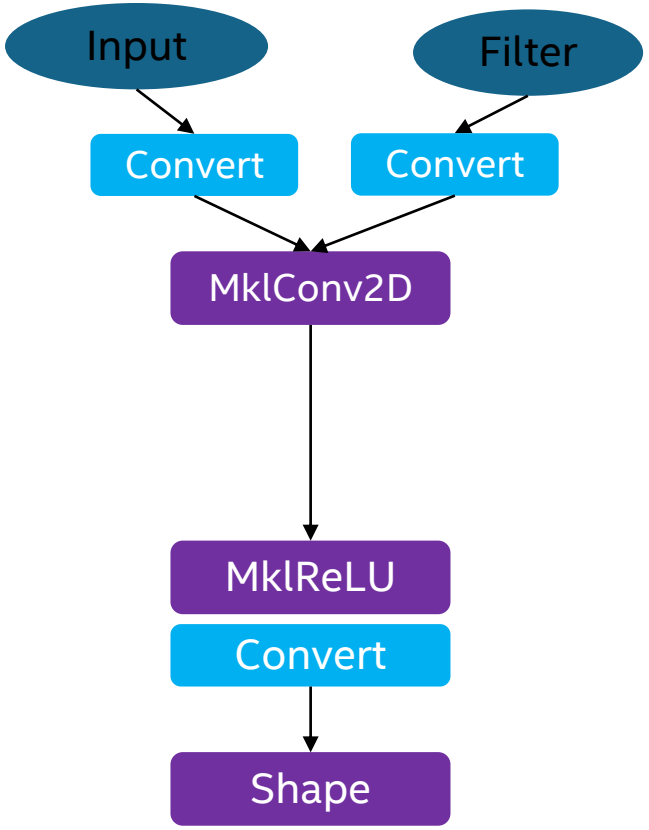
GRAPH OPTIMIZATIONS: LAYOUT CONVERSION



Initial Graph

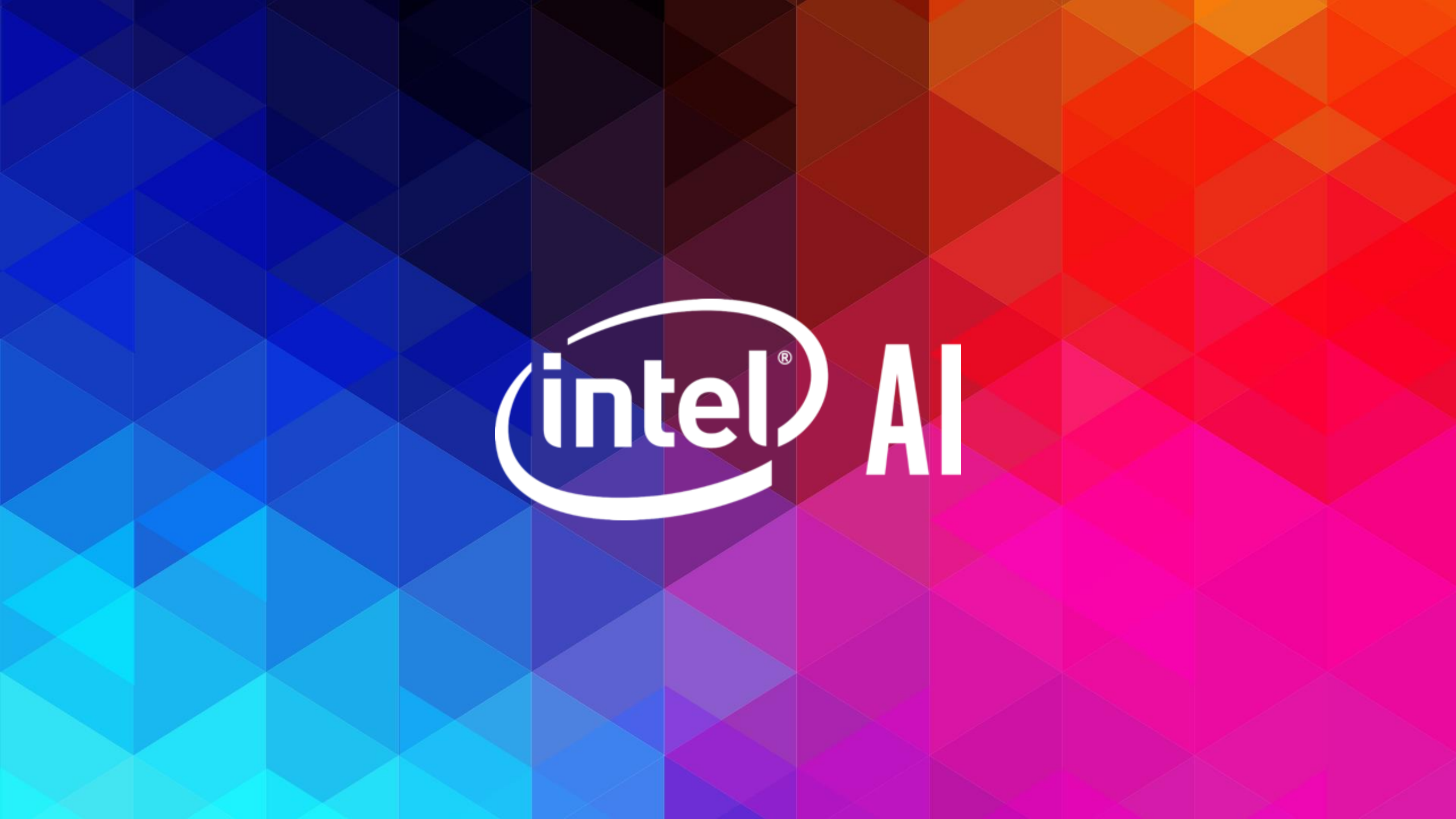


After Layout Conversions



After Layout Propagation

- All MKL-DNN operators use highly-optimized layouts for TensorFlow tensors.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