ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

LAB06: Tiling on PULP

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Objective of the Class

Intro: Tiling

Tasks:

- 2D convolution in L1
- 2D convolution in L2
- Layer Tiling

Programming Language: C

Lab duration: 3h

Assignment:

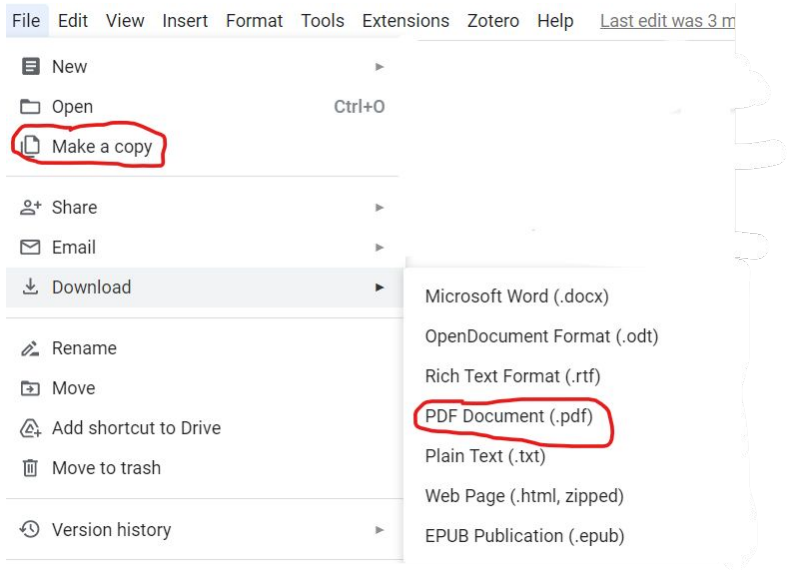
- Time for delivery: 1 week
- Submission deadline: Nov 23th 2022 (16:00)

The class is meant to be interactive: coding together and on your own!

How to deliver the Assignment

You will deliver ONLY the GDOC assignment, no code

- Copy the google doc to your drive, so that you can modify it. (File -> make a copy)
- Fill the tasks on this google doc.
- Export to pdf format.
- Rename the file to: LAB<number_of_the_lesson>_APAI_<your_name>.pdf
- Use Virtuale platform to load ONLY your .pdf file



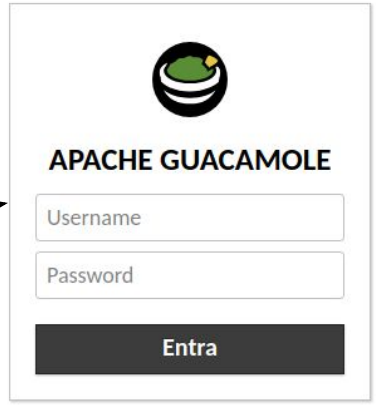
SETUP: How to access the server

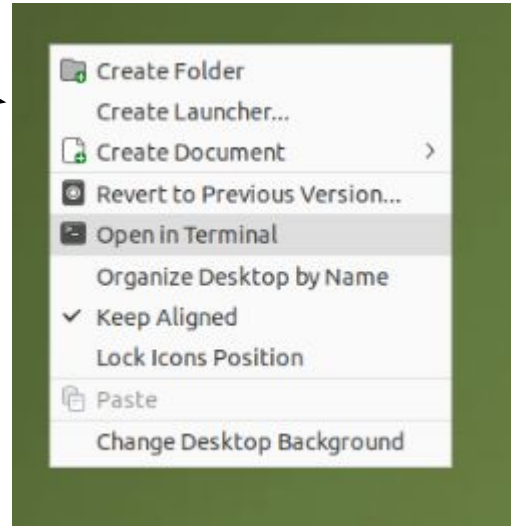
1. Open this web page: https://compute.eees.dei.unibo.it:8443/guacamole/
   (works only from ALMA WIFI NETWORK!)

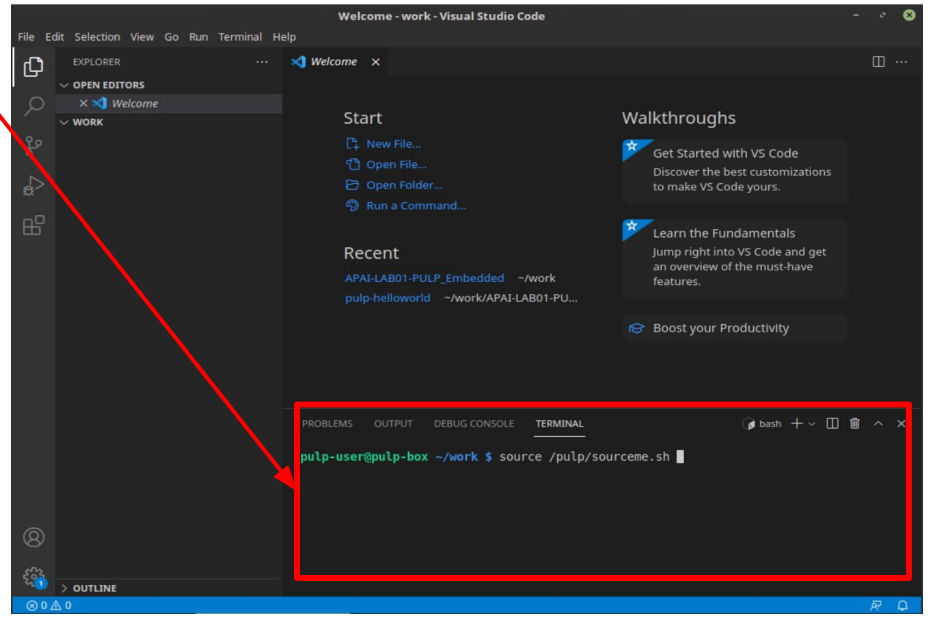
2. Login. We distribute credentials by hand.

3. Open a terminal (right click – open a new terminal)

4. Open a text editor (For example “VSCode”): `$ code .`
   Now you can use the integrated terminal to run your applications!







IMPORTANT: activate the pulp-sdk module file every time a new shell is open.

```
$ module load pulp-sdk
$ module load dory-conda
```

SETUP: How to access the server

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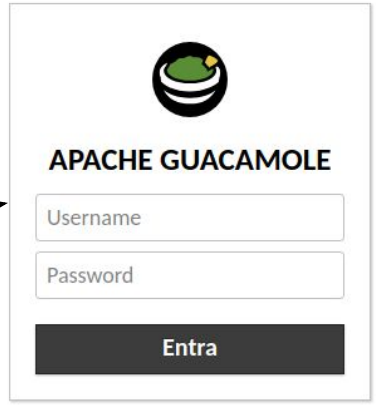

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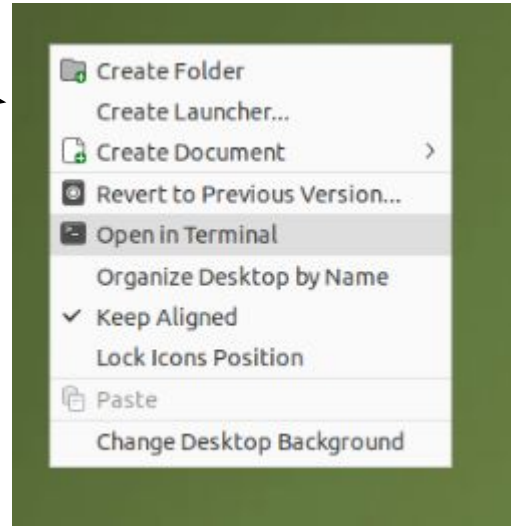

4. Clone:
   `git clone https://github.com/EEESlab/<insert_here_the_right_repo!>`

5. `module load pulp-sdk`

6. `cd <insert_here_the_right_repo!>`

7. `make clean all run`

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INTRO

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TASK1: fit in L1

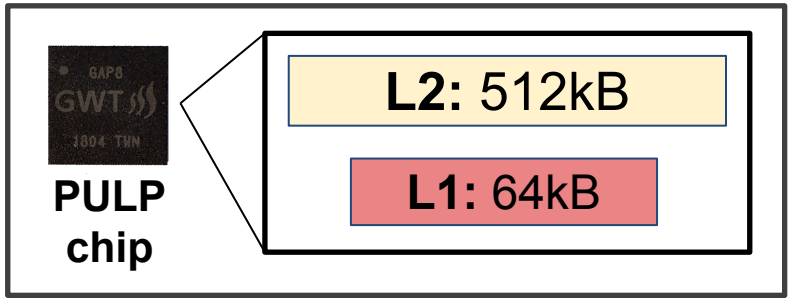
Case study: 1x1 conv2D

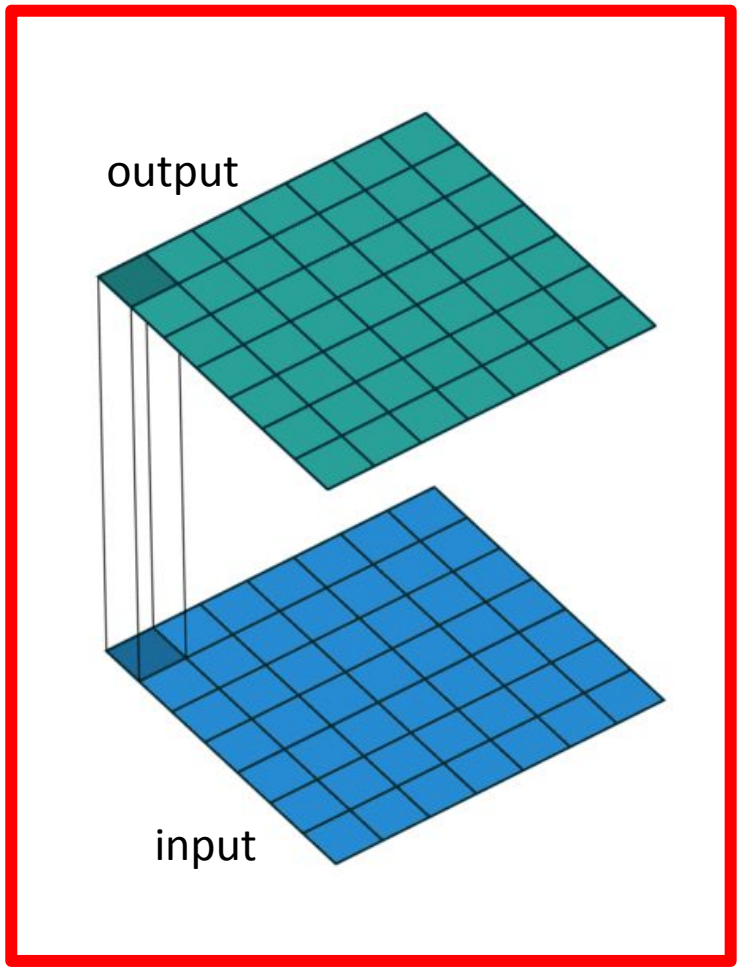
We tackle a 1x1 convolution with this sizes:

- Input = SPATIAL_DIM → defined by you
- Output = SPATIAL_DIM → defined by you
- Kernel = 1x1
- Stride = 1
- Padding = 0

NB: with conv1x1 the spatial size between input and output does not change!

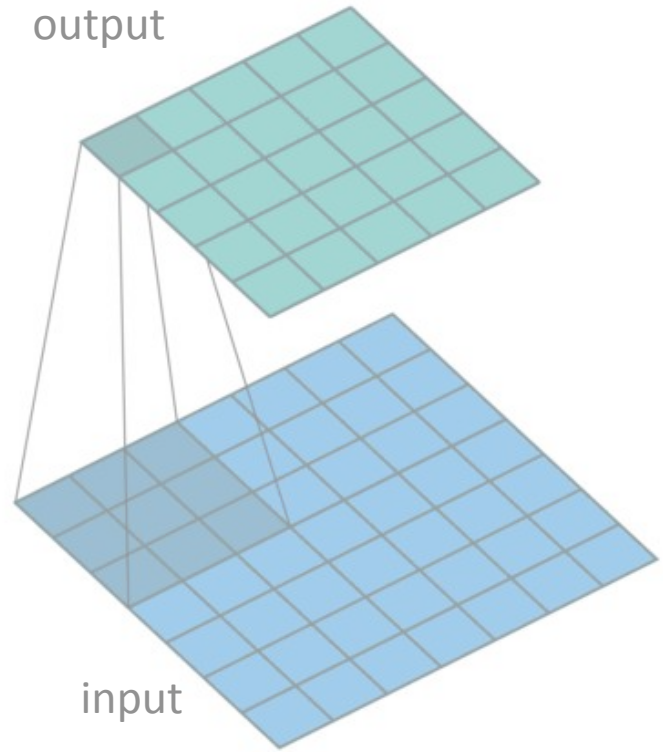
We want to fit into the L1 memory!





1x1 Convolution

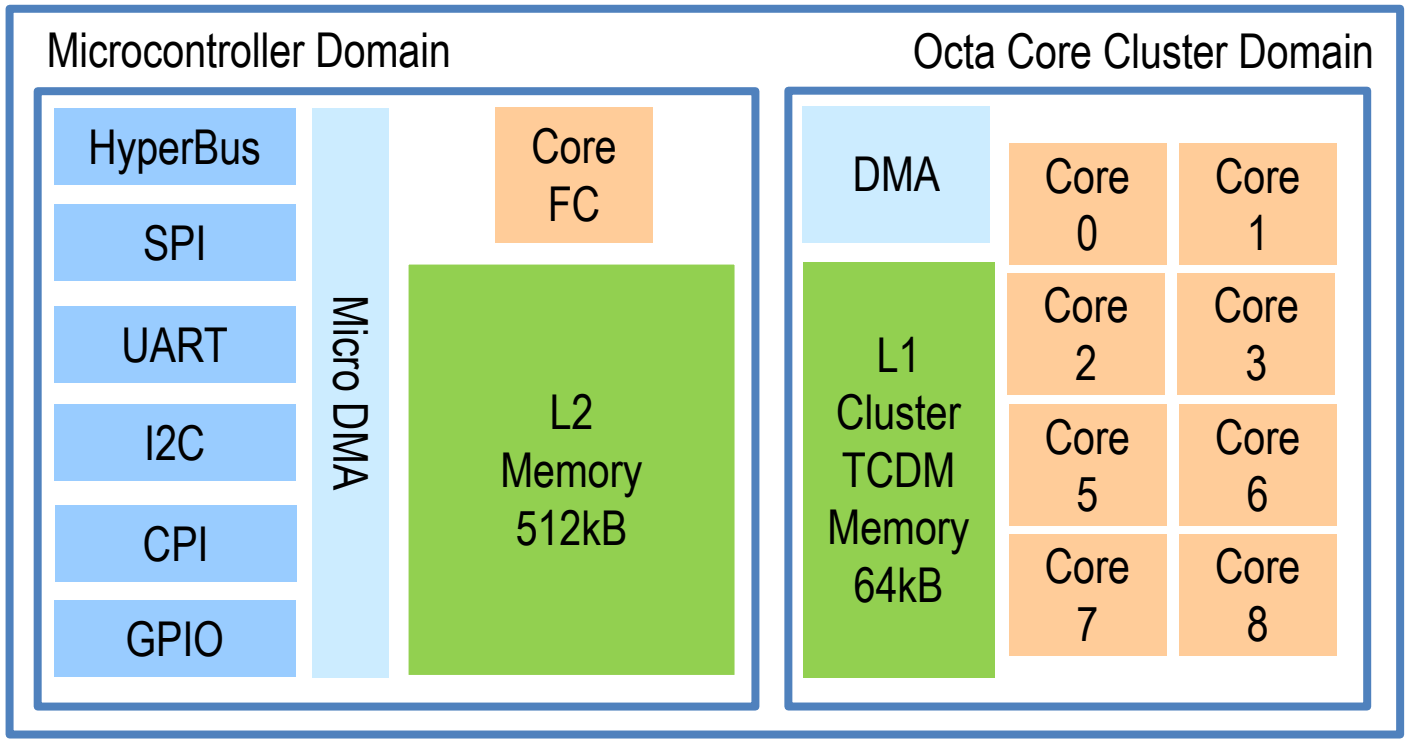
Used today!



3x3 Convolution

Used in lab04!

PULP Platform: today we focus on the 8-cores cluster



- **Cores**: 1 + 8
- **On-chip Memories**
  - A level 2 Memory, shared among all cores
  - A level 1 Memory, shared by the 8-cores cluster
- **cluster-DMA:** A multi-channel 1D/2D DMA, controlling the transactions between the L2 and L1 memories
- **micro-DMA**: A smart, lightweight and completely autonomous DMA () capable of handling complex I/O scheme
  - **Bus+Peripherals:** HyperBus, I2S, CPI, timers, SPI, GPIOs, etc…

NB: this is the architecture you find on the nano-drone!

GitHub HW Project: https://github.com/pulp-platform/pulp
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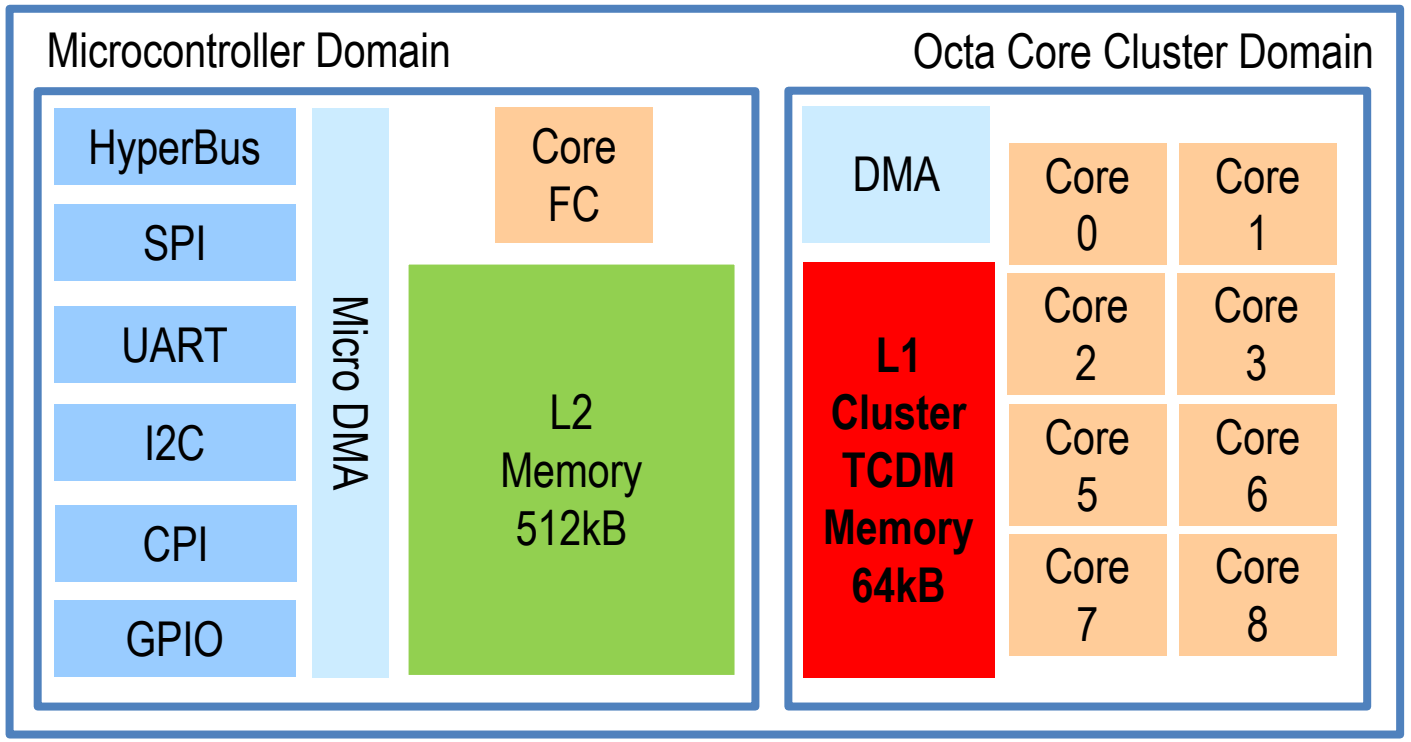

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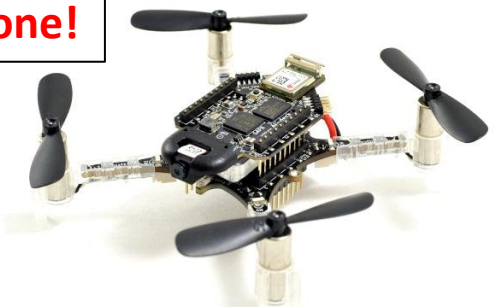

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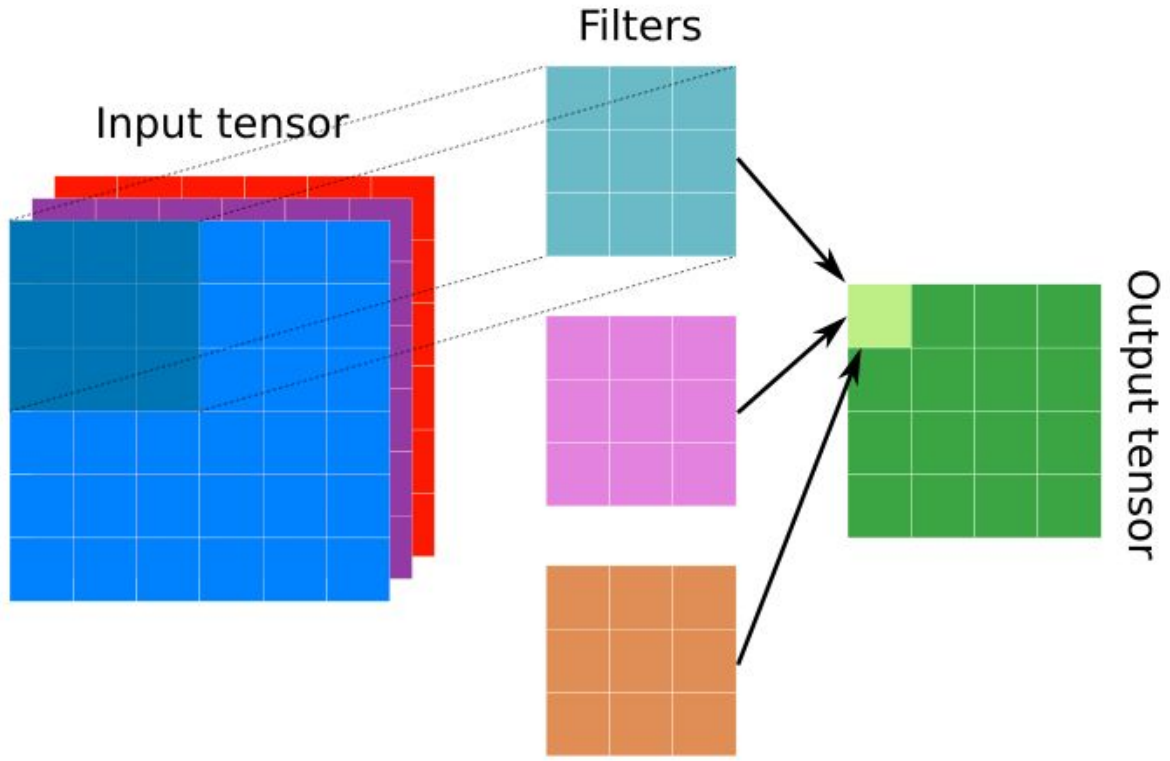
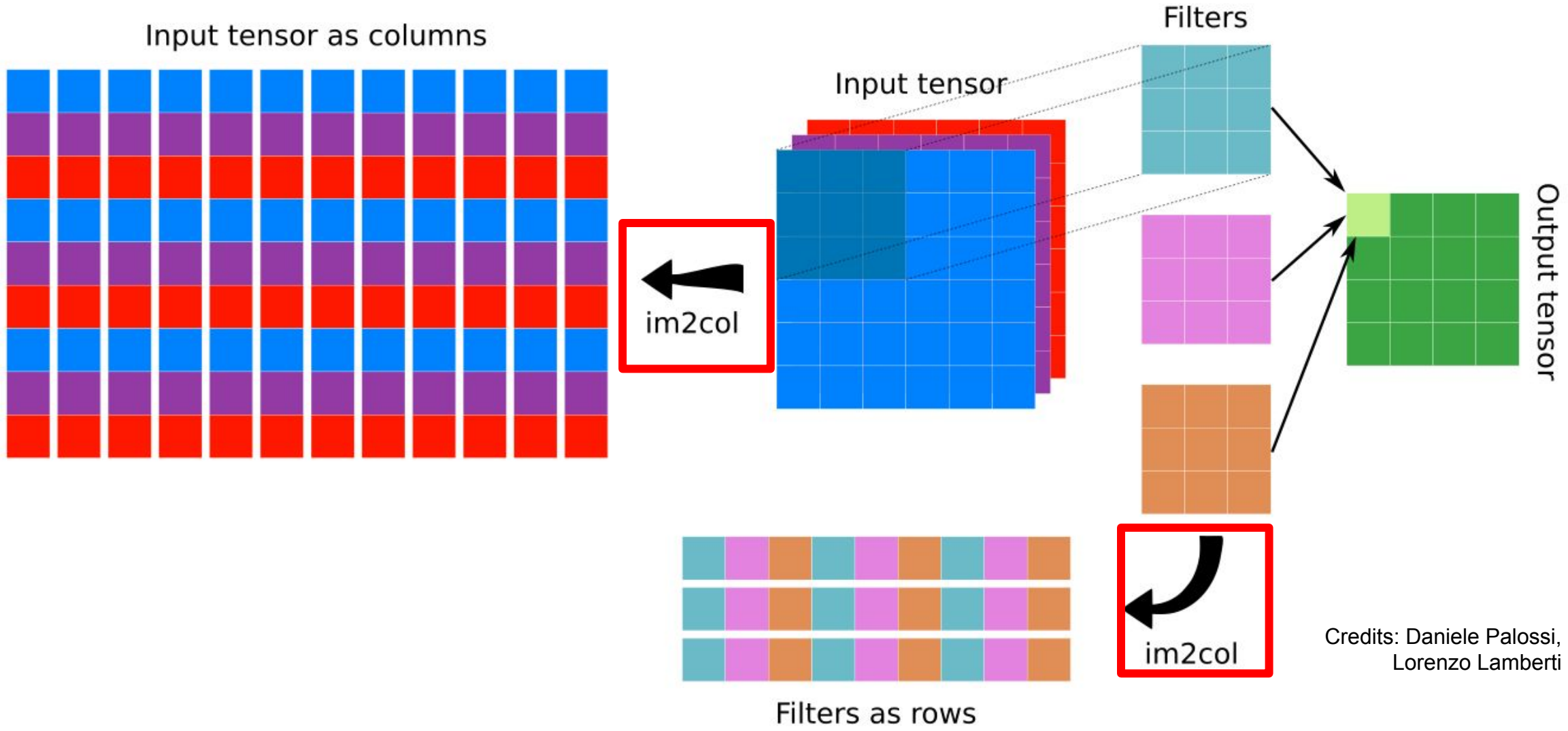
Convolution Operation: naive



Credits: Daniele Palossi,
Lorenzo Lamberti

Convolution Operation: im2col and MatMul



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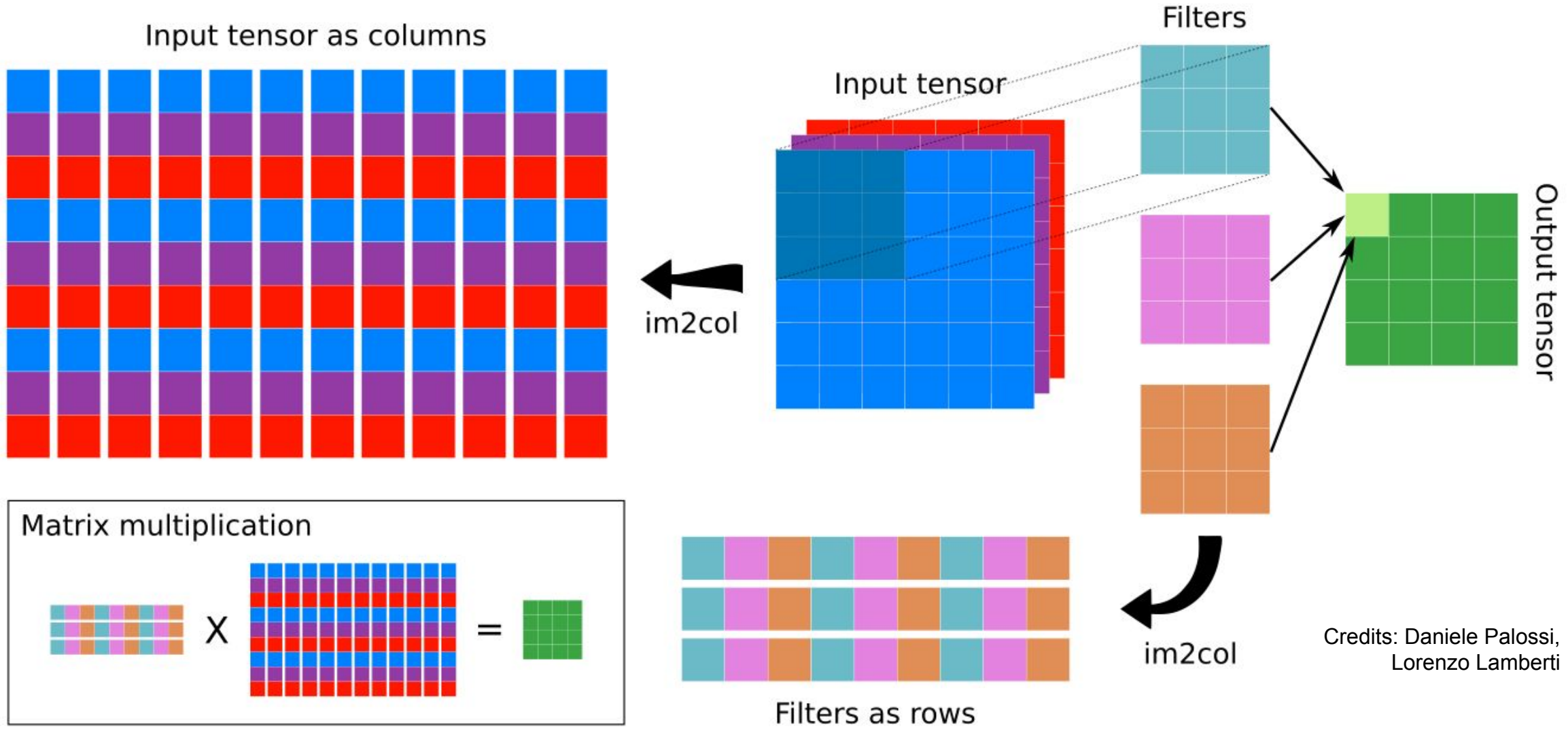

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EX1: find maximum dimensions of layers fitting L1 without tiling

```
Prerequisites:
module load pulp-sdk
module load dory-conda

Run the code:
$ python3 parameters_generate.py --channels=<add_here> --spatial_dimension=<add_here>
$ make clean all run
```

Follow the assignment document.

NB: Choose the exercise by uncommenting one of the following defines in `main.h`:

```
#define EXERCISE1
//#define EXERCISE2
// #define EXERCISE3
```

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TASK2: fetch from L2

EX2: fetch data from L2

Run the code:

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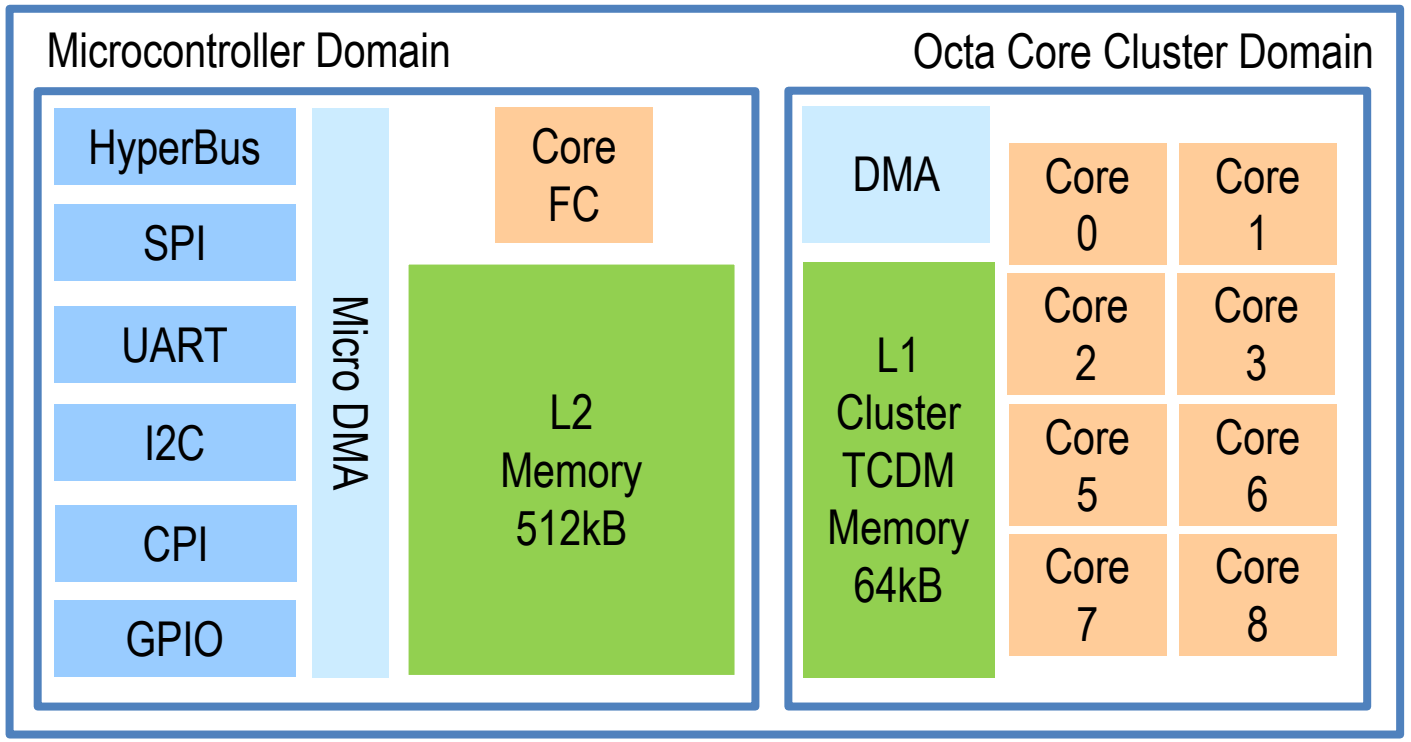

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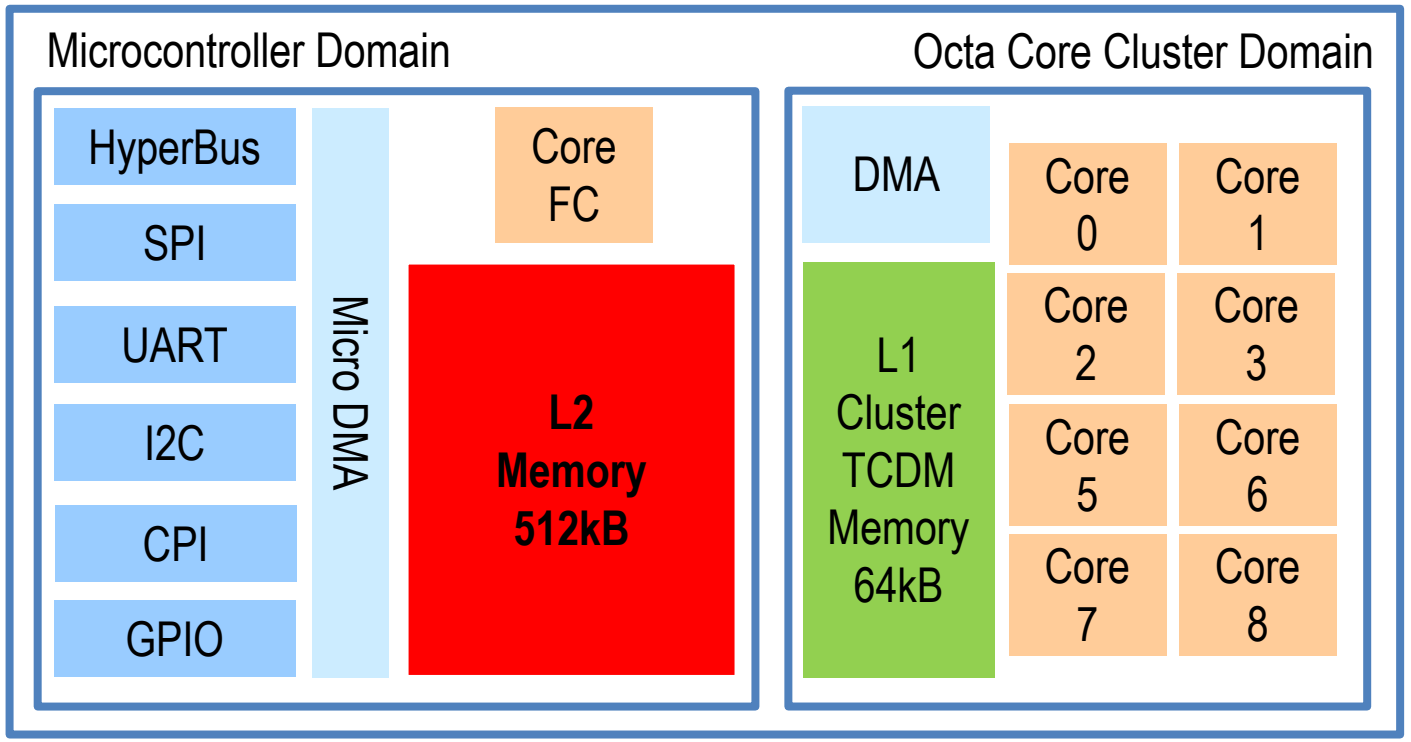

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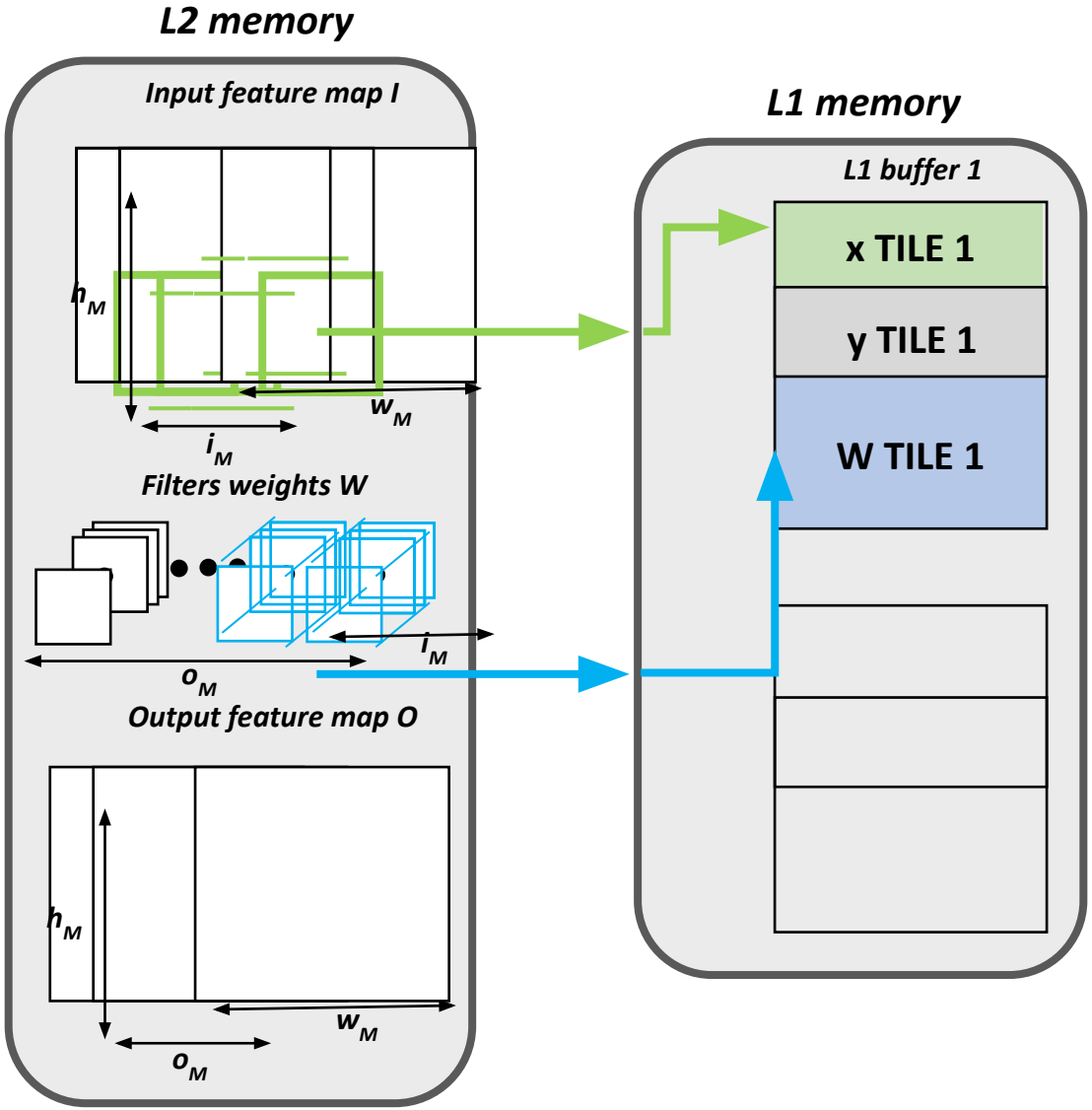
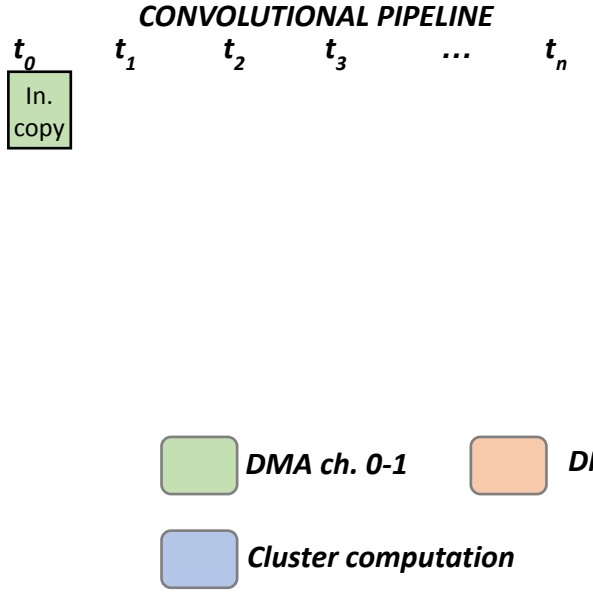
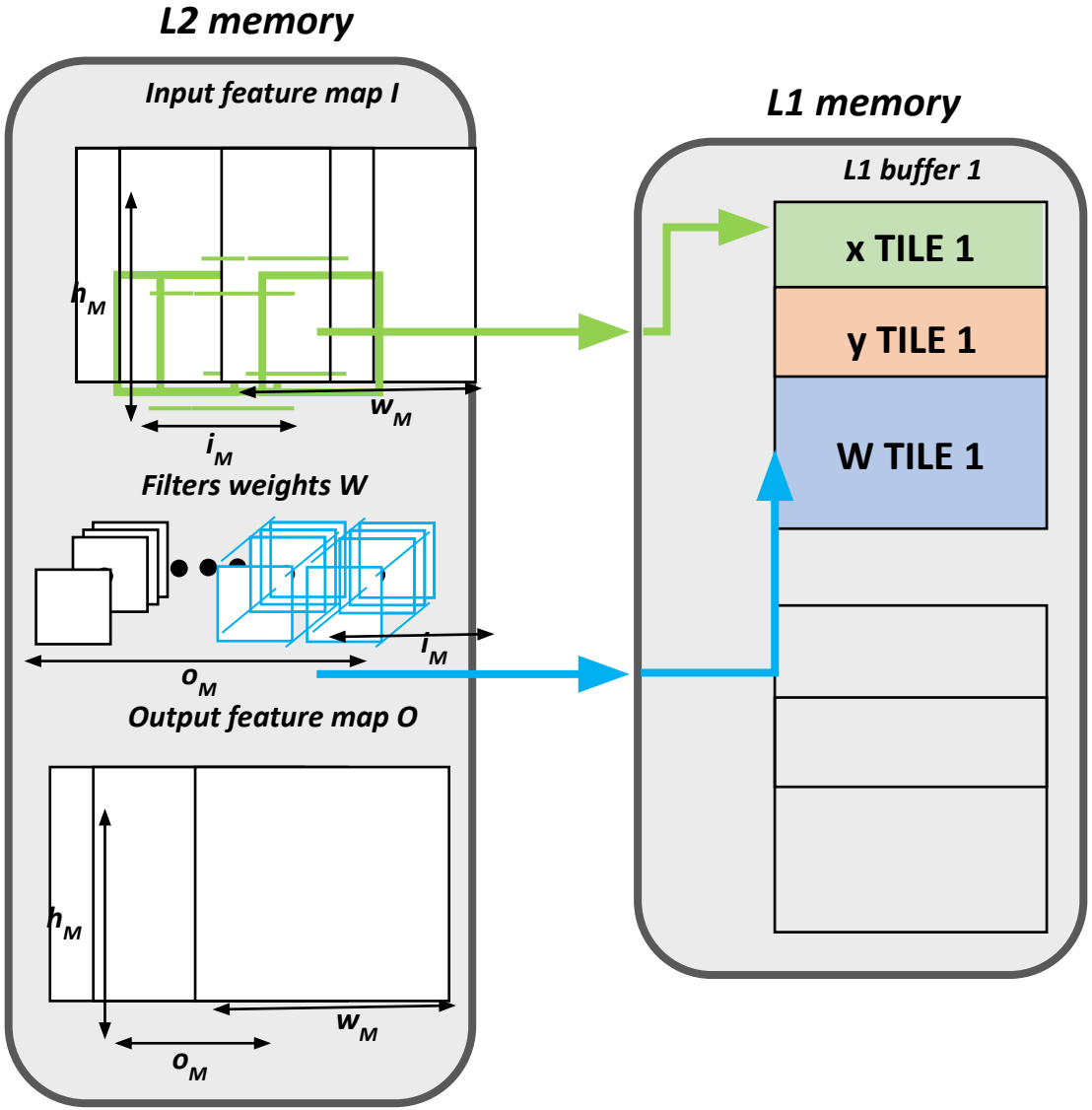
TASK3: Tiling

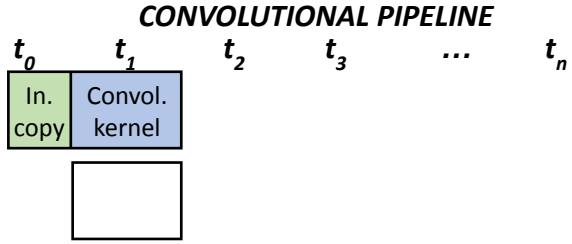
Tiling from L2 to L1



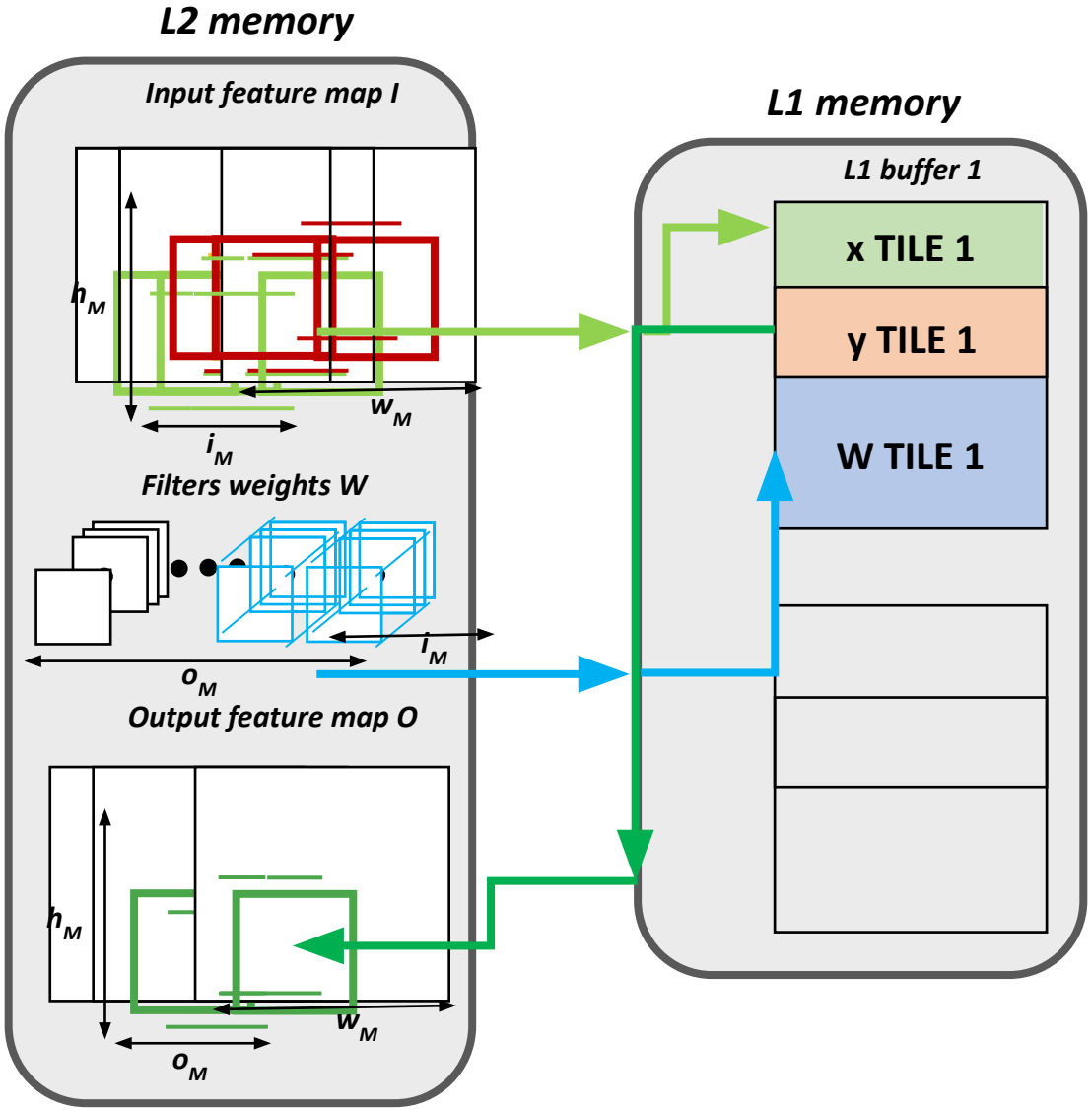


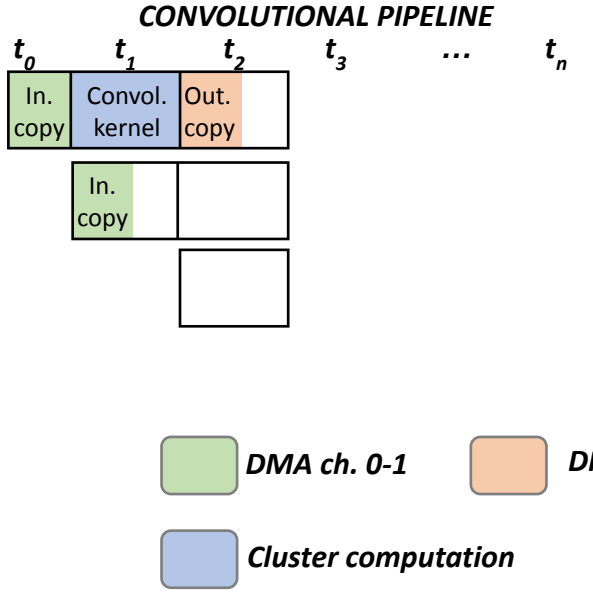
Tiling from L2 to L1





Tiling from L2 to L1





EX3: Tiling layer

Run the code:

```
$ python3 parameters_generate.py --channels=#### --spatial_dimension=####
$ make clean all run
```

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