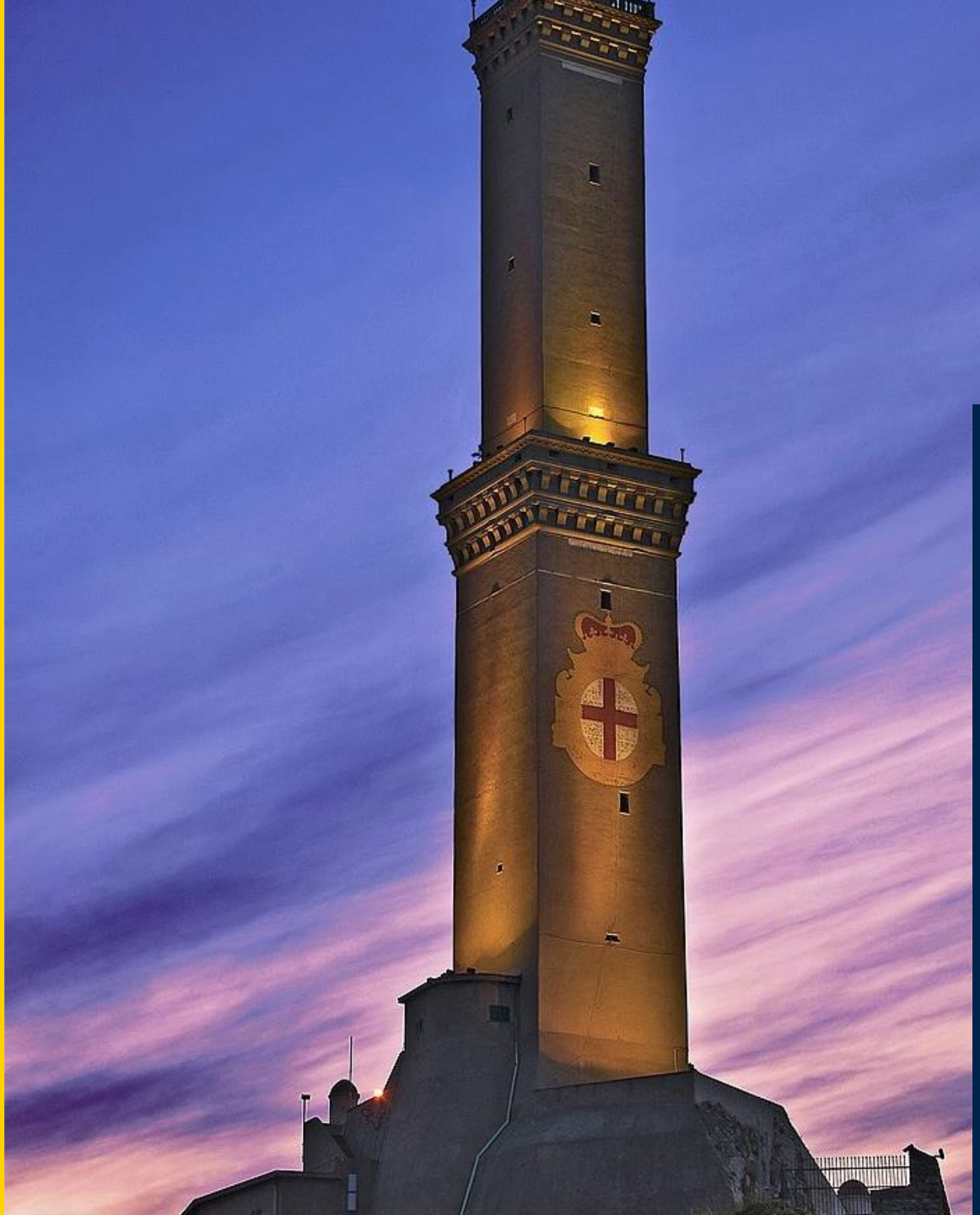

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From Heterogenous Development Frameworks to Unified Benchmarking in the Cloud

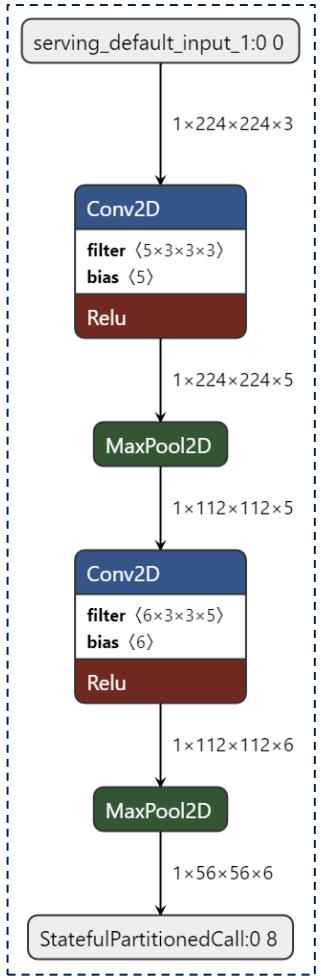
Marco Lattuada, PhD

STMicroelectronics

Introduction

- Deployment of **Machine Learning** models on **Embedded Systems** is becoming **more and more relevant**
- Machine learning models can be very different in terms of algorithms, size, formats, etc.
- An automatic deployment flow must tackle this **heterogeneity** to reduce as much as possible the restrictions to the end users
- This presentation will show:
  - What characterize heterogeneity of Machine Learning models
  - How heterogeneity can be addressed to **maximize the support** and to **maximize sharing and reuse**

From Machine Learning to Implementation



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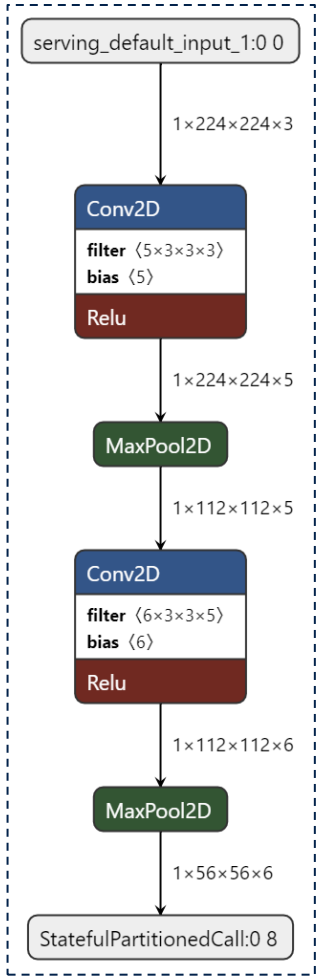
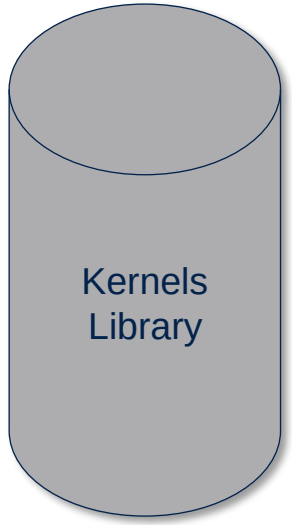
From Machine Learning to Implementation





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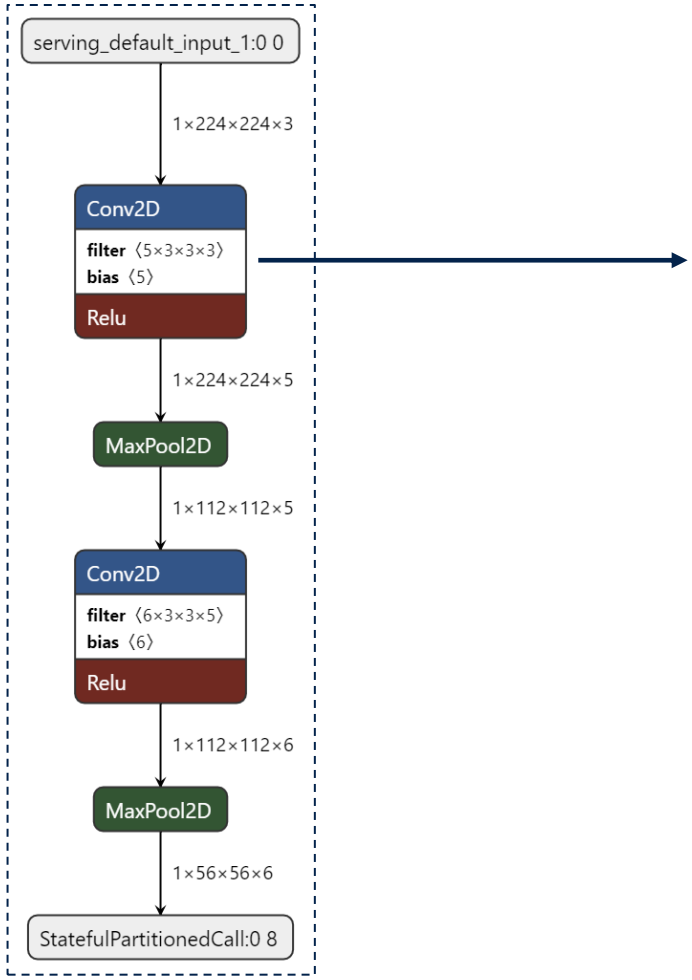
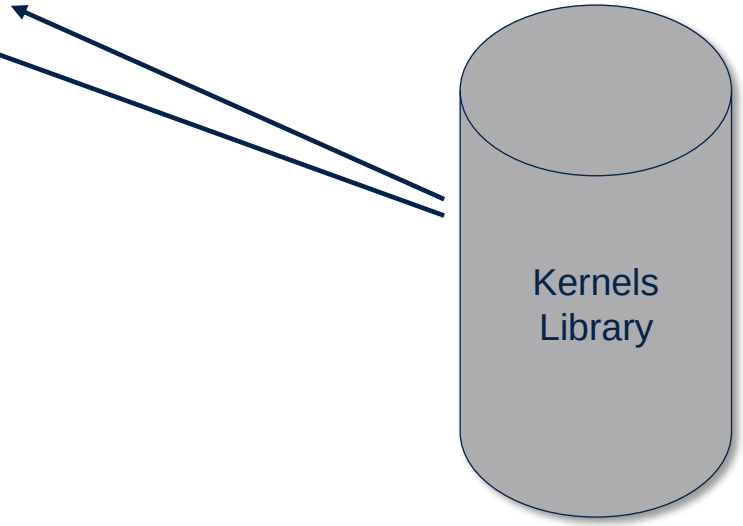



```
float * temp1 = conv2d(input);
float * temp2 = relu(temp1);
```



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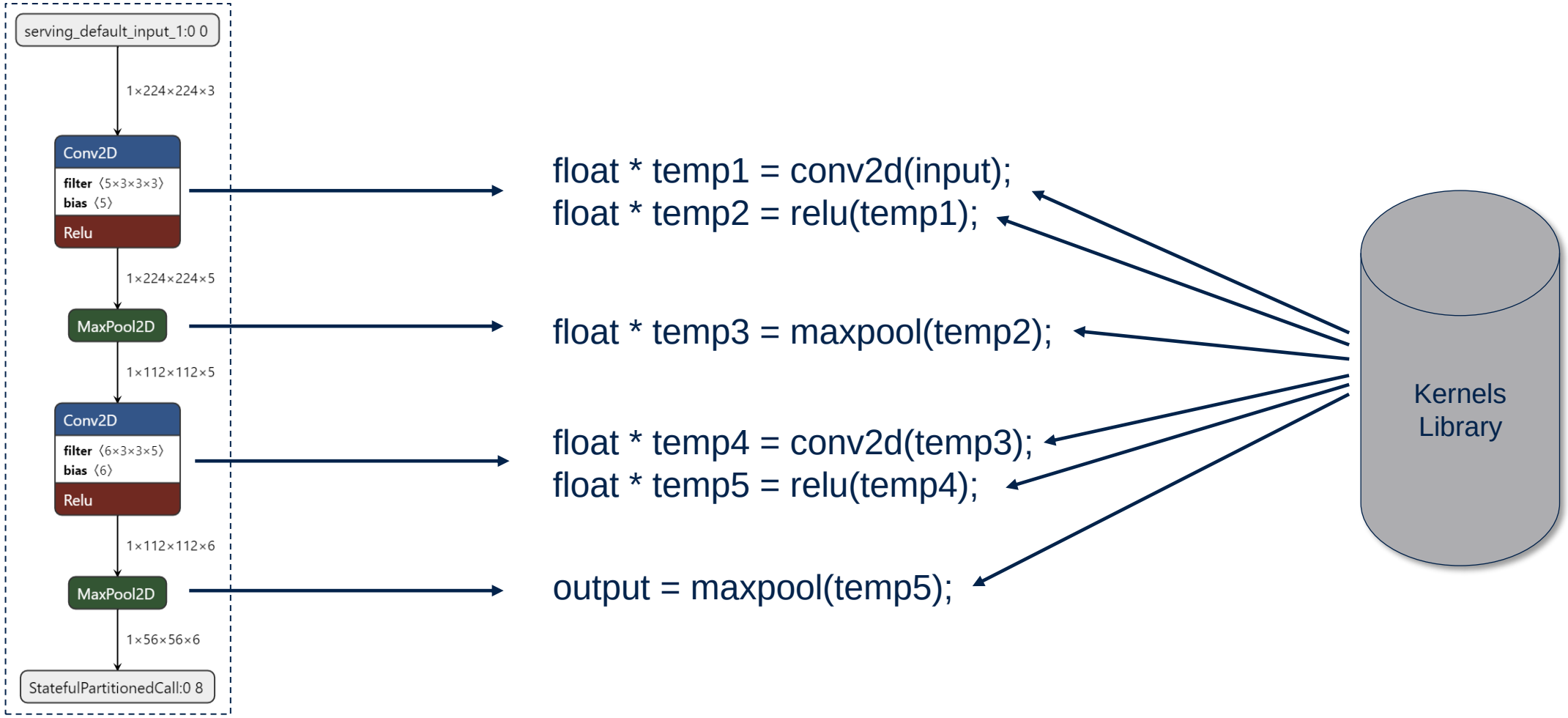
From Machine Learning to Implementation



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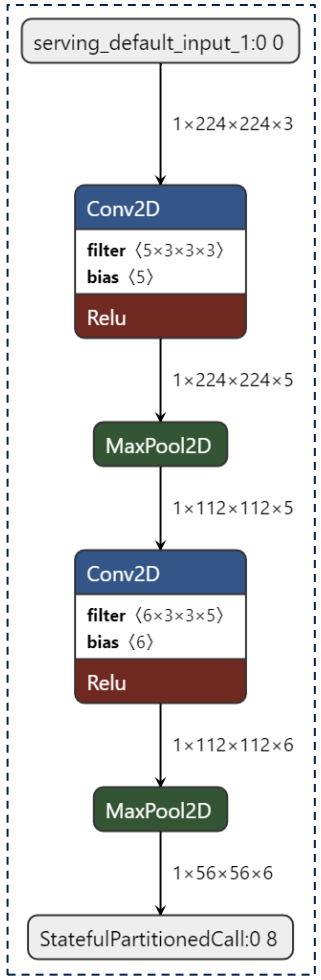
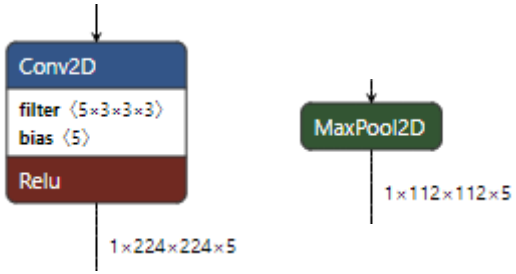



```
void network(float * input, float * output) {

    float * temp1 = conv2d(input);
    float * temp2 = relu(temp1);

    float * temp3 = maxpool(temp2);

    float * temp4 = conv2d(temp3);
    float * temp5 = relu(temp4);

    output = maxpool(temp5);

}
```

Kernels Library

Heterogeneity: Operators



Heterogeneity: Operators

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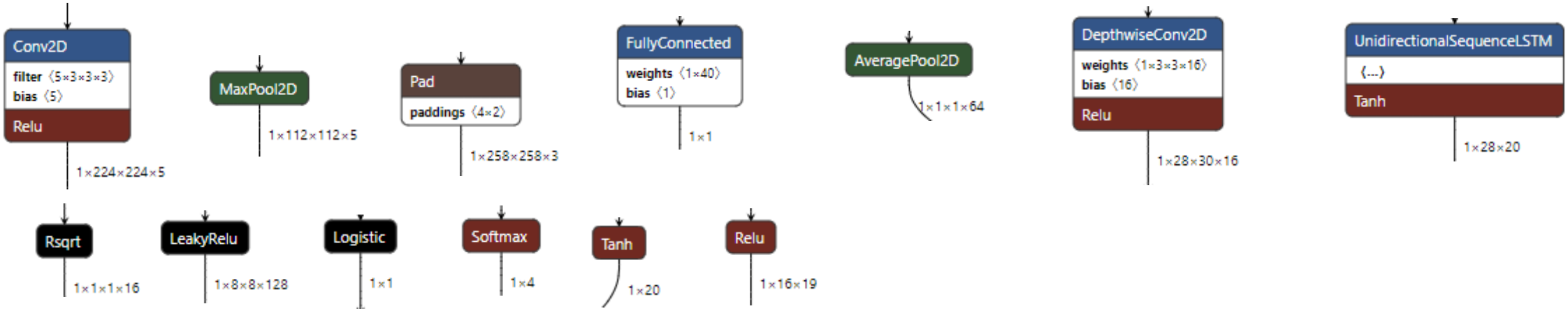
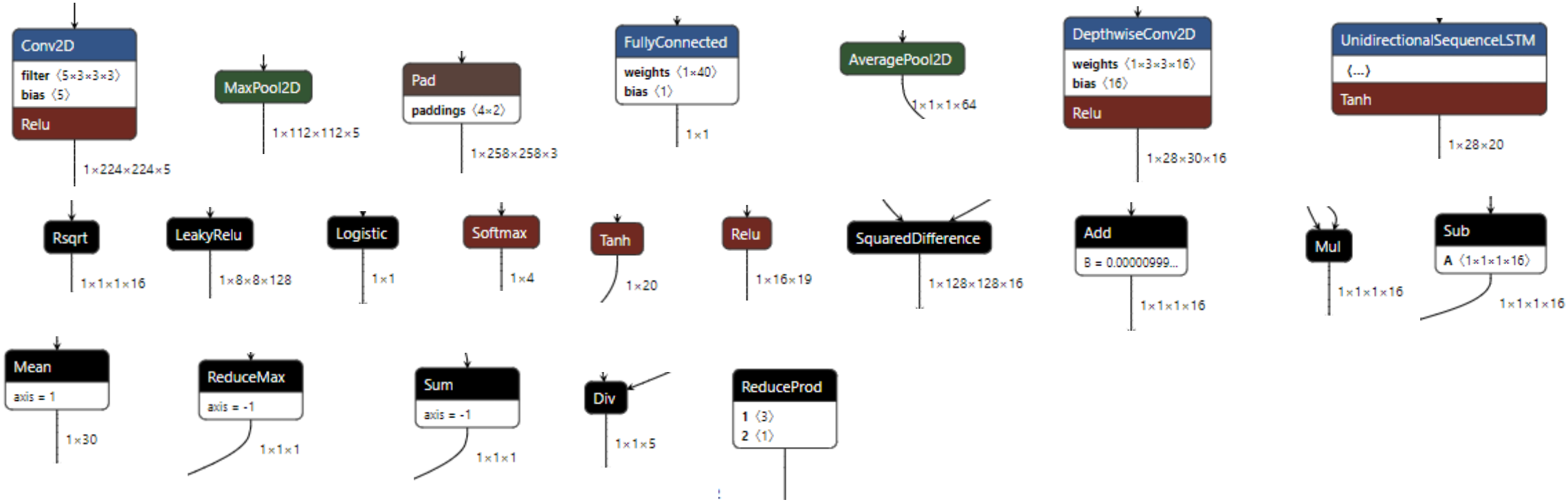


Heterogeneity: Operators



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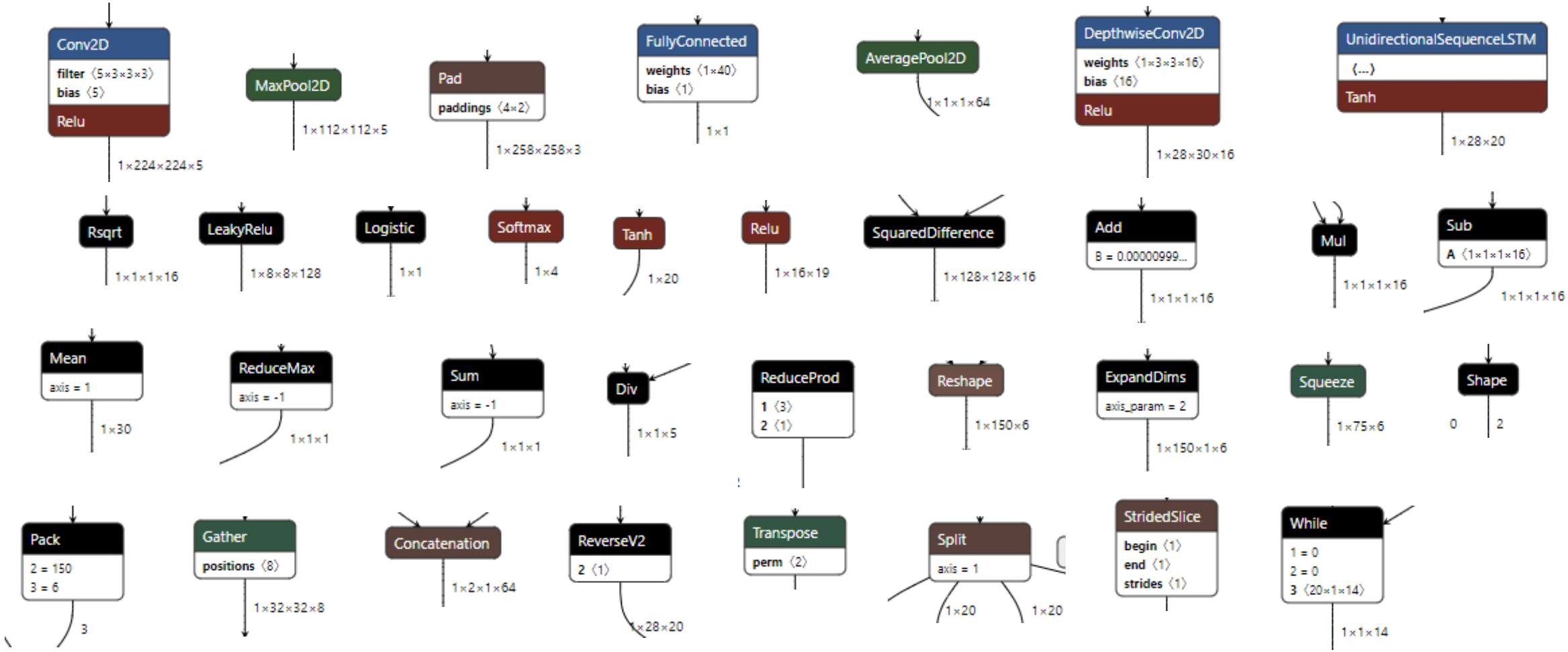

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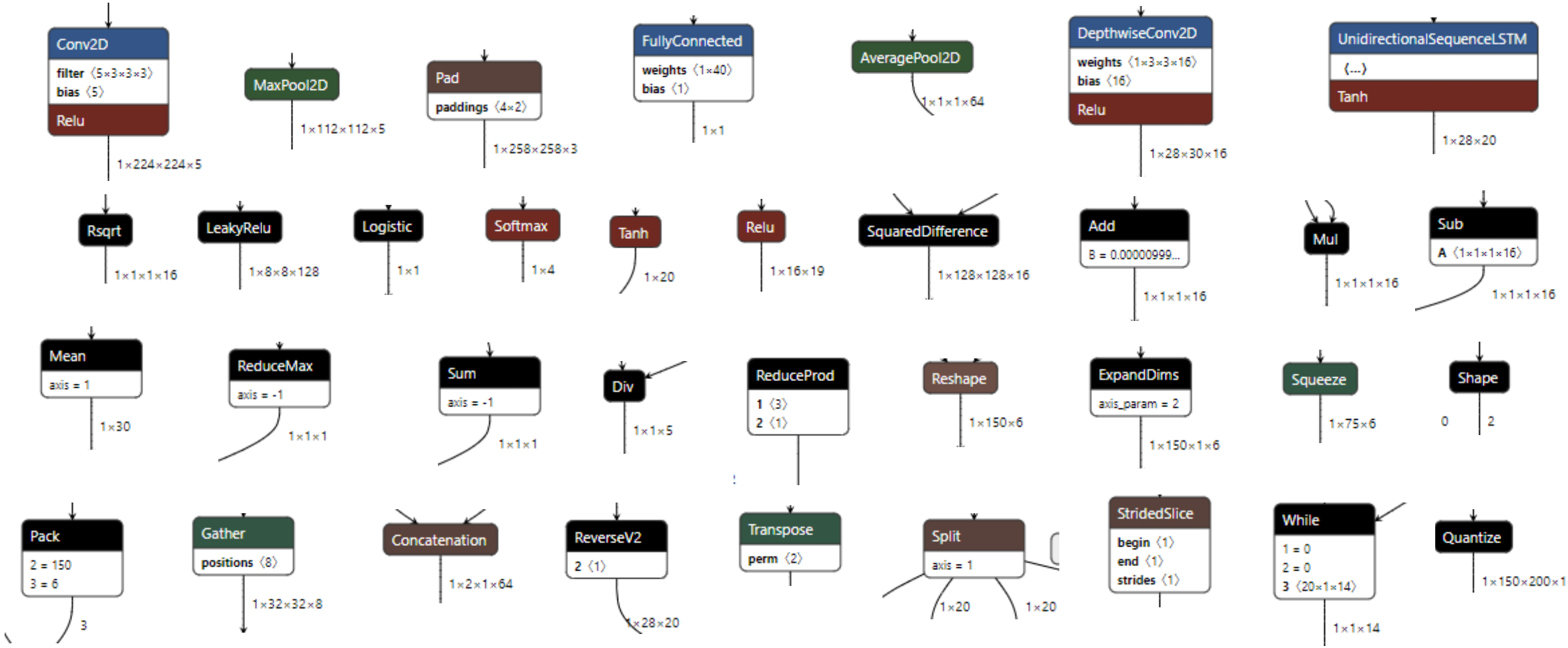

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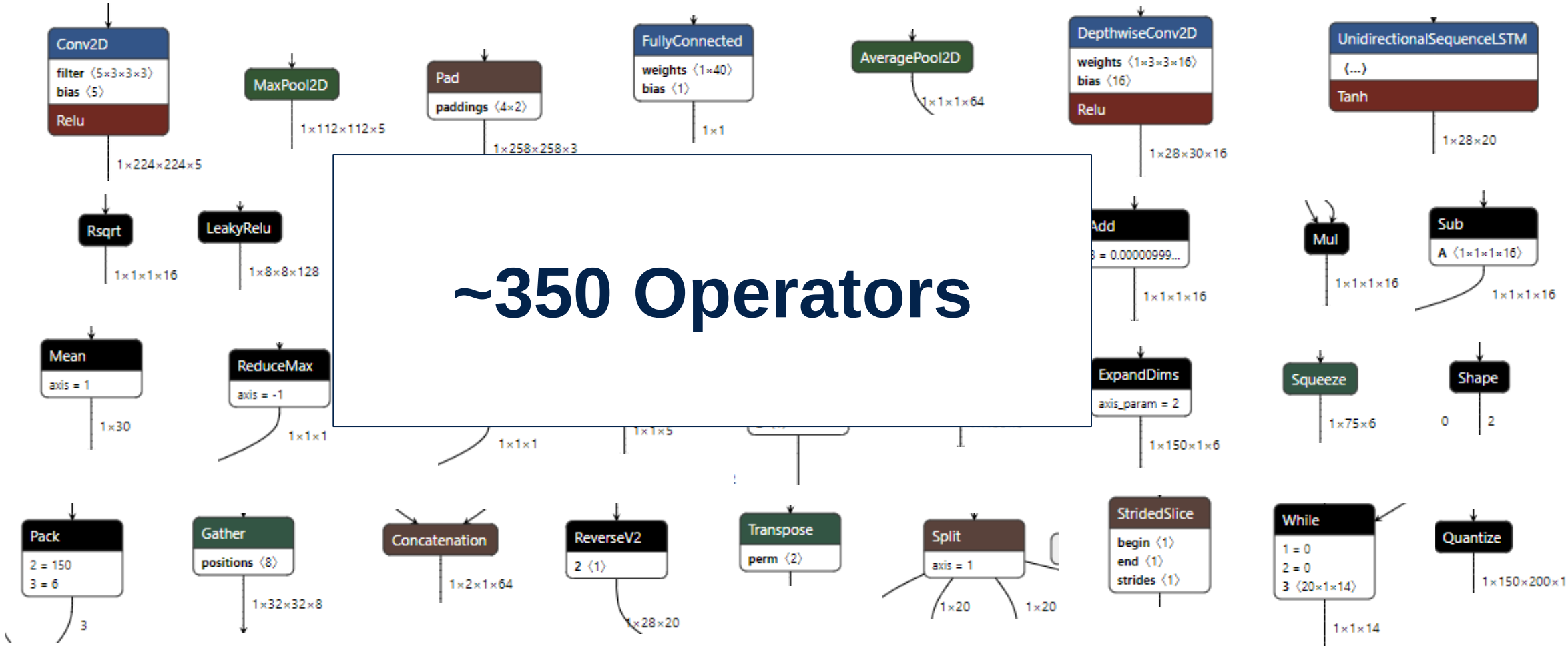

~350 Operators

Heterogeneity: DL Formats

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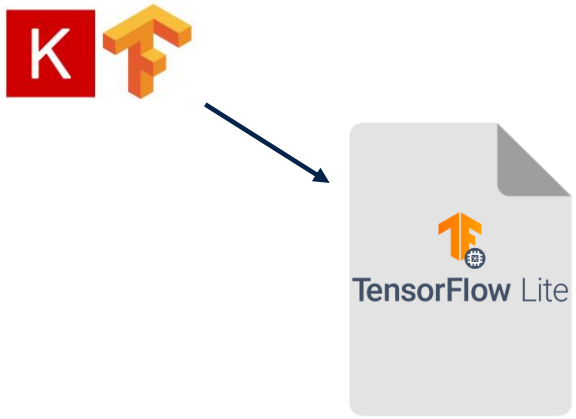

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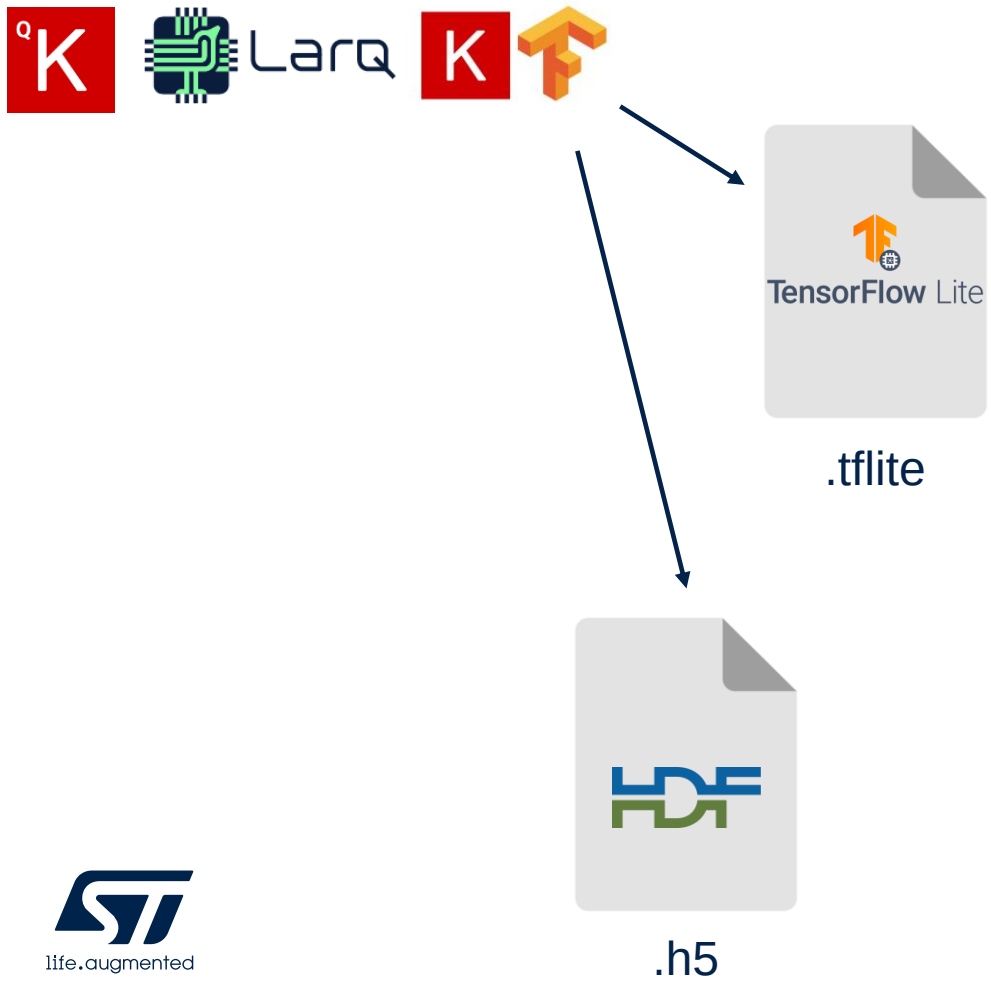

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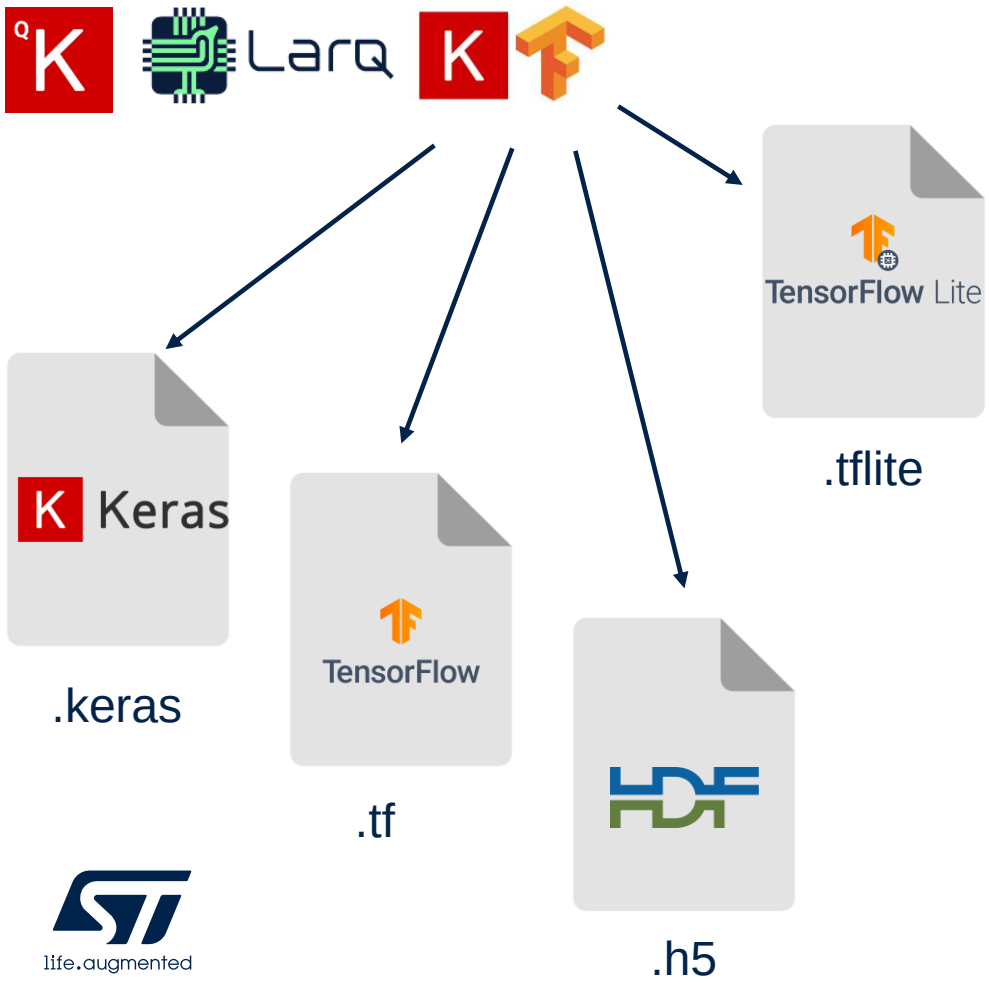

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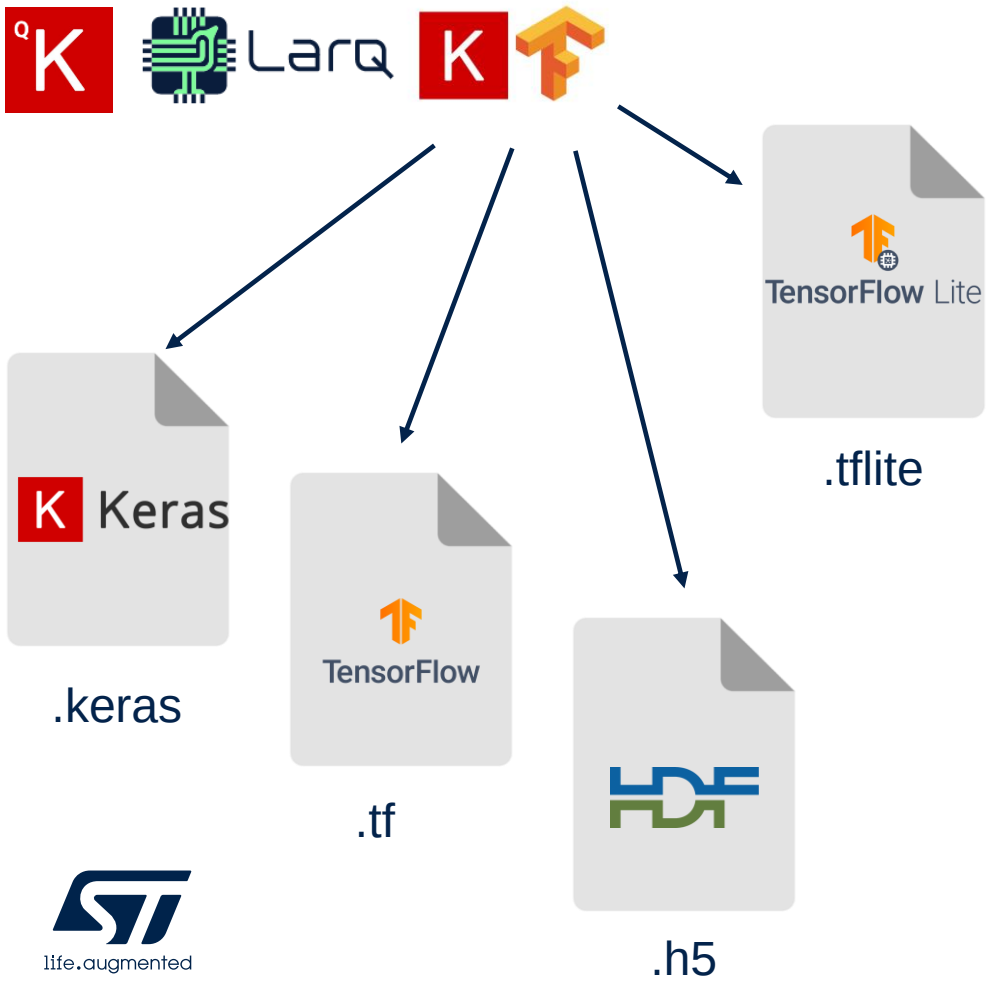

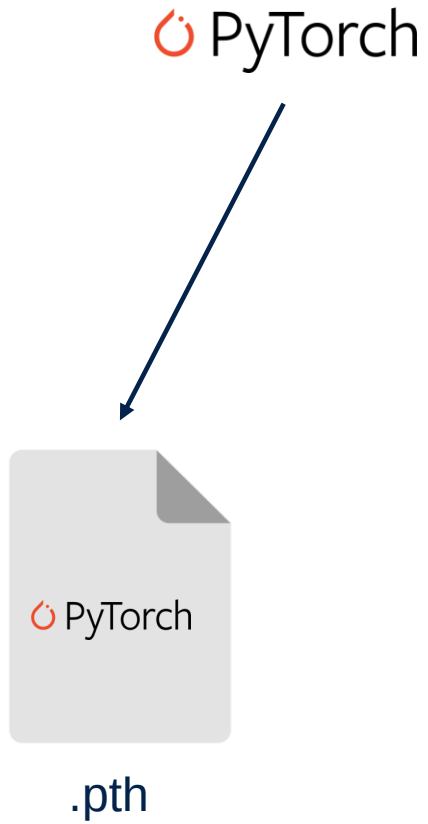

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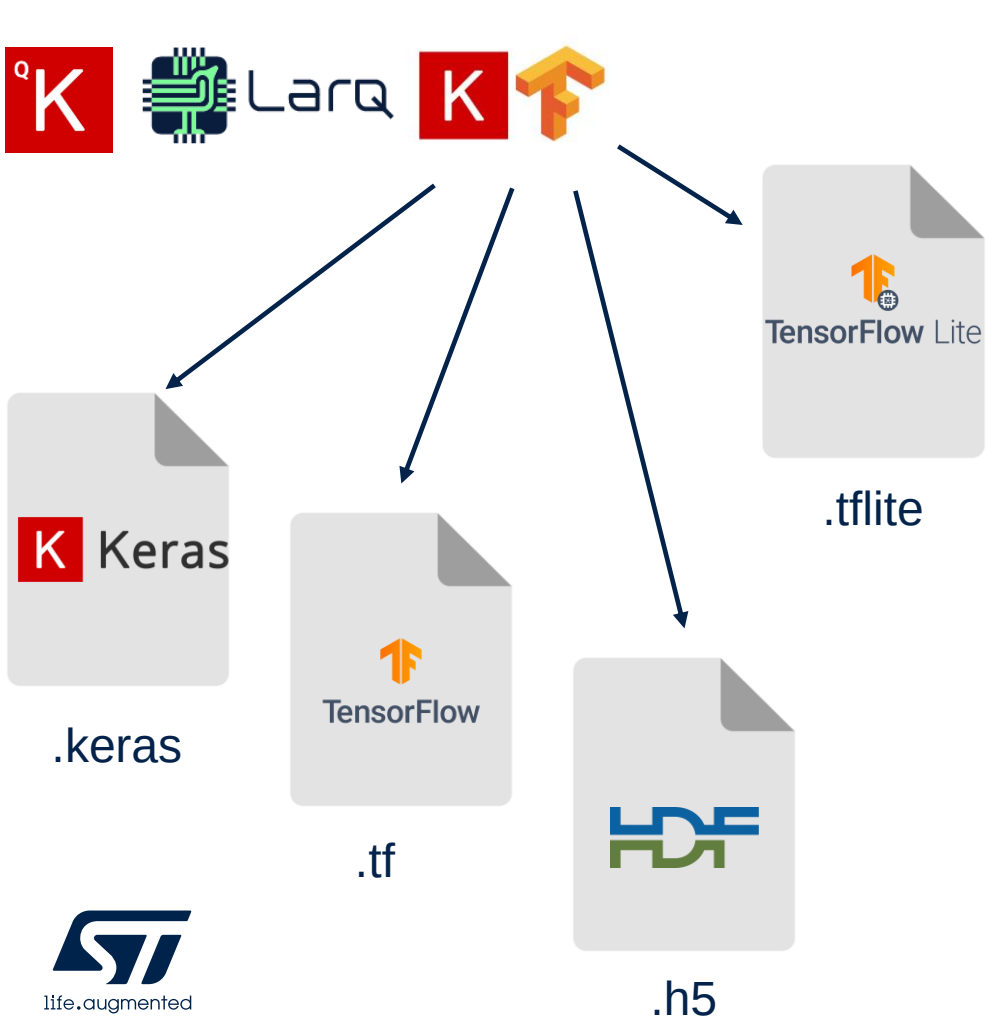

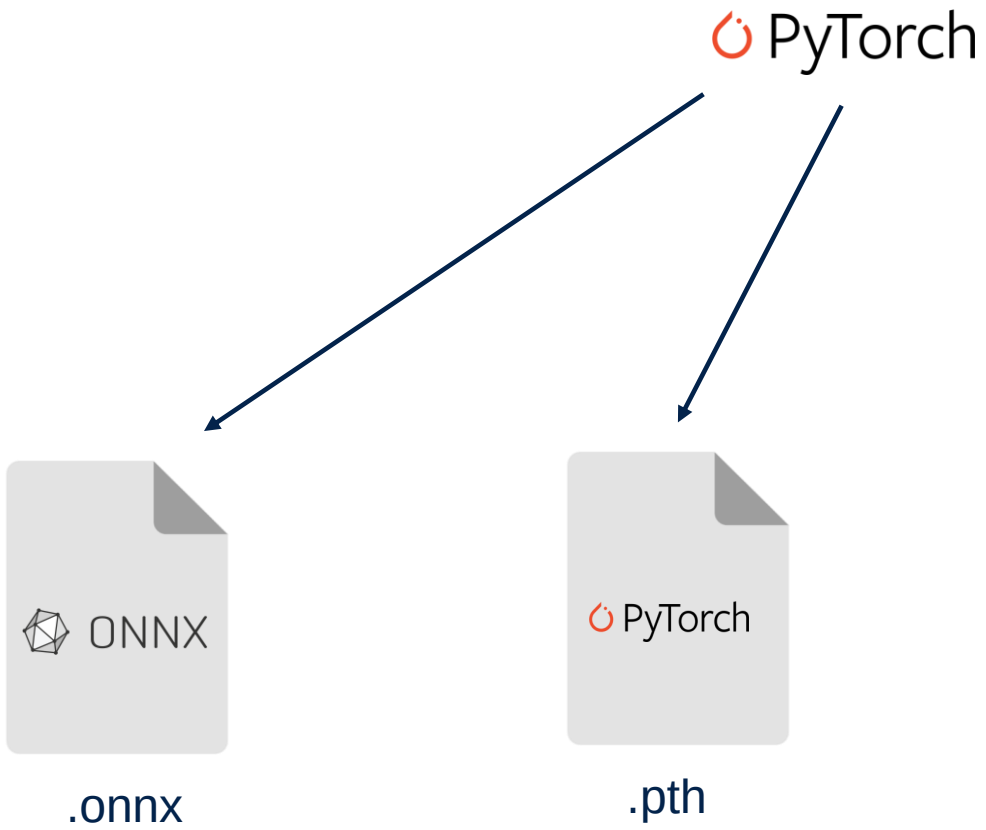

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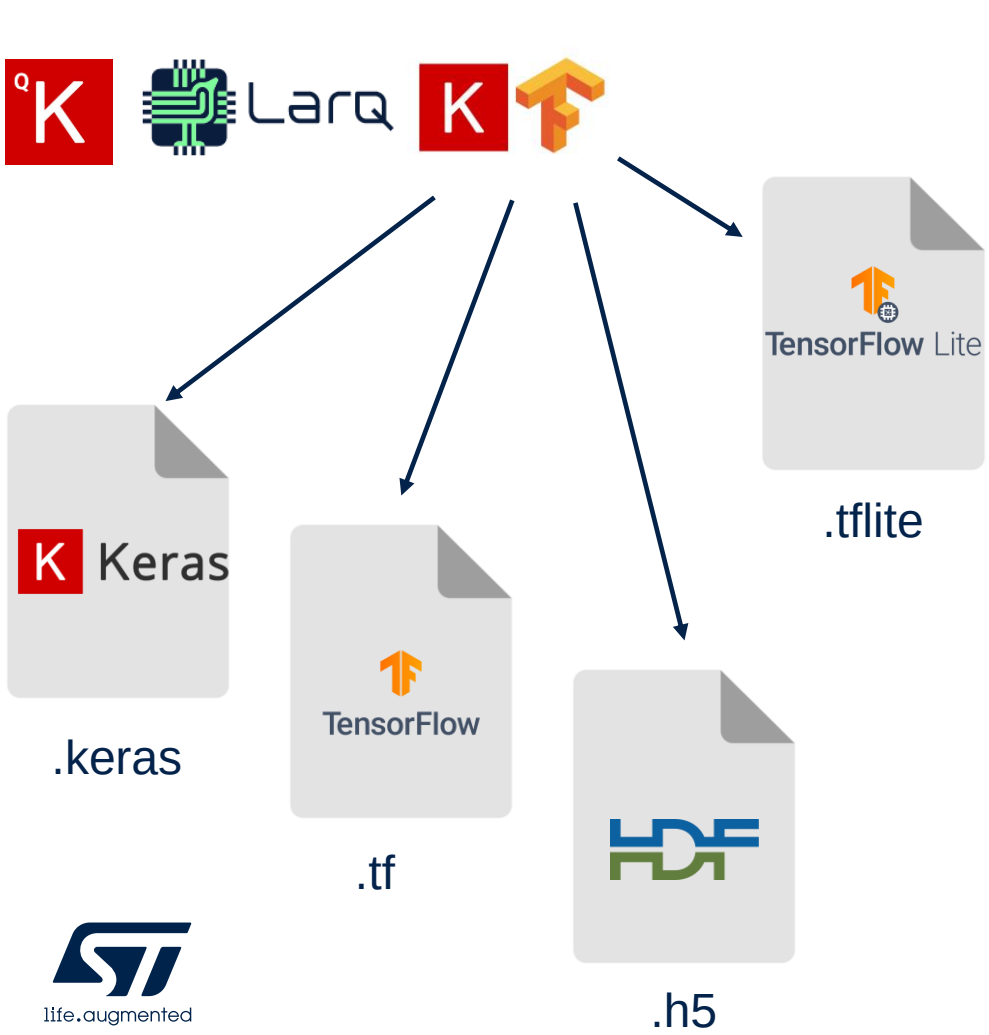

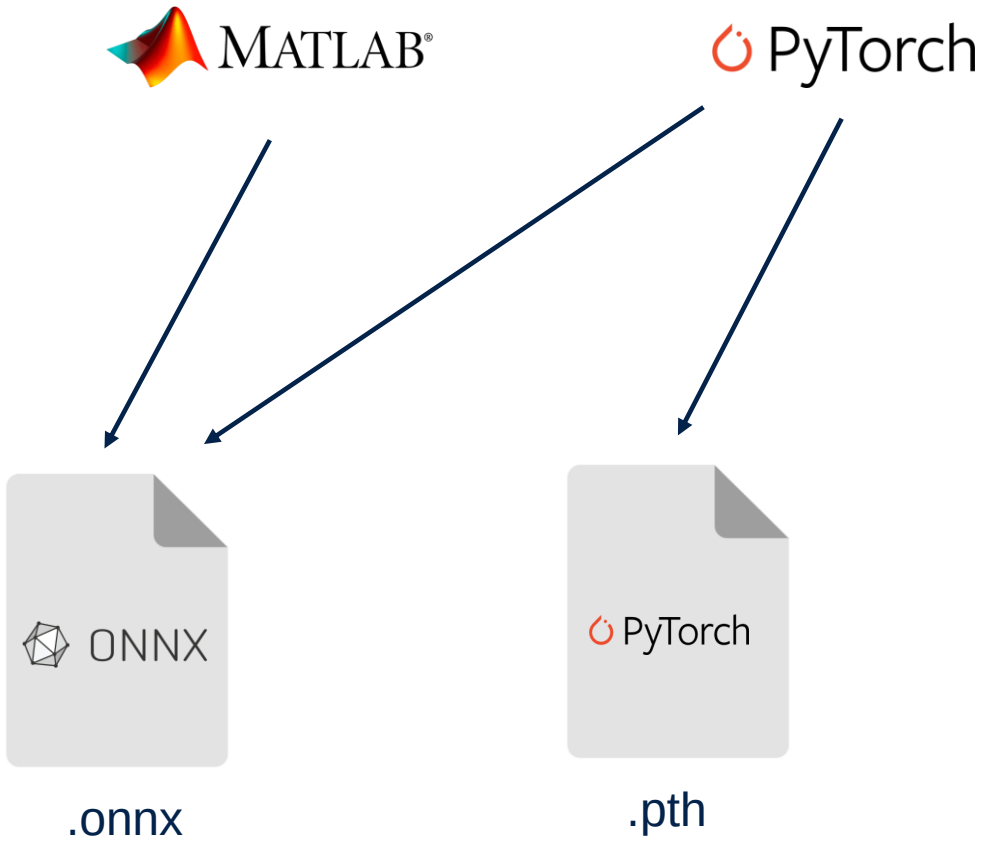

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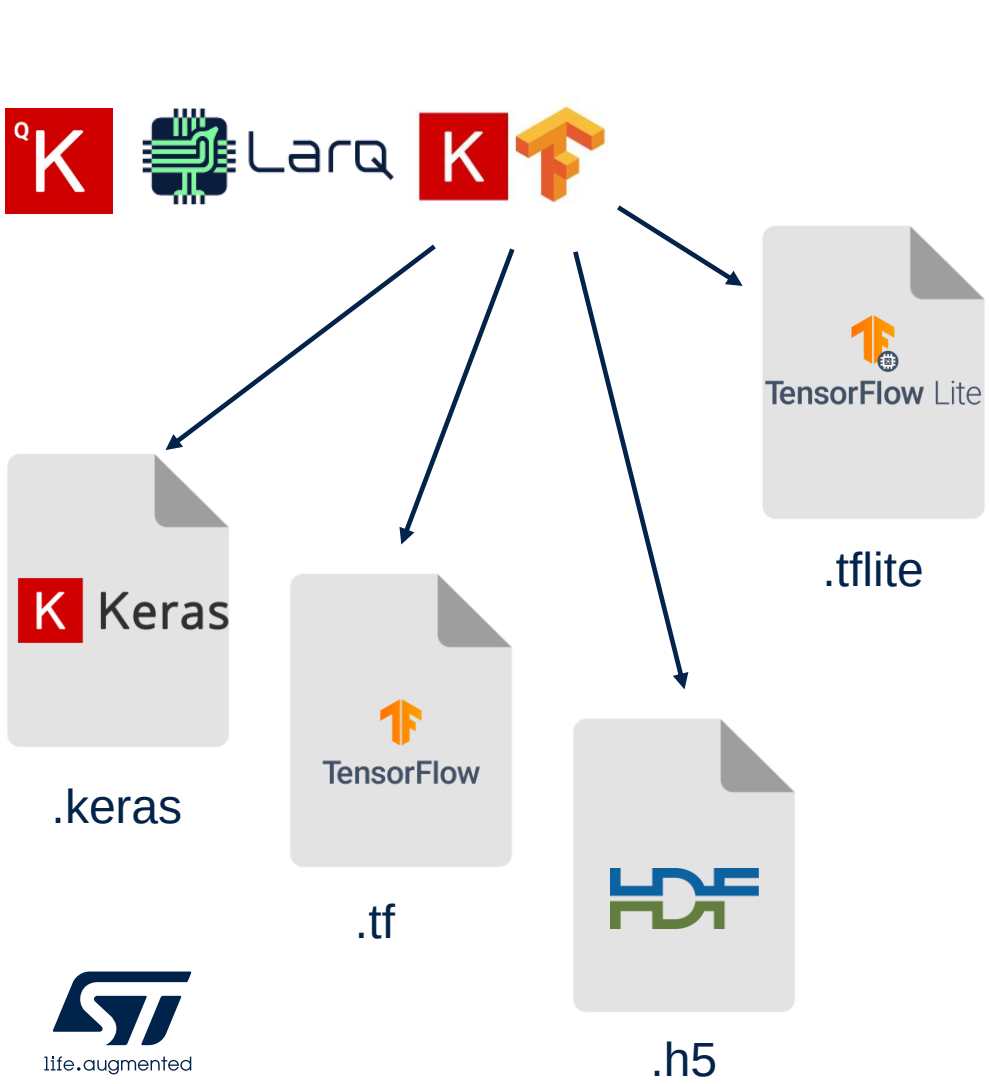

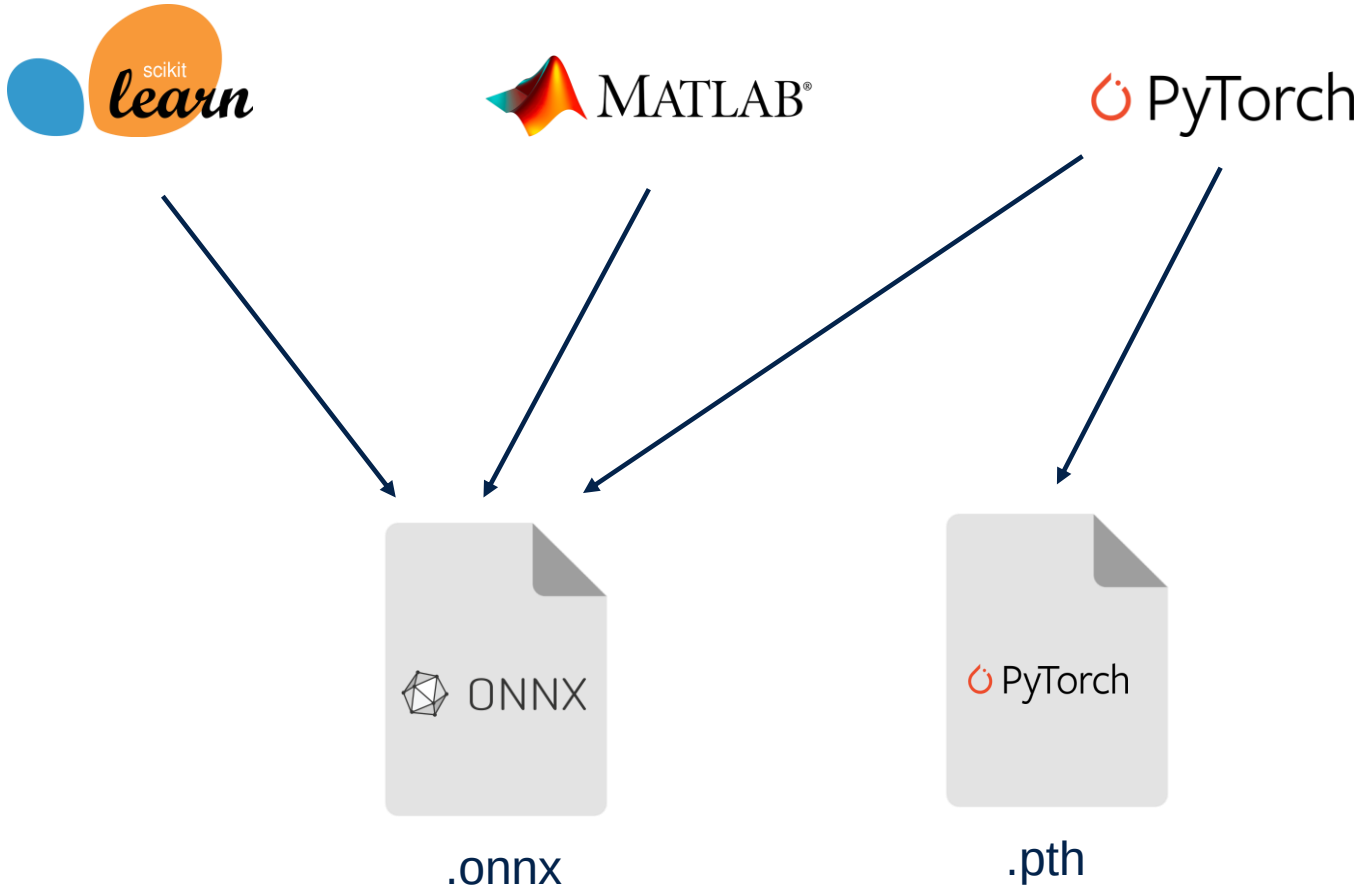

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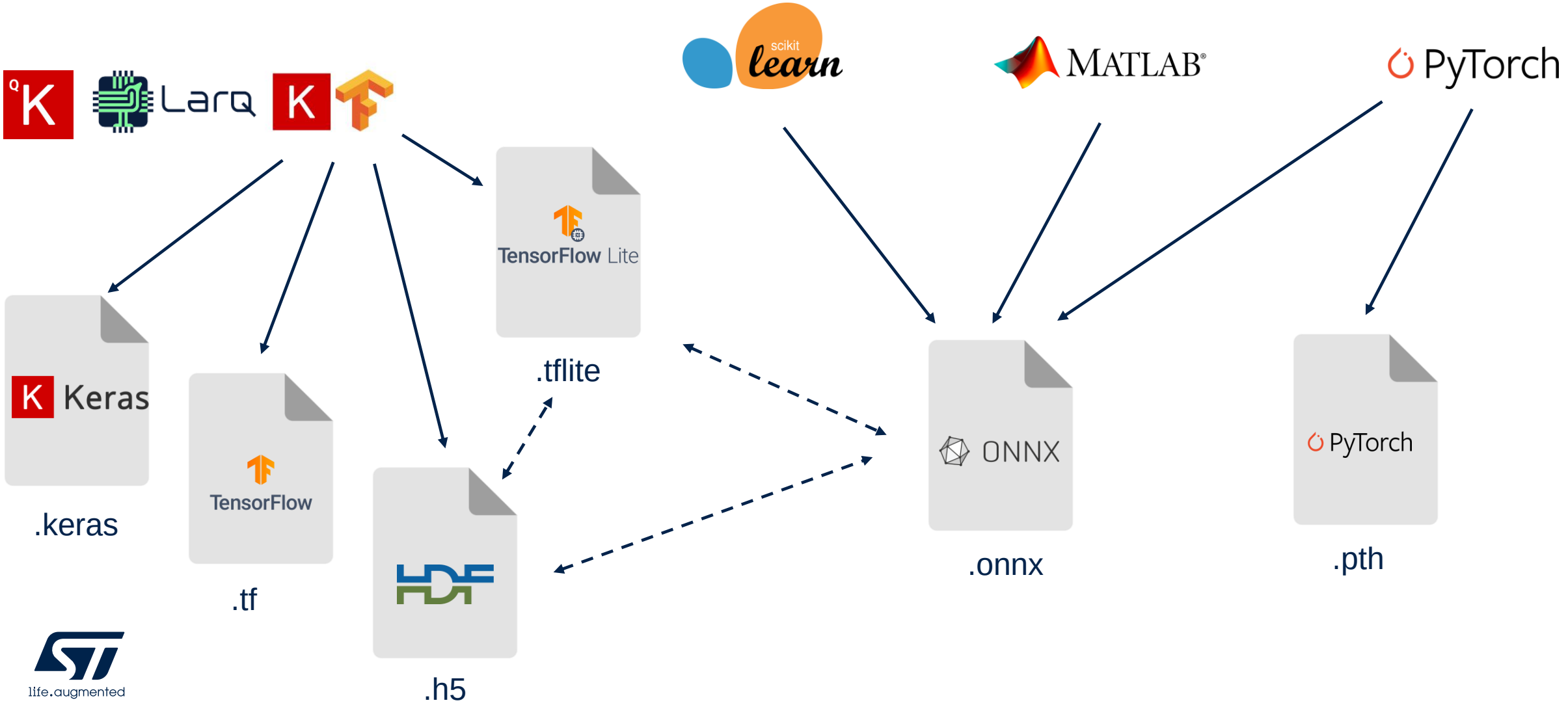

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Heterogeneity: DL Differences

- Availability of operators: not all operators are available in all frameworks
- Attributes: different attributes, different meaning, different default values
- Data layout, i.e., channel first vs. channel last
- Quantization, i.e., available precisions to represent data

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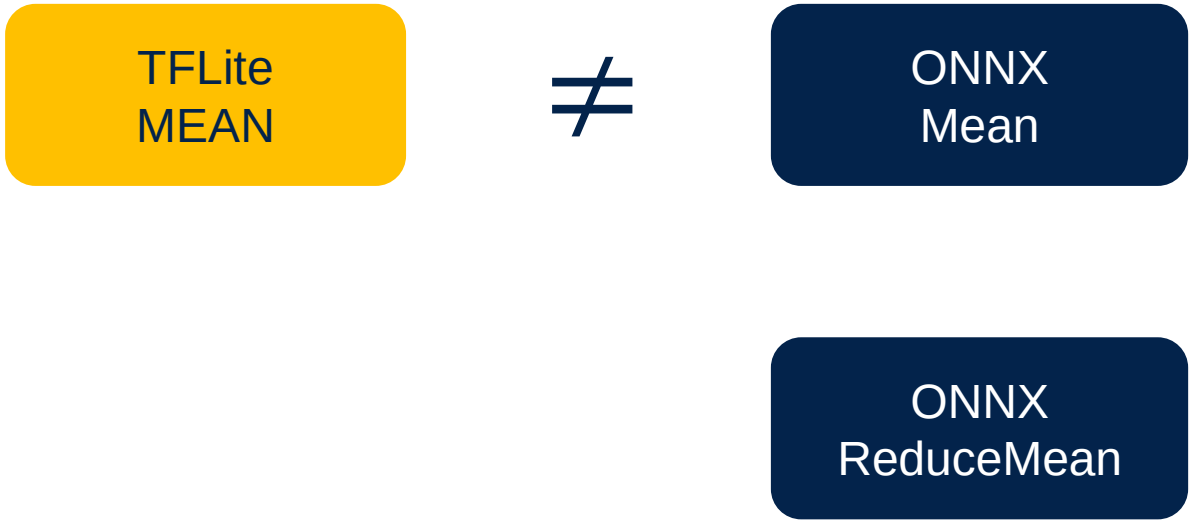

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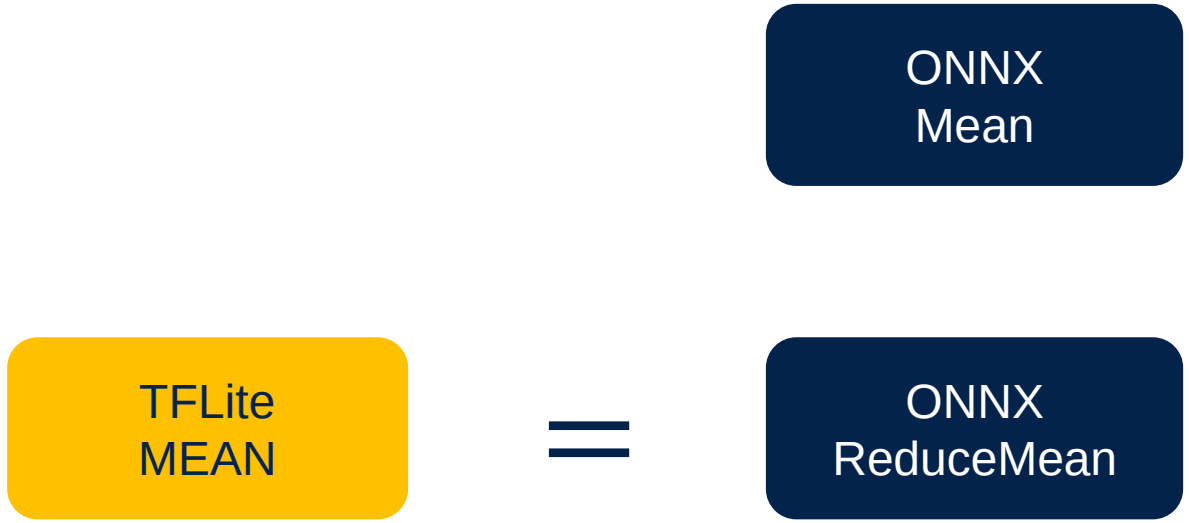

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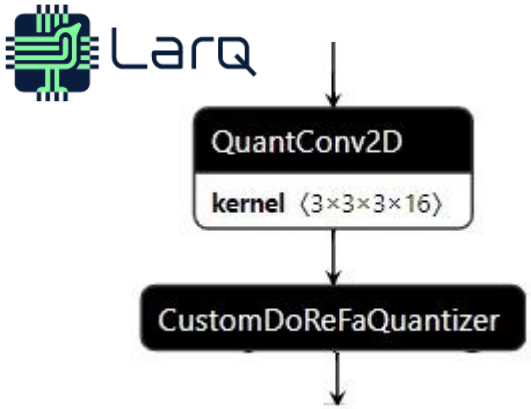

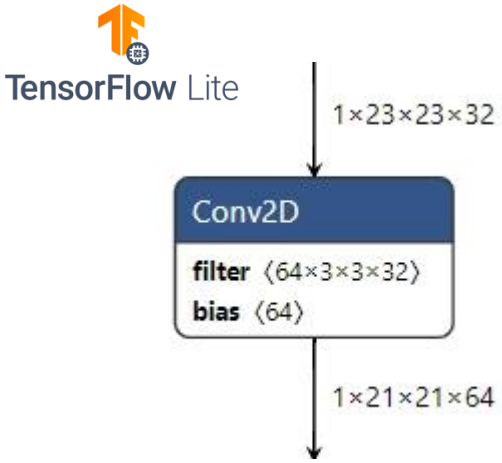

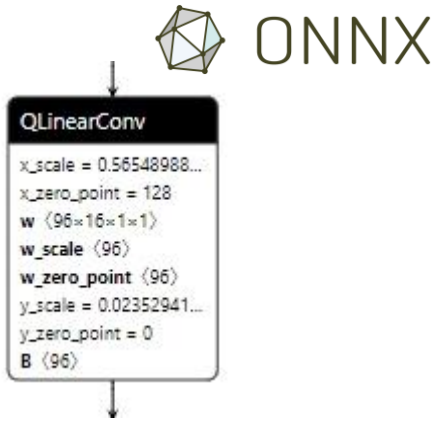

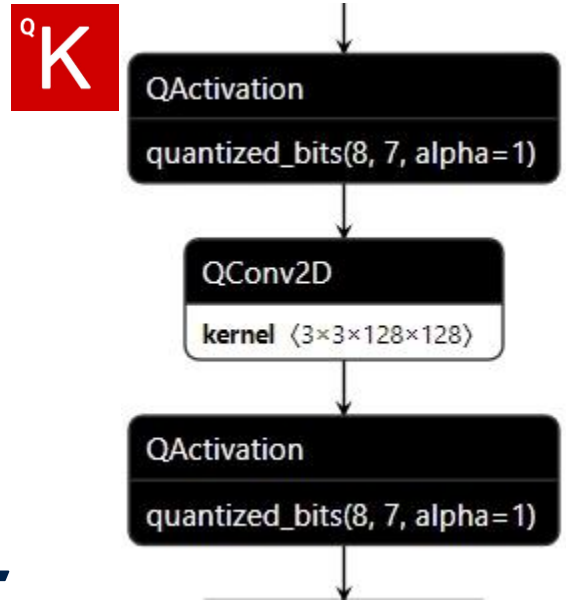

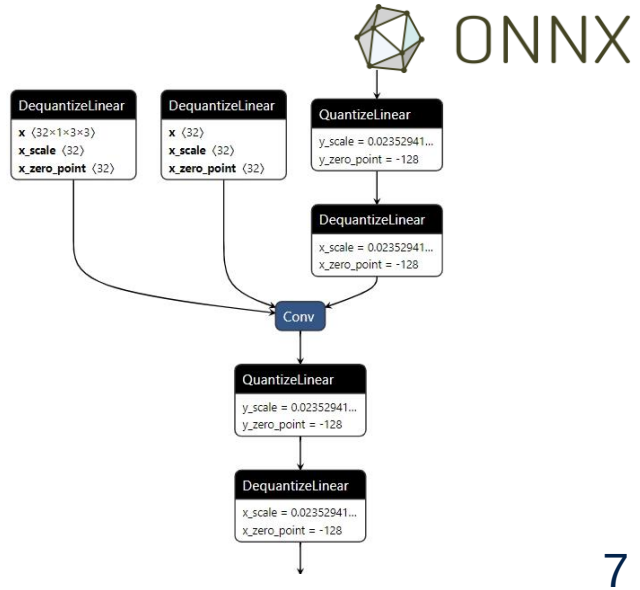

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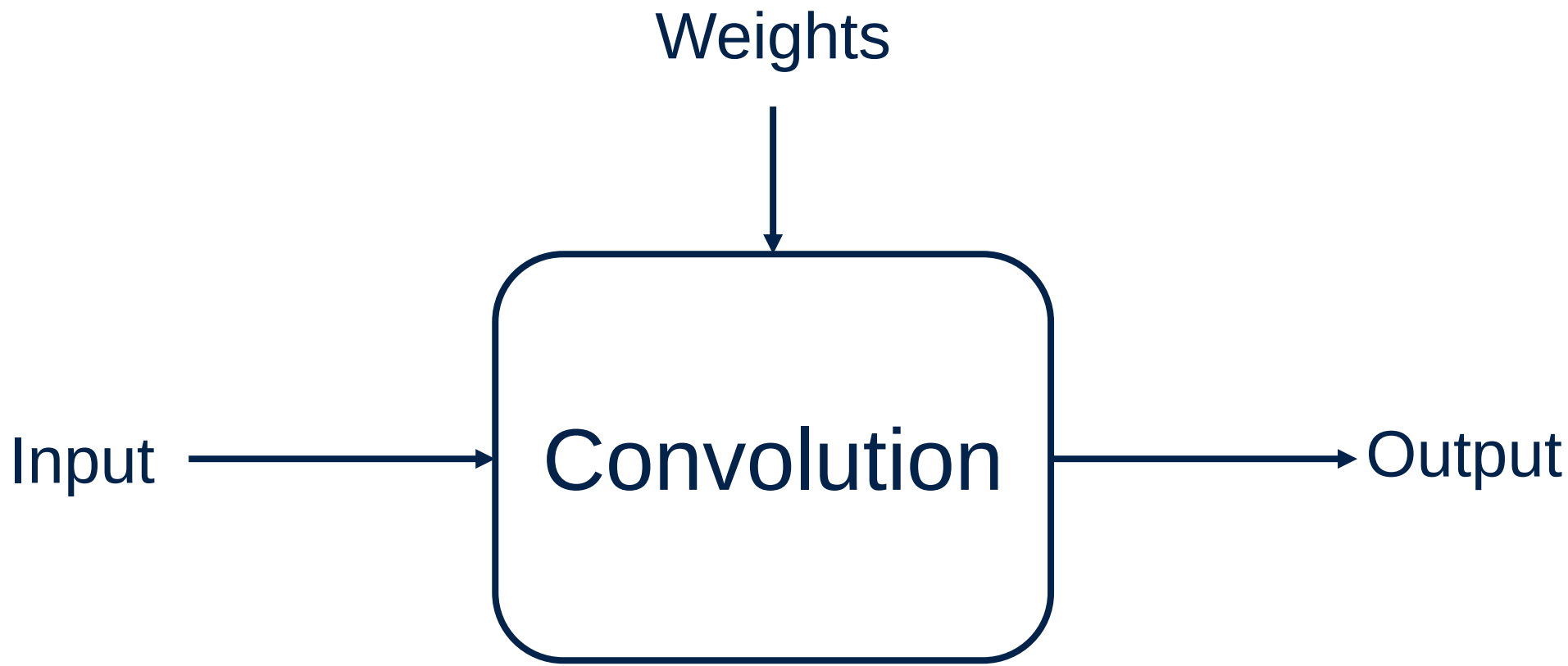
Heterogeneity: Quantization



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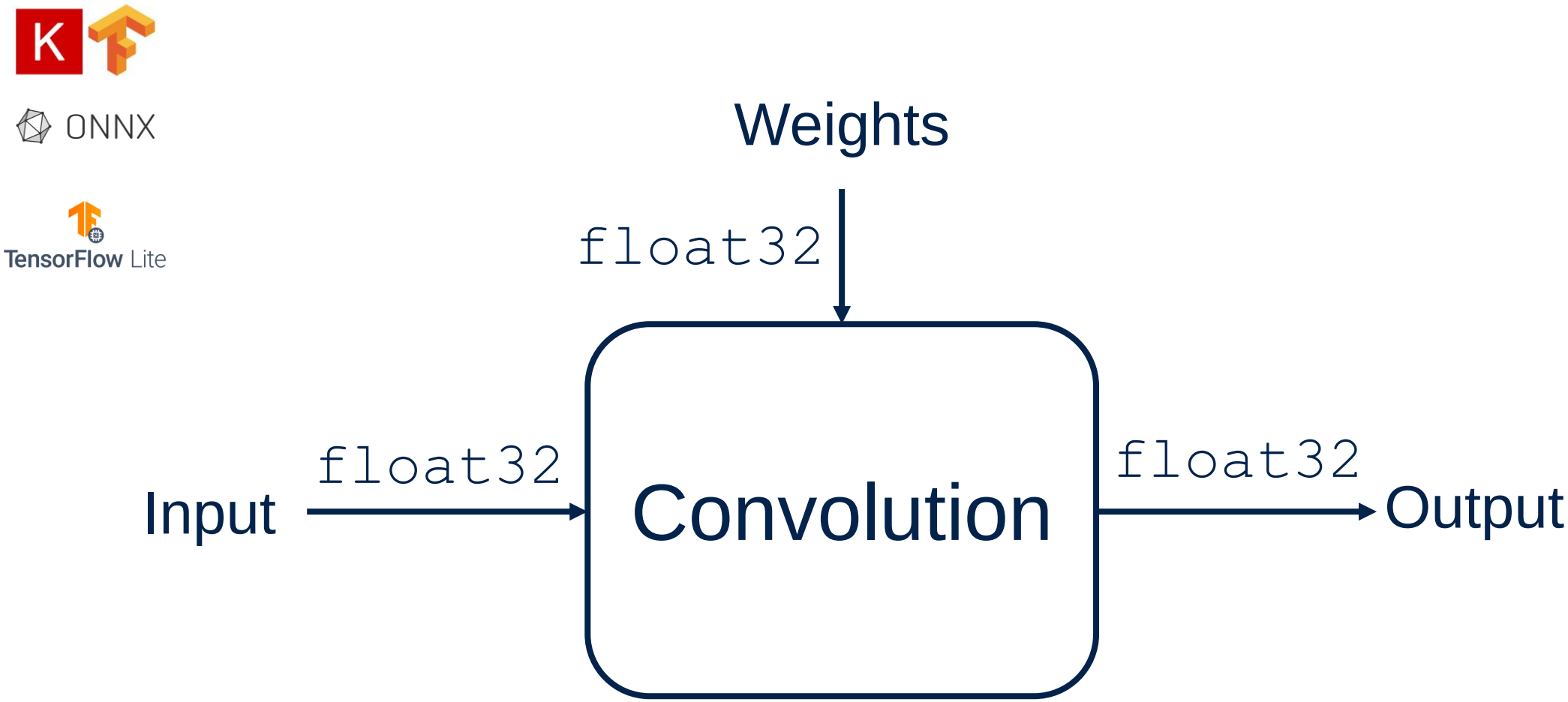

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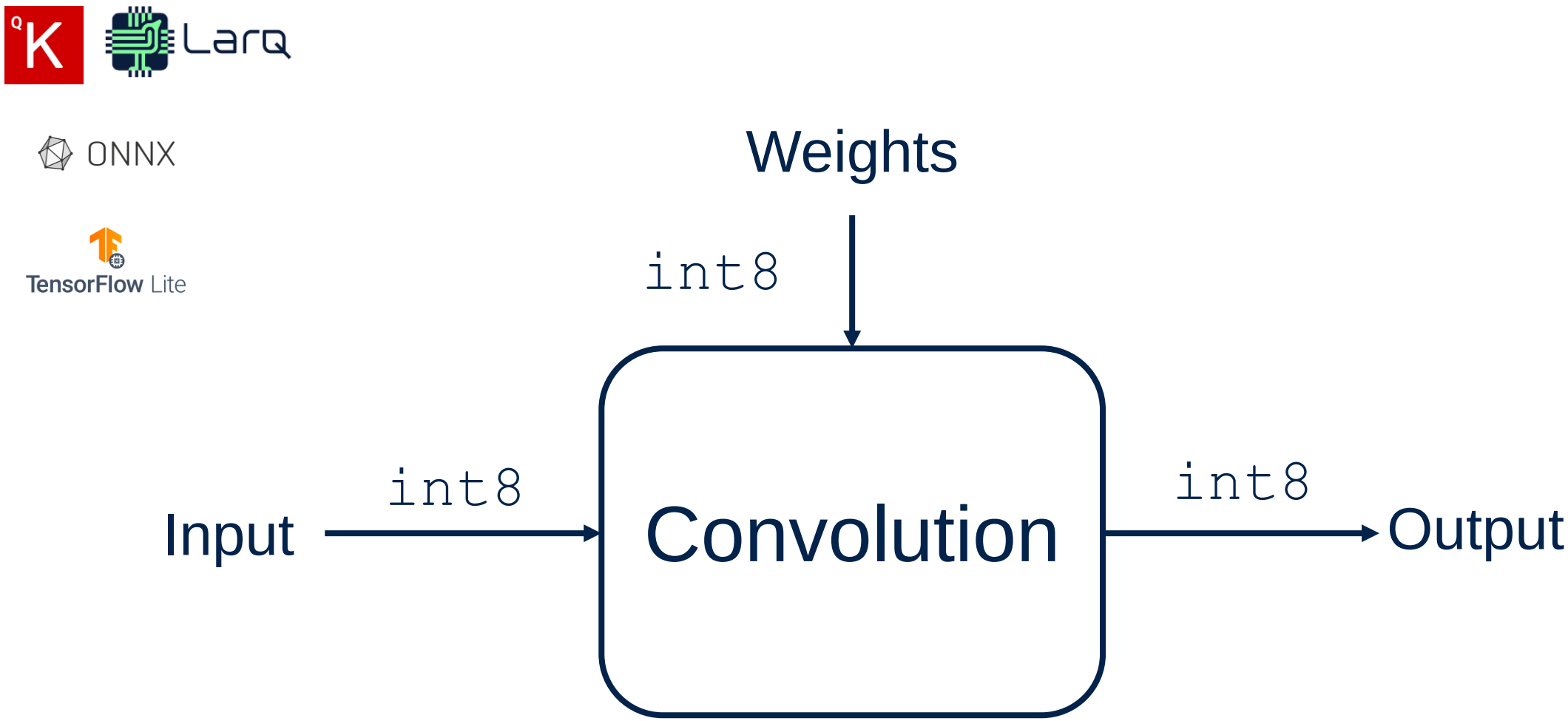

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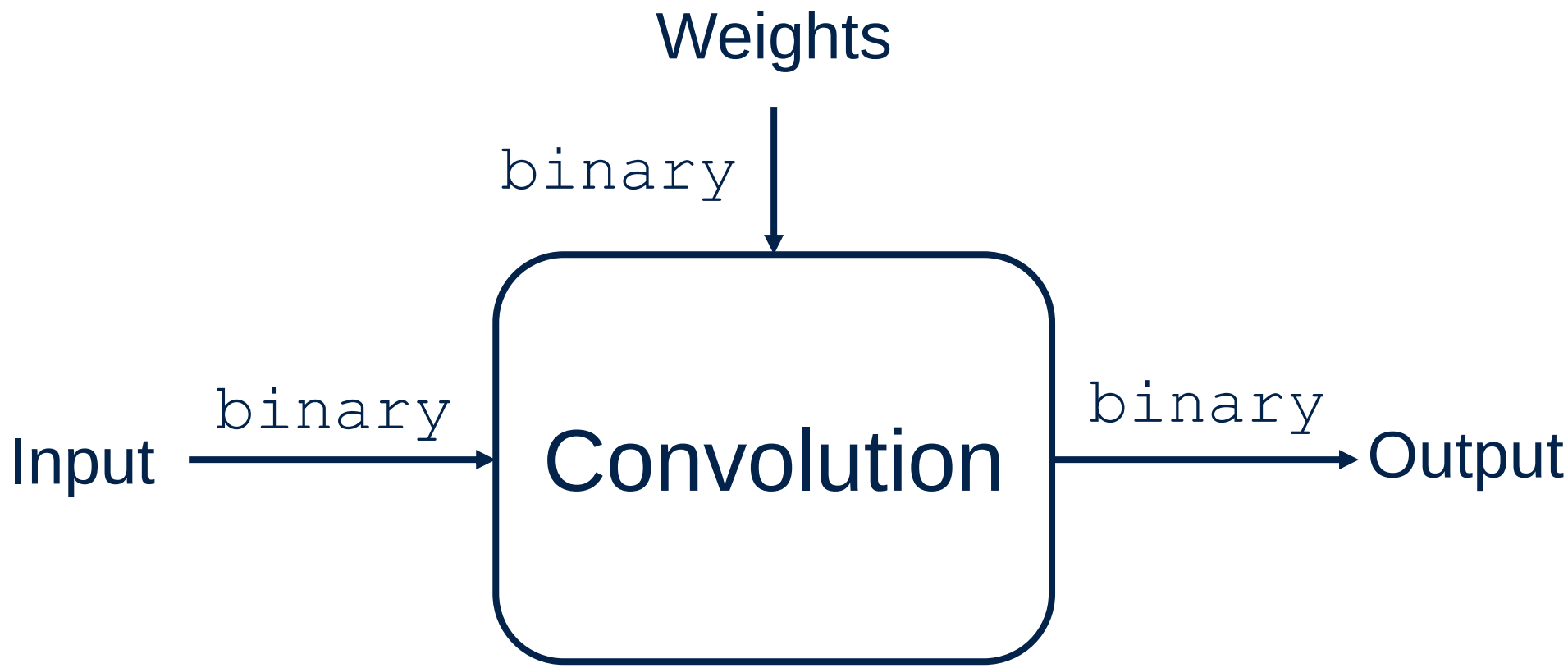

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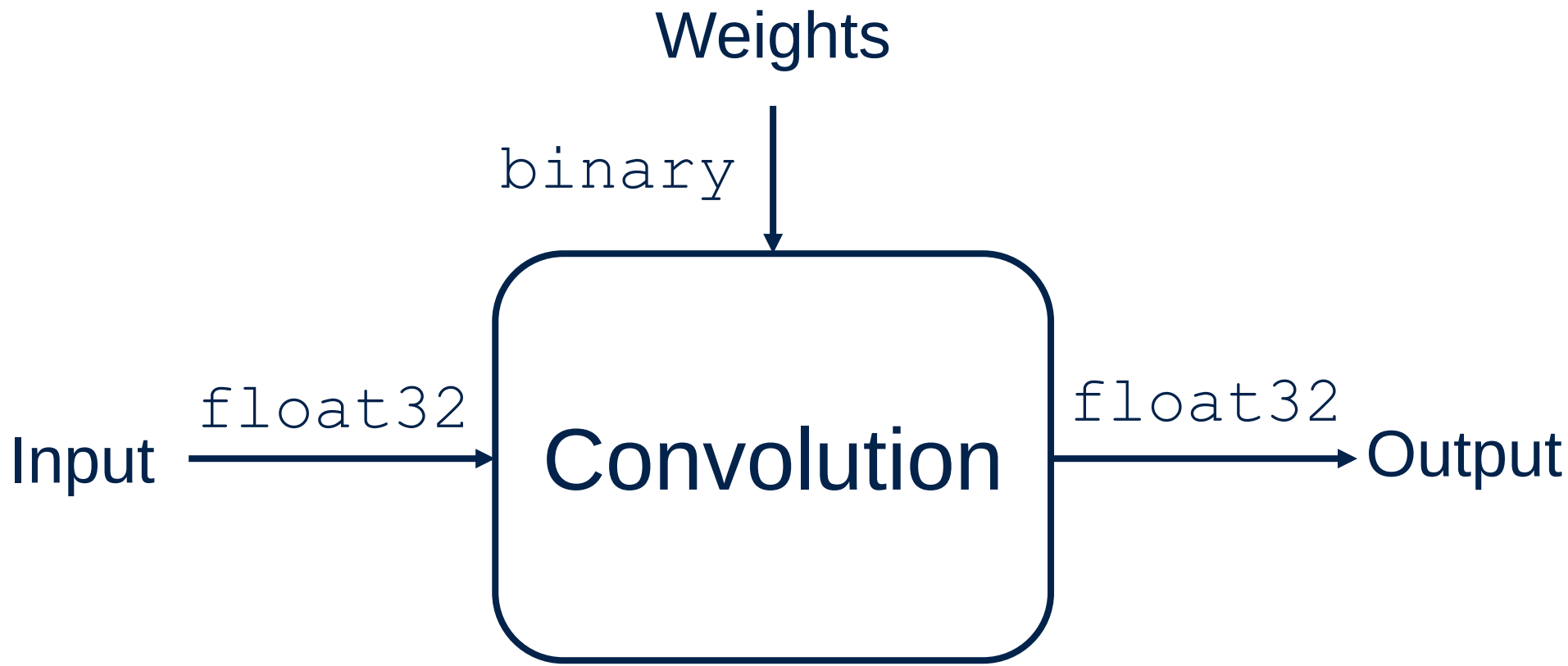

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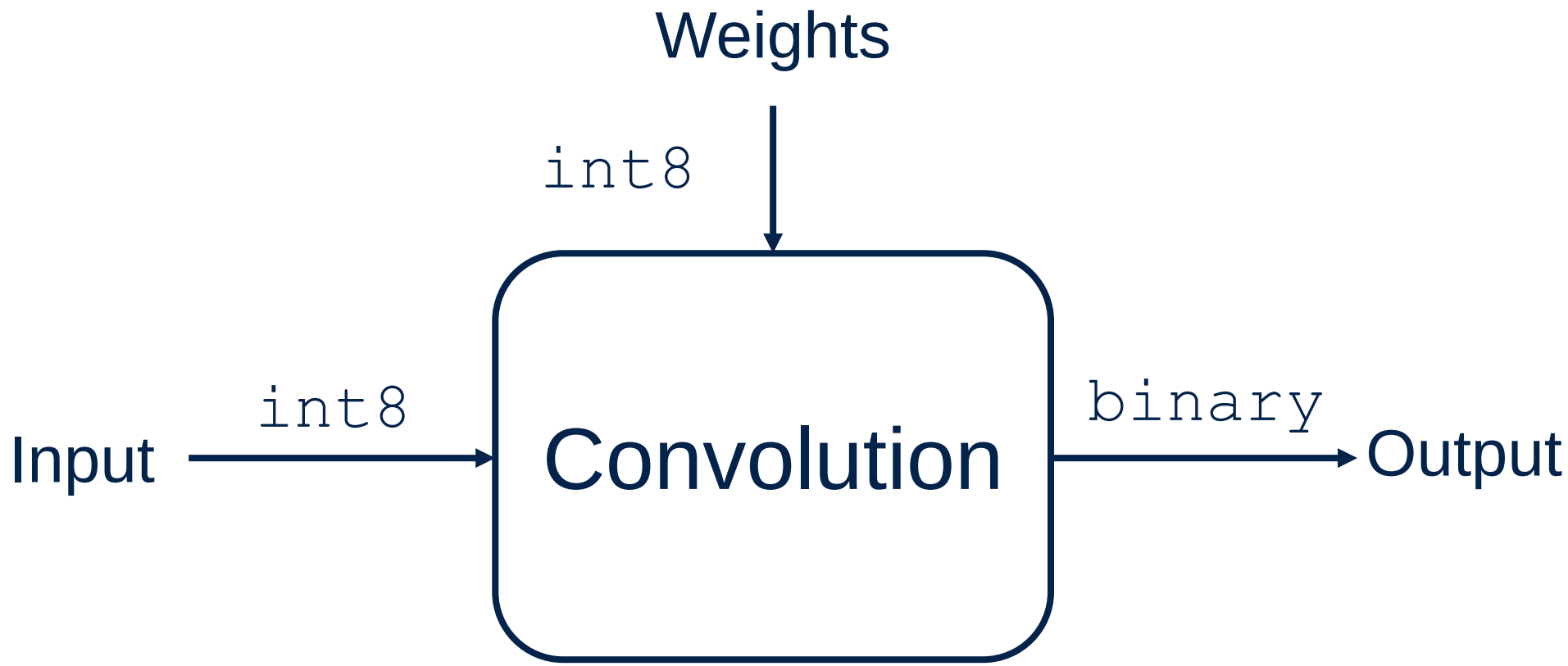


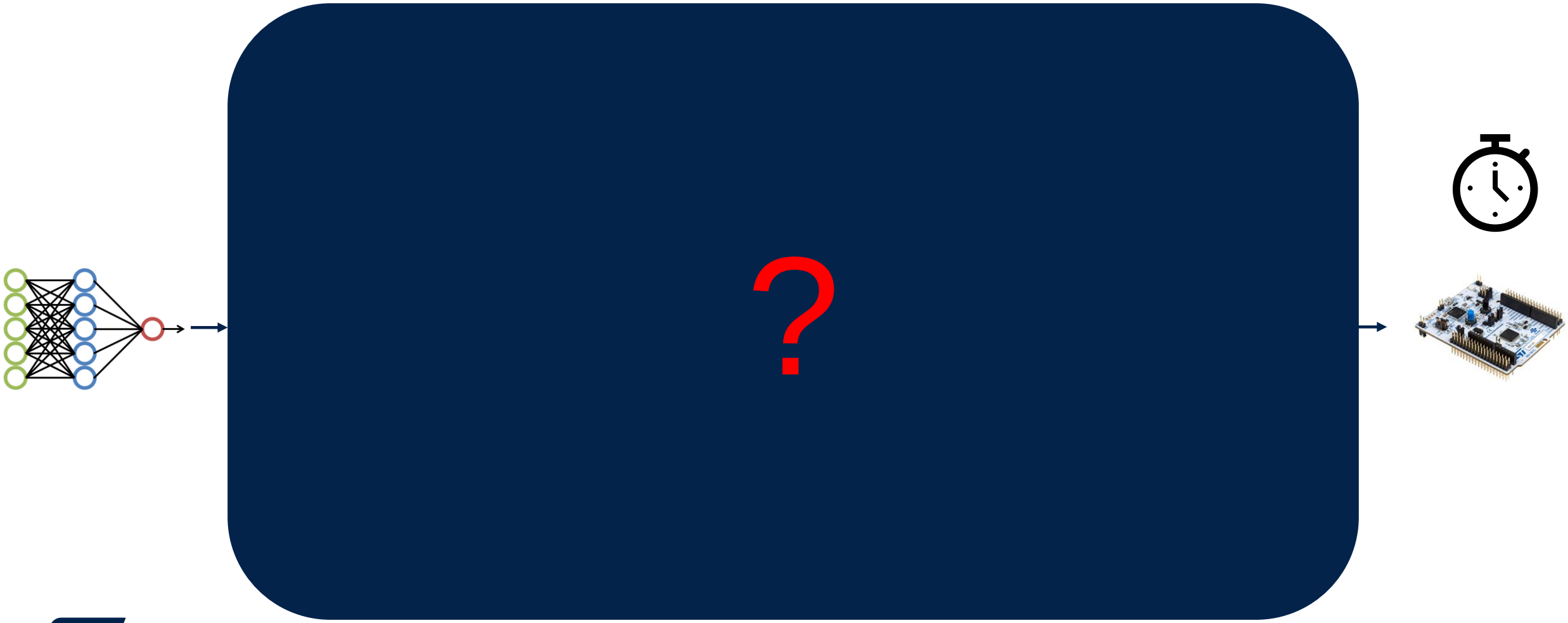
Heterogeneity: Quantization

Limiting to binary, int8, float32 there are 3^3=27 combinations to be supported for a single layer

Input

put

Removing Heterogeneity



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Removing Heterogeneity

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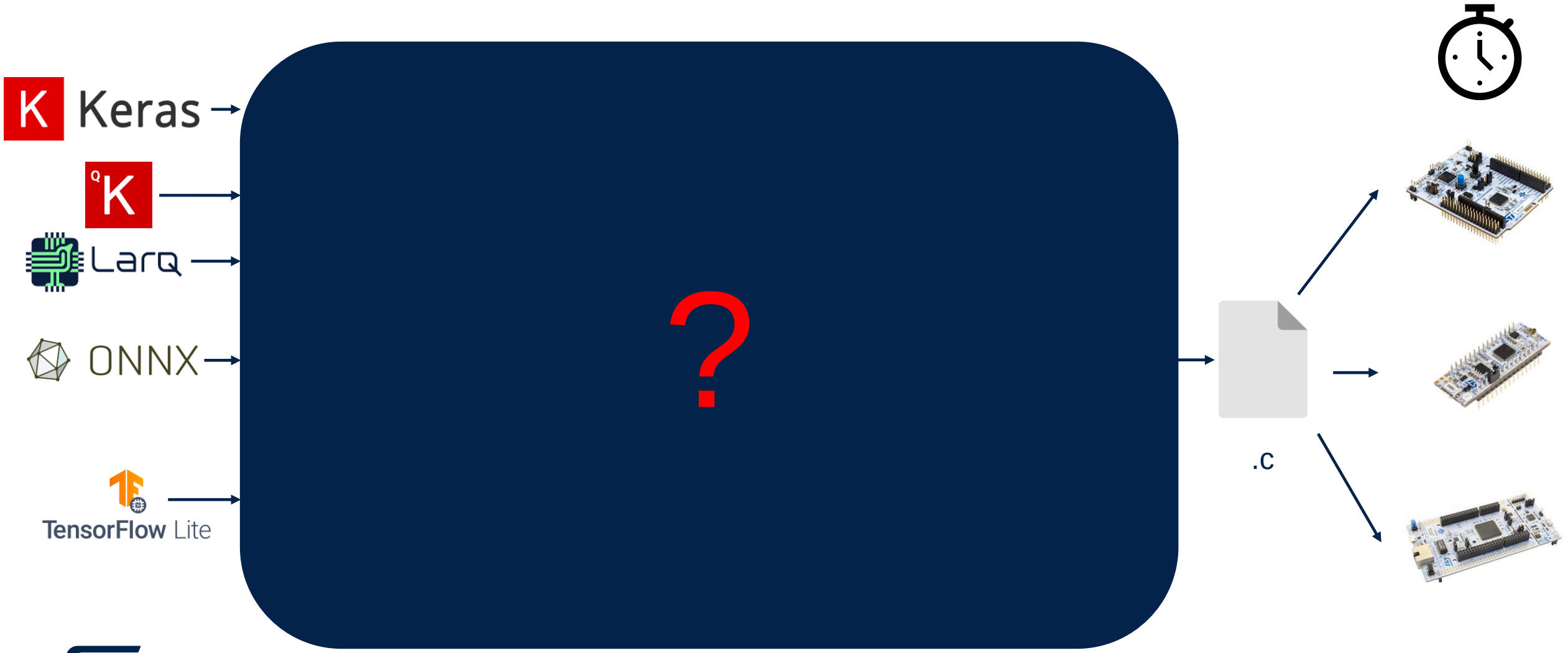
Removing Heterogeneity



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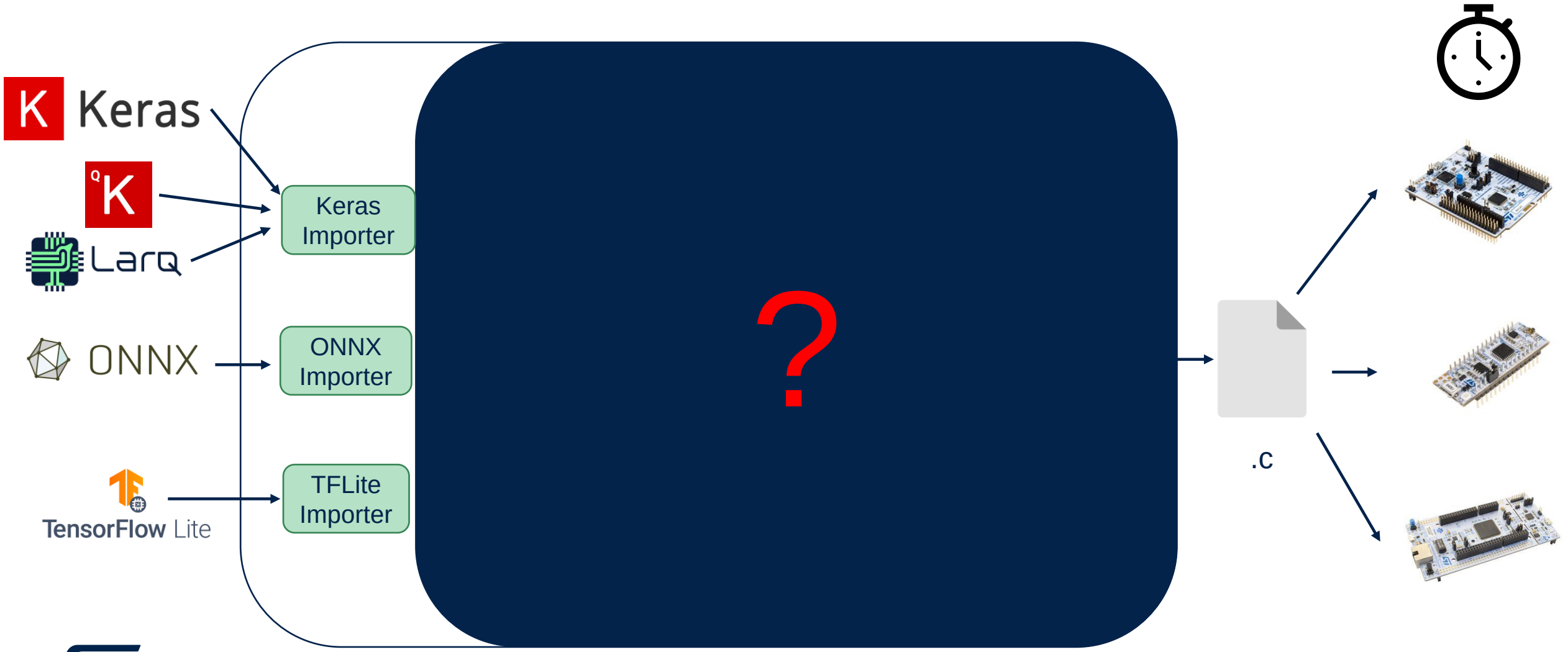

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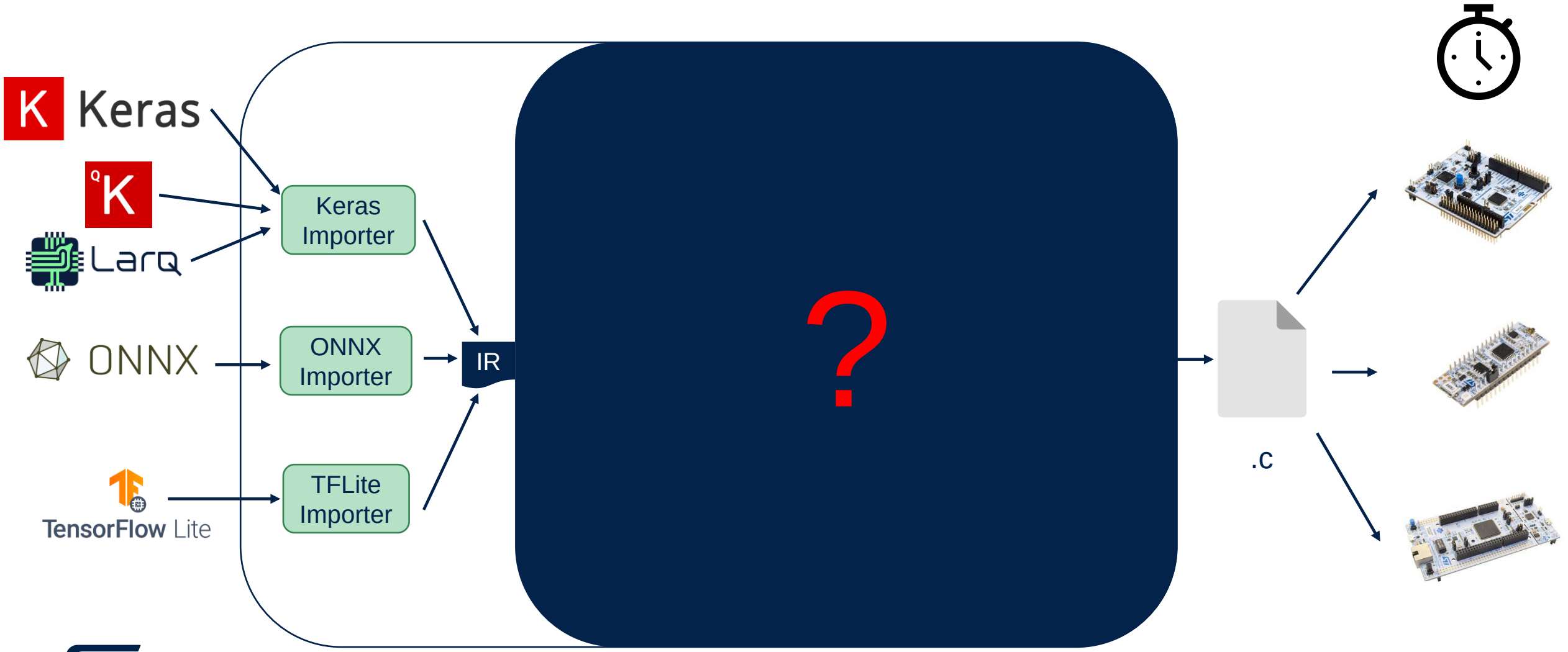

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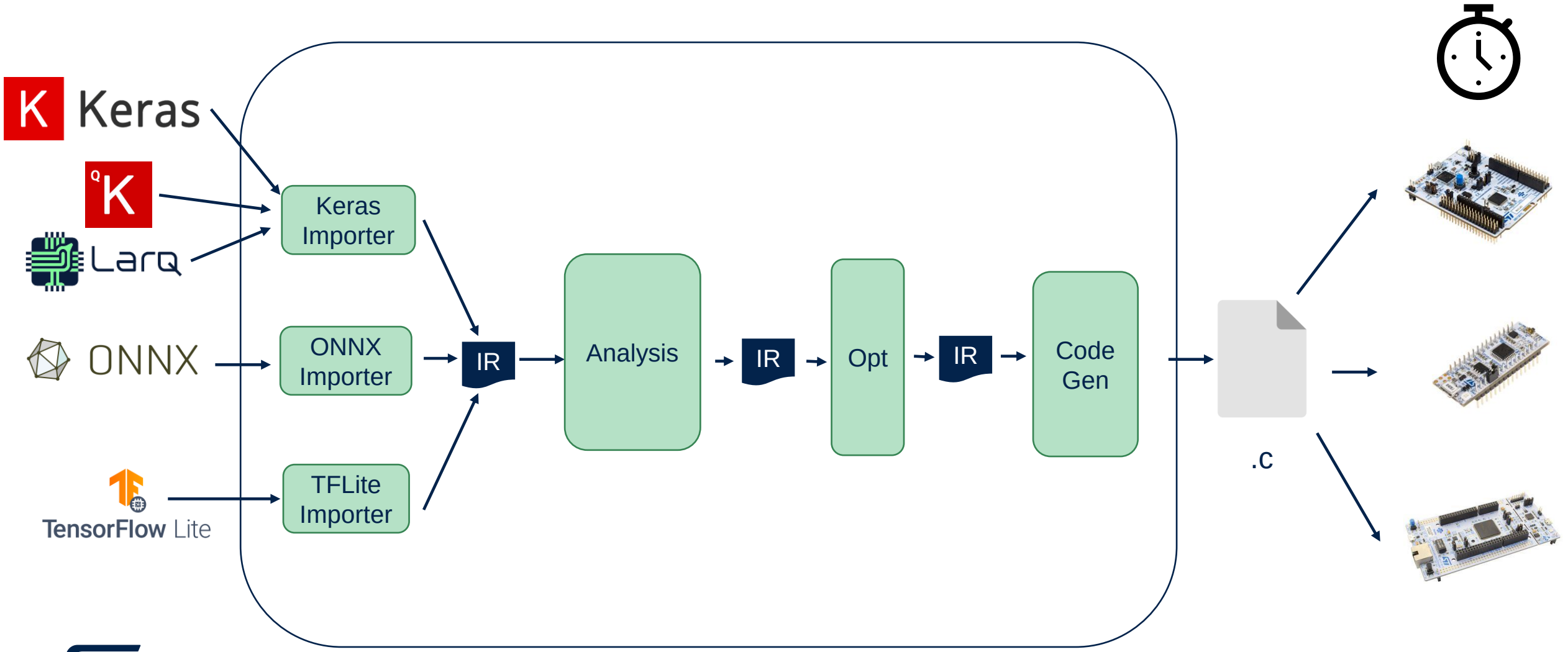
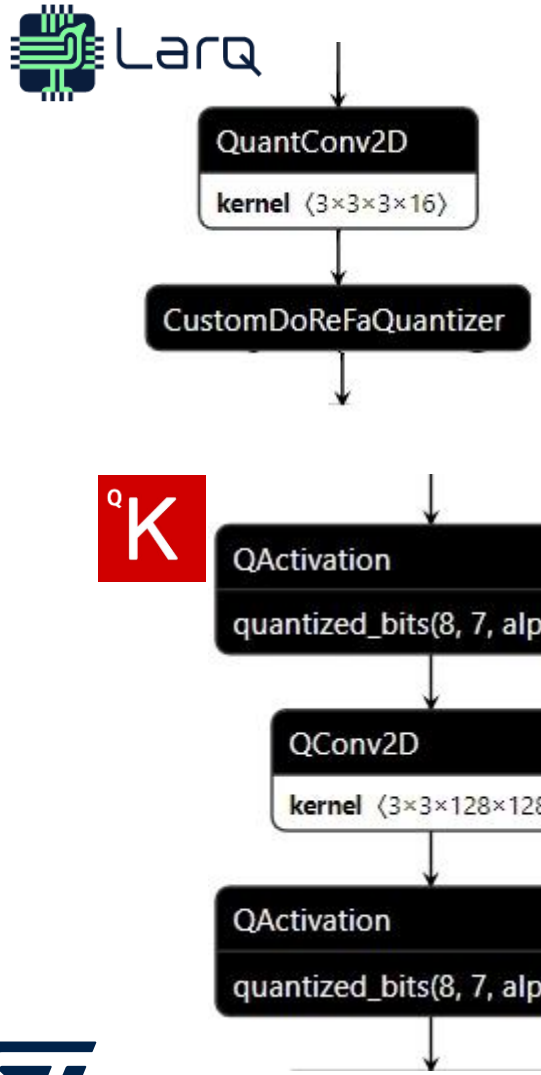
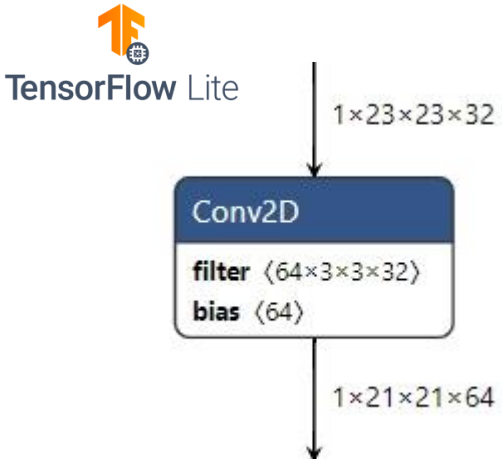
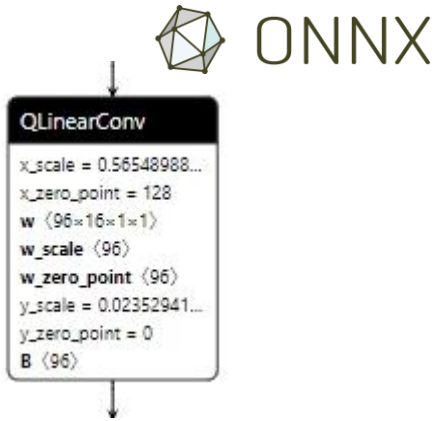
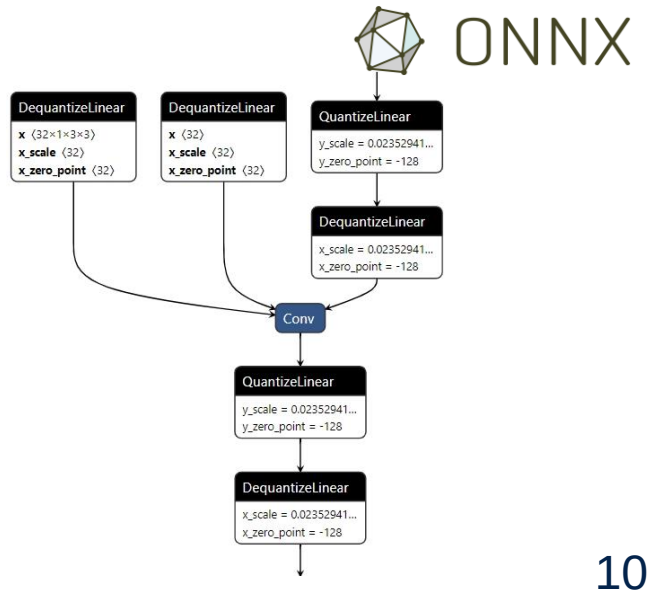


Common Intermediate Representation









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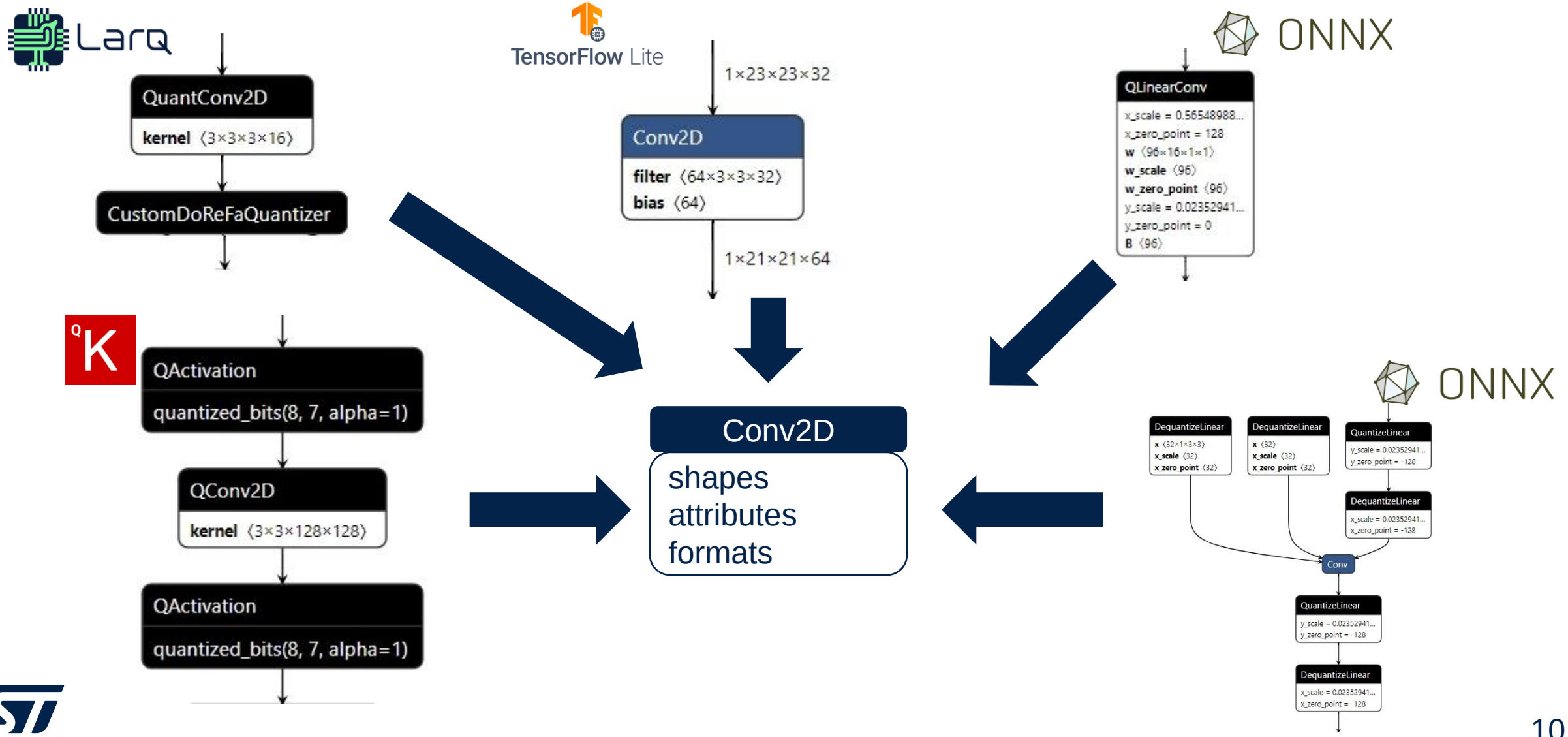

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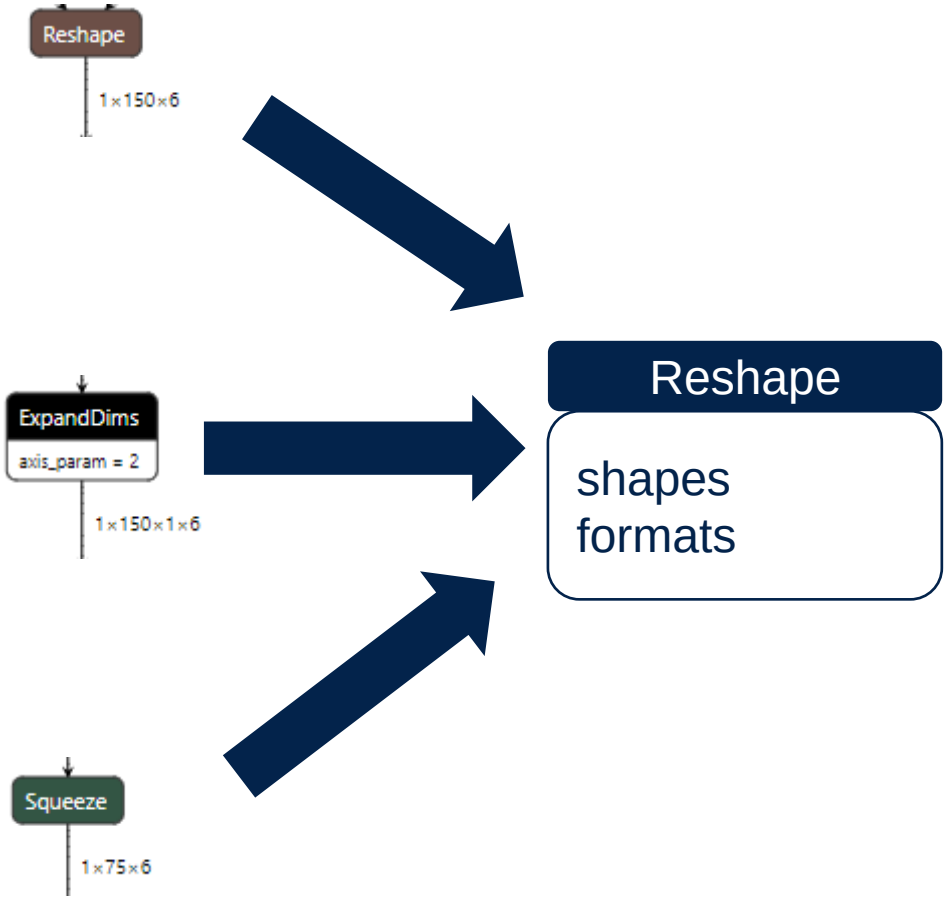
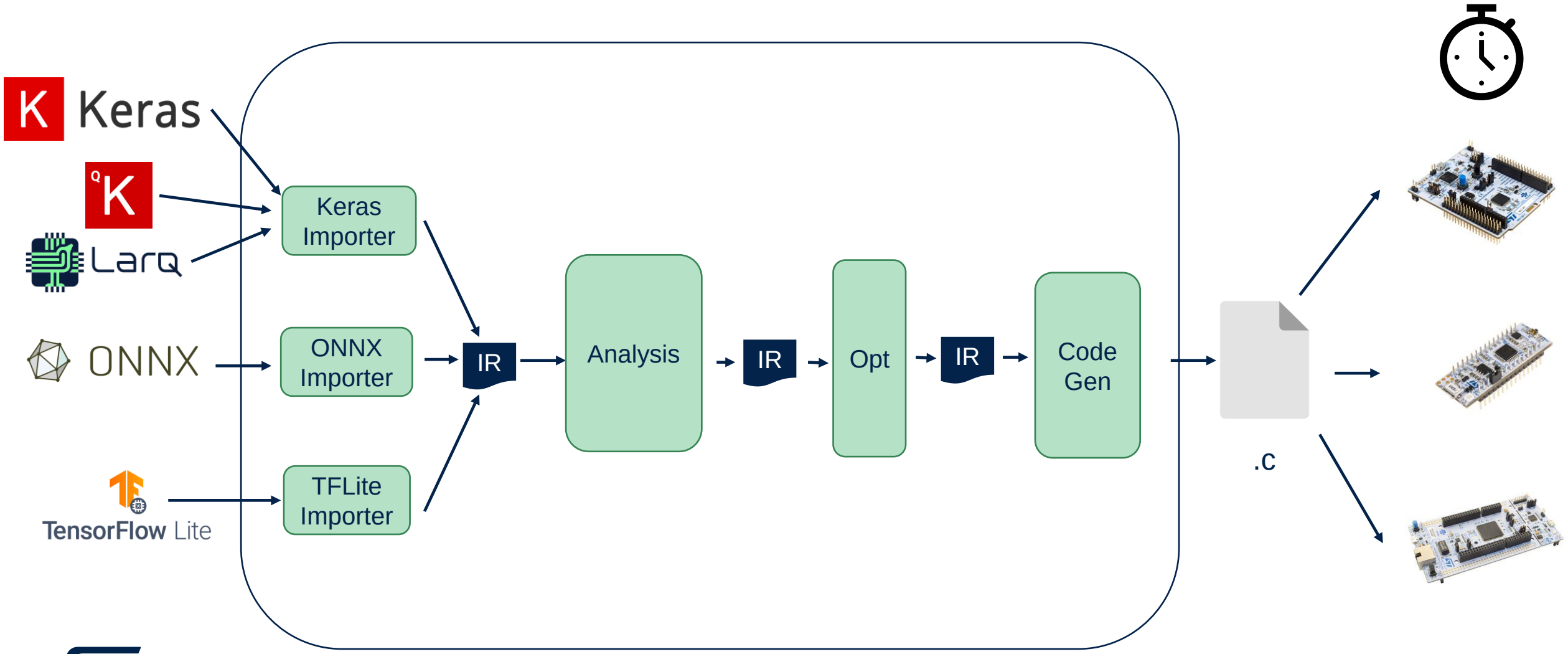


STM32Cube.AI Developer Cloud



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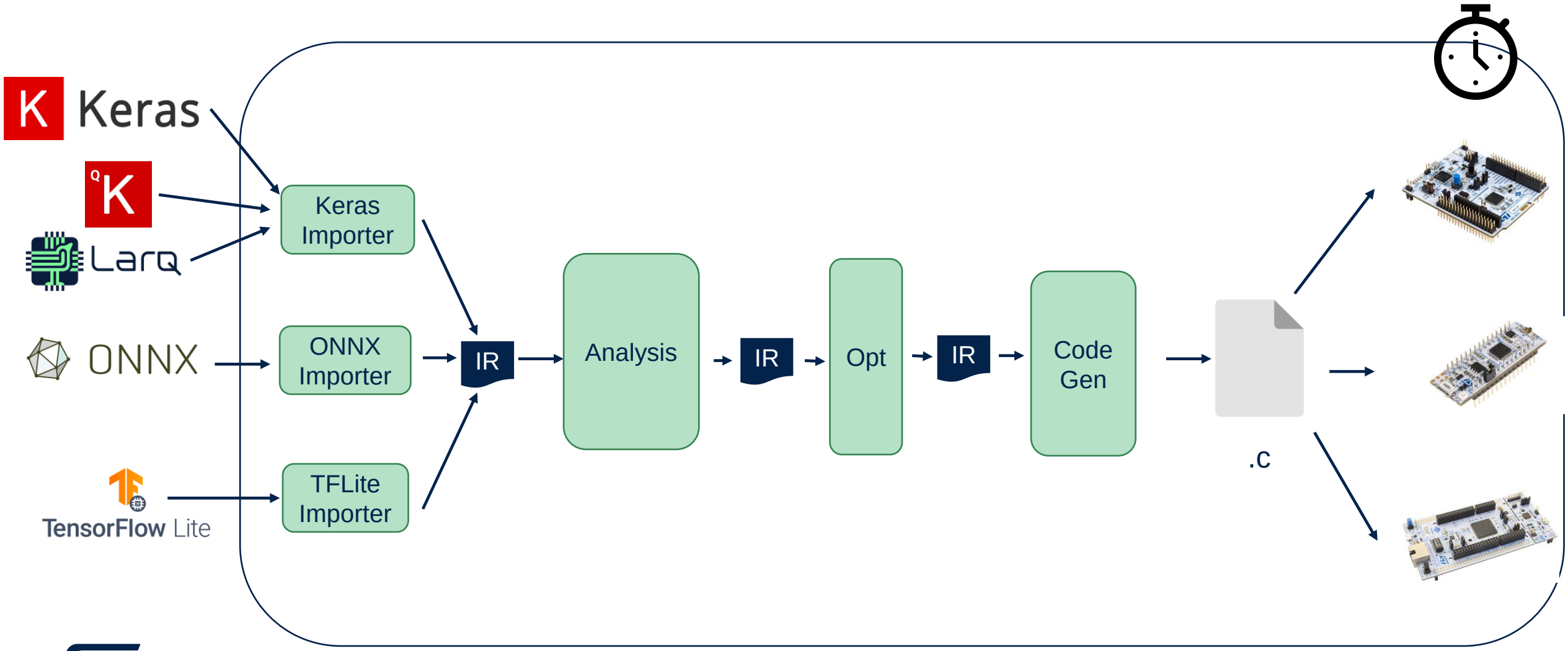

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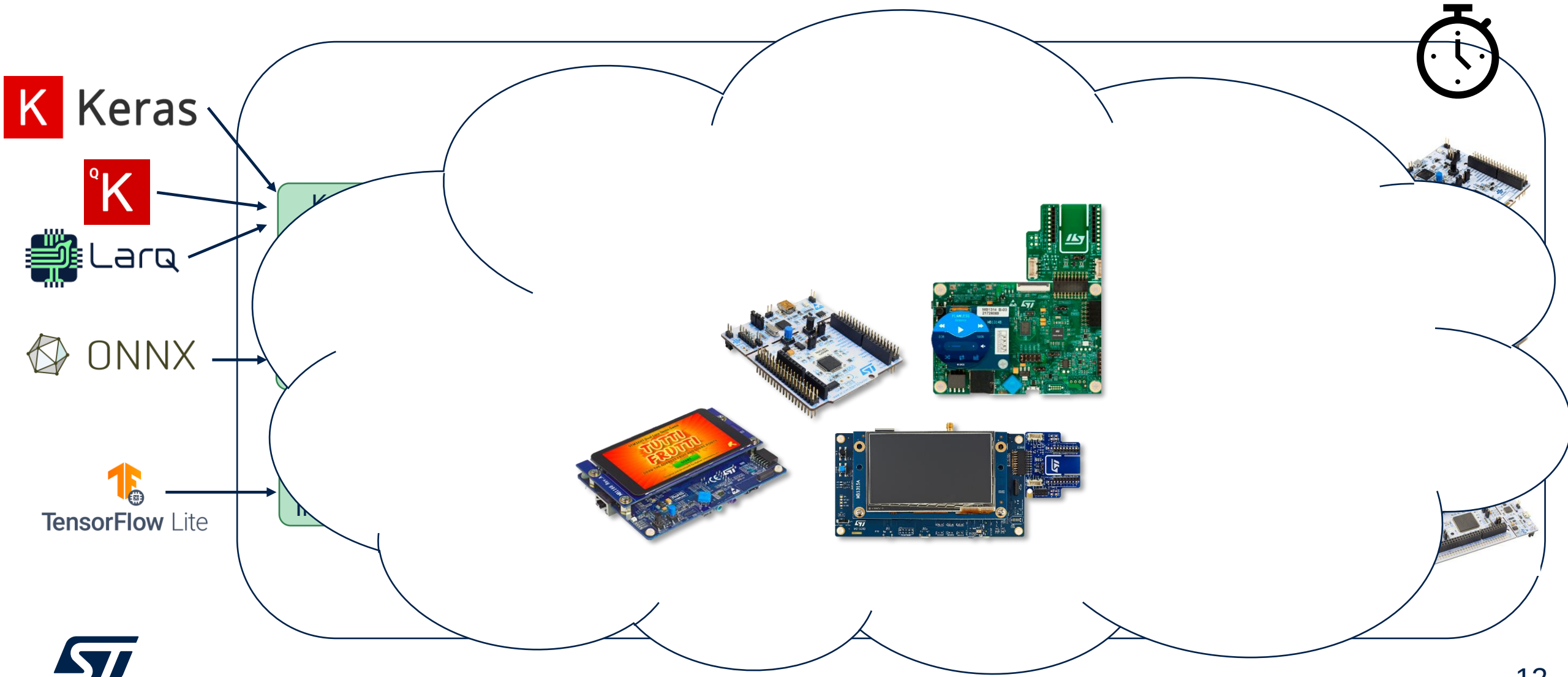

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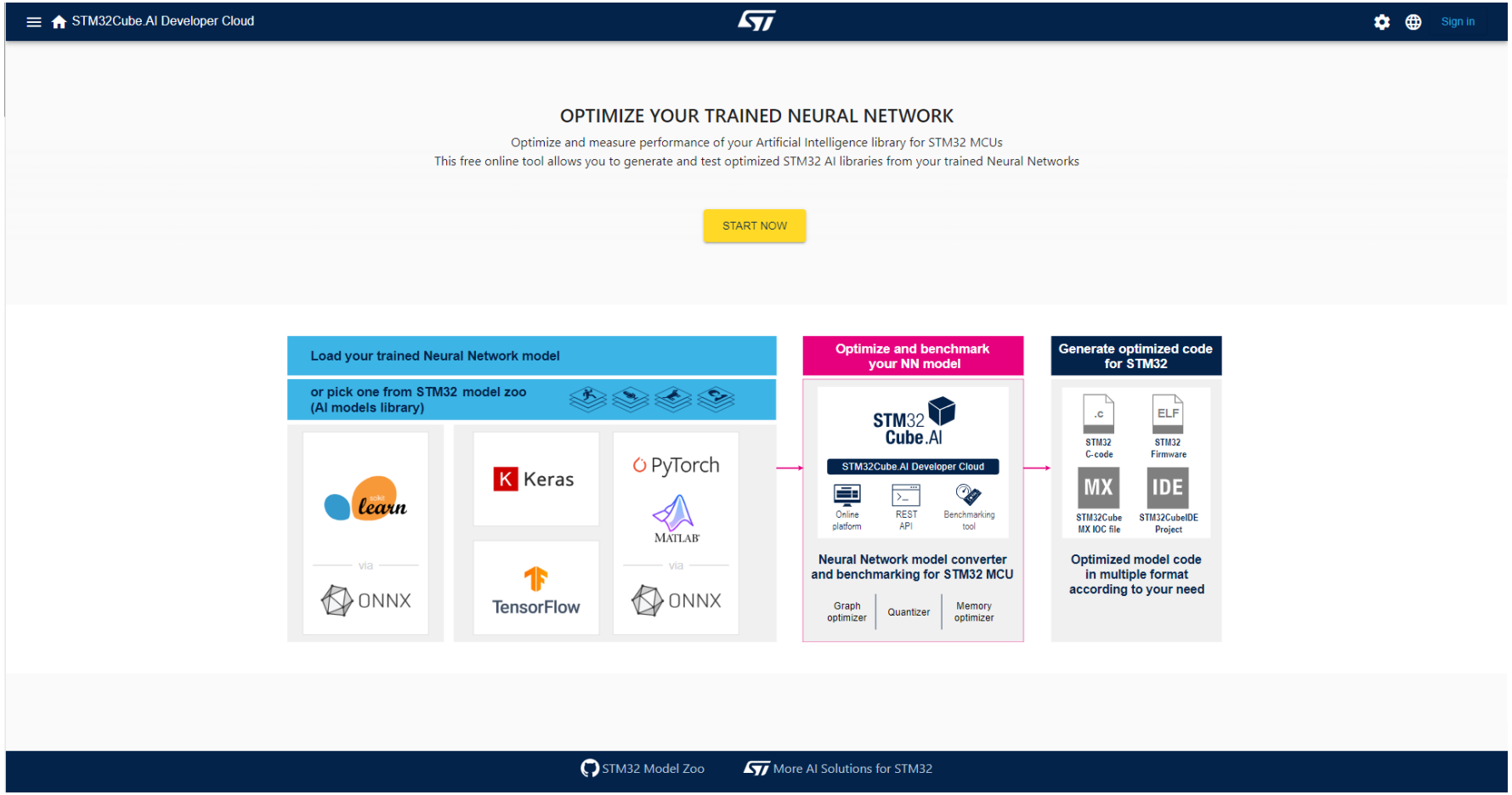
STM32Cube.AI Developer Cloud



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