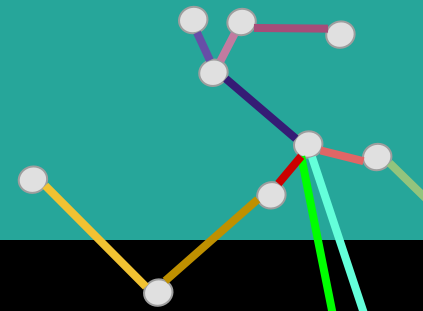
Deep Learning for Human Pose Estimation

—

Alejandro (Ale) Solano - EuroSciPy 2018




“You should always include **live demos** in presentations”

What was that?

BLACK
BOX

BLACK
BOX

Human Pose Estimation

COCO dataset

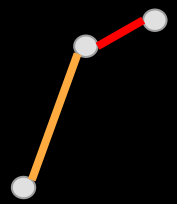
COCO dataset

1 body part

COCO dataset

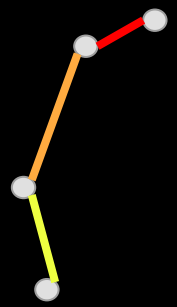
2 body parts

COCO dataset



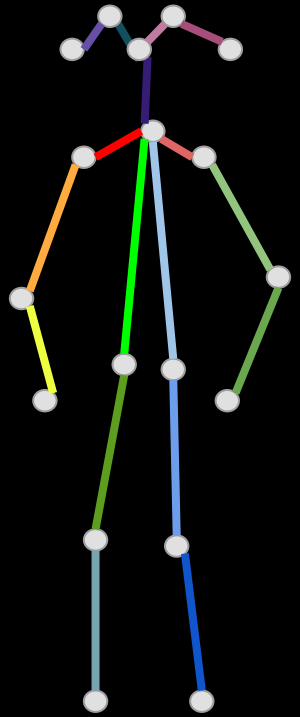
3 body parts

COCO dataset



4 body parts

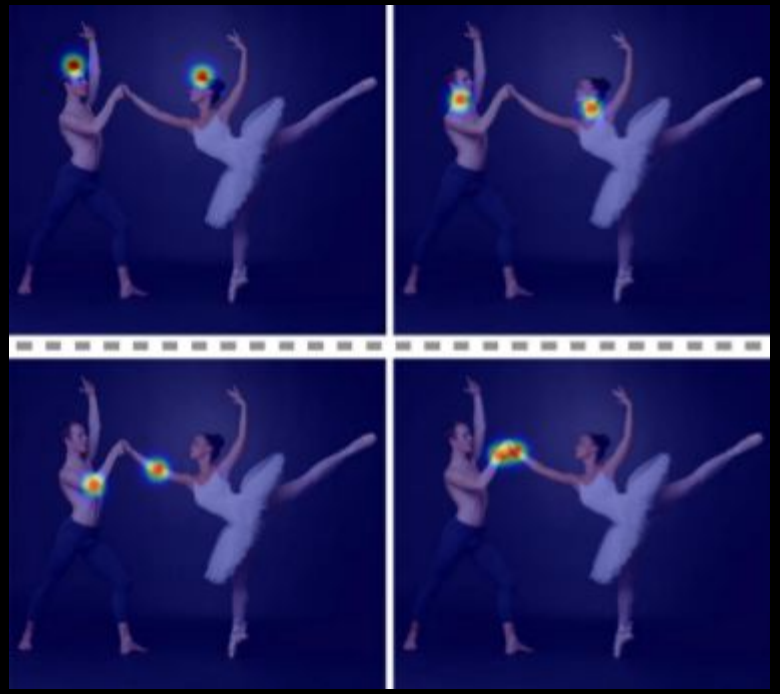
COCO dataset



18 body parts

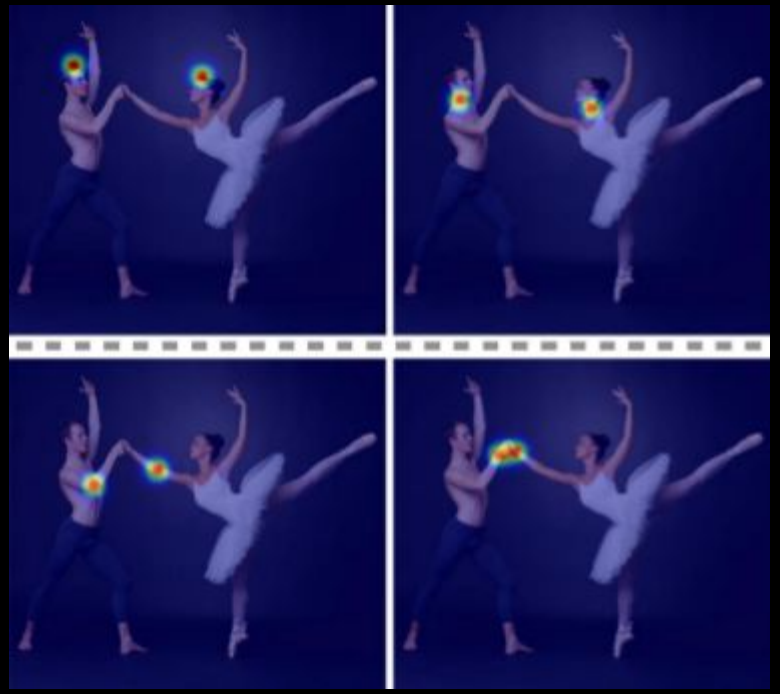
18 Heatmaps

CNNs

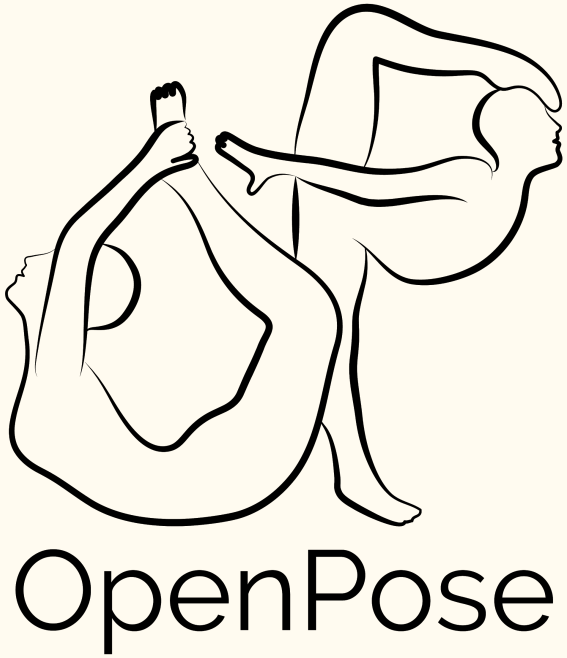


18 Heatmaps

CNNs



Which part belongs to which person?



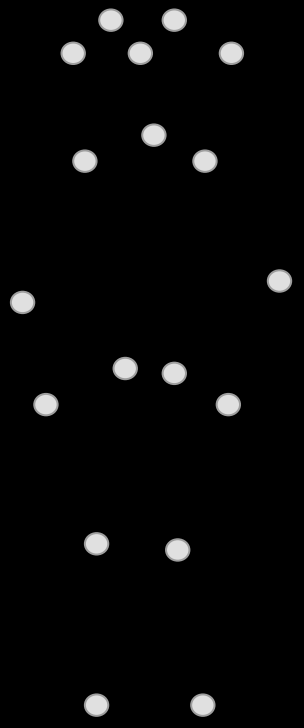
OpenPose

Developed by CMU, placed first in 2016 COCO keypoints challenge.

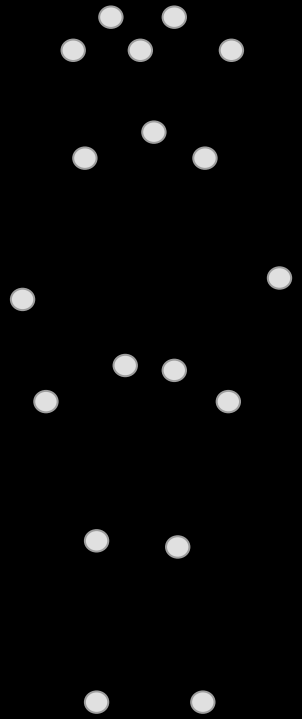
Open source.

https://arxiv.org/pdf/1611.08050.pdf

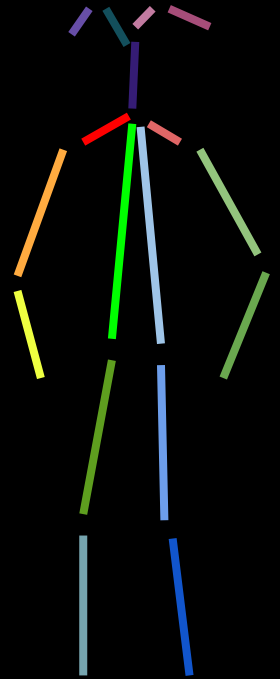
18 body parts



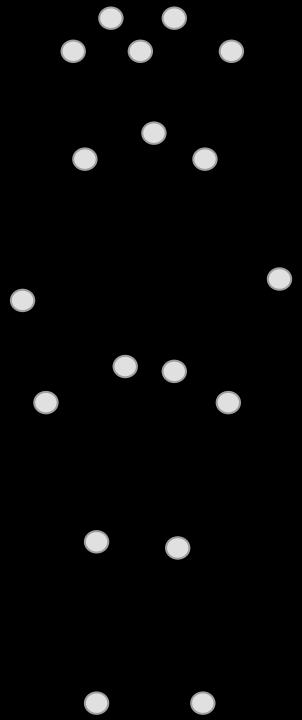
18 body parts



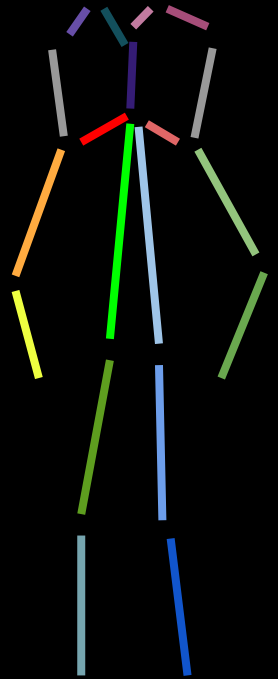
17 connections



18 body parts



19 connections



18 Heatmaps

CNNs

18 Heatmaps

CNNs

2x19 PAFs

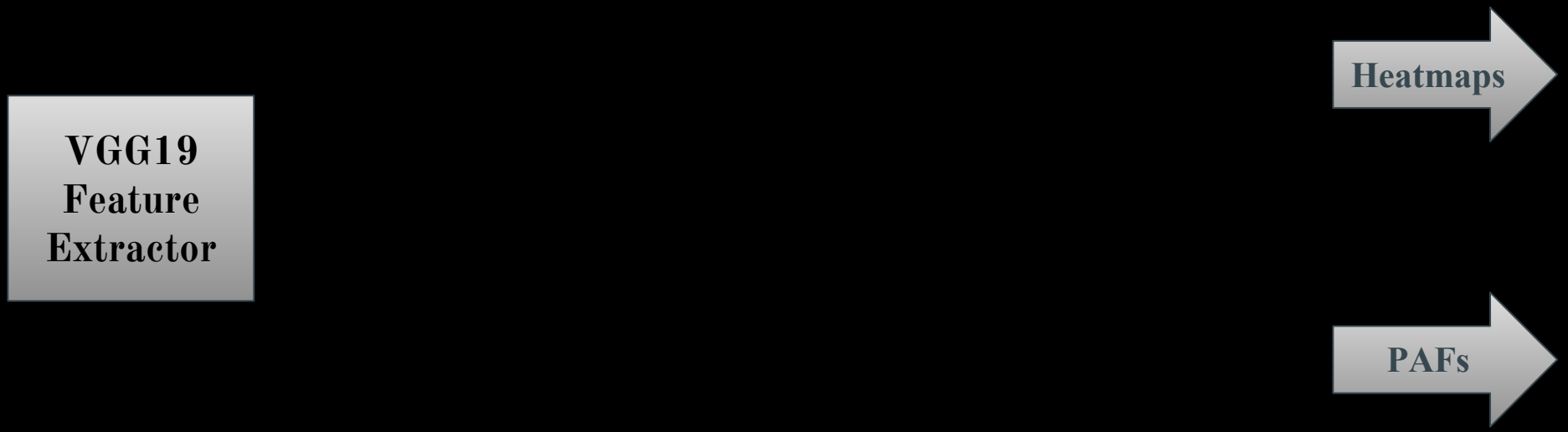
18 Heatmaps

CNNs

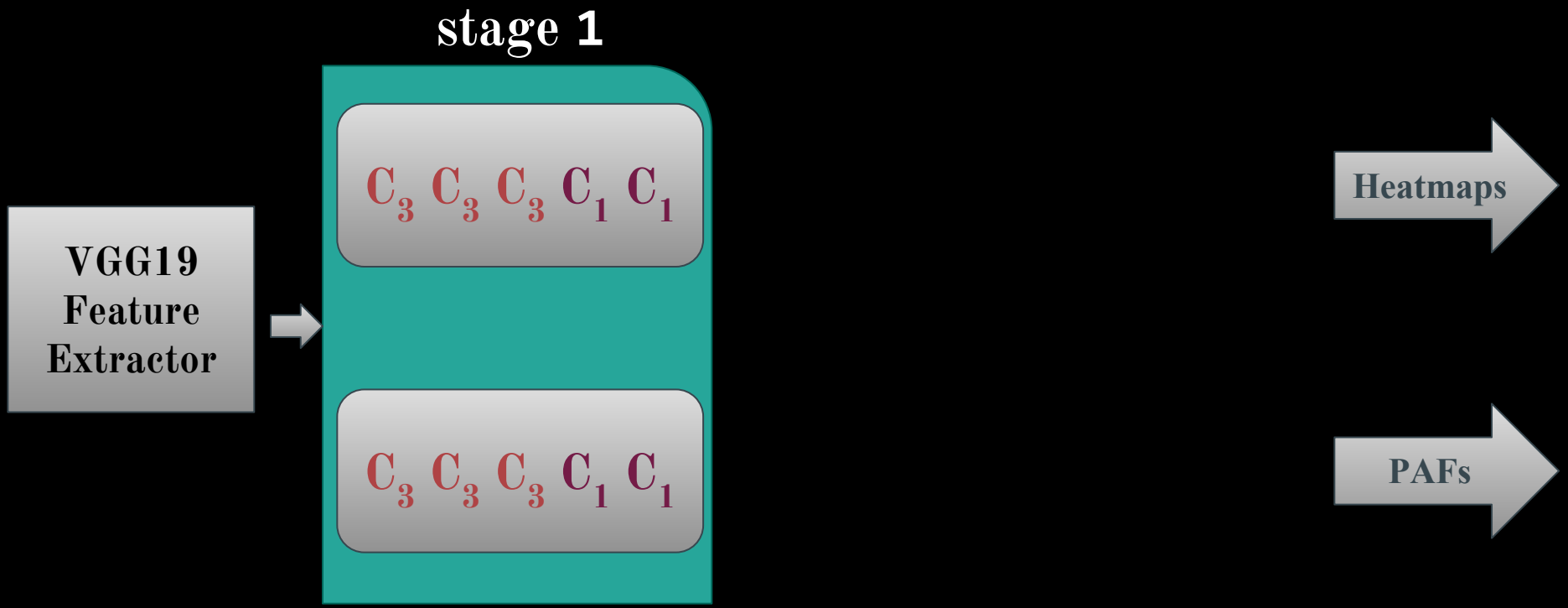
2x19 PAFs

PP

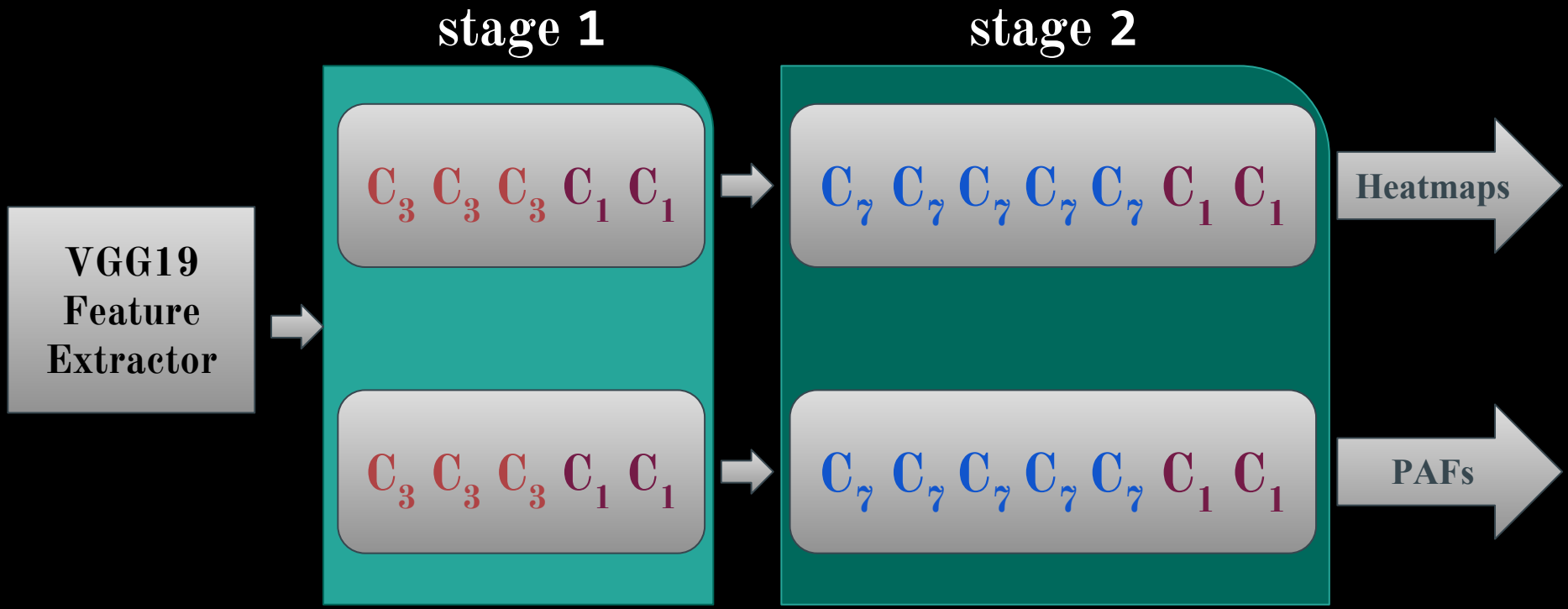
OpenPose

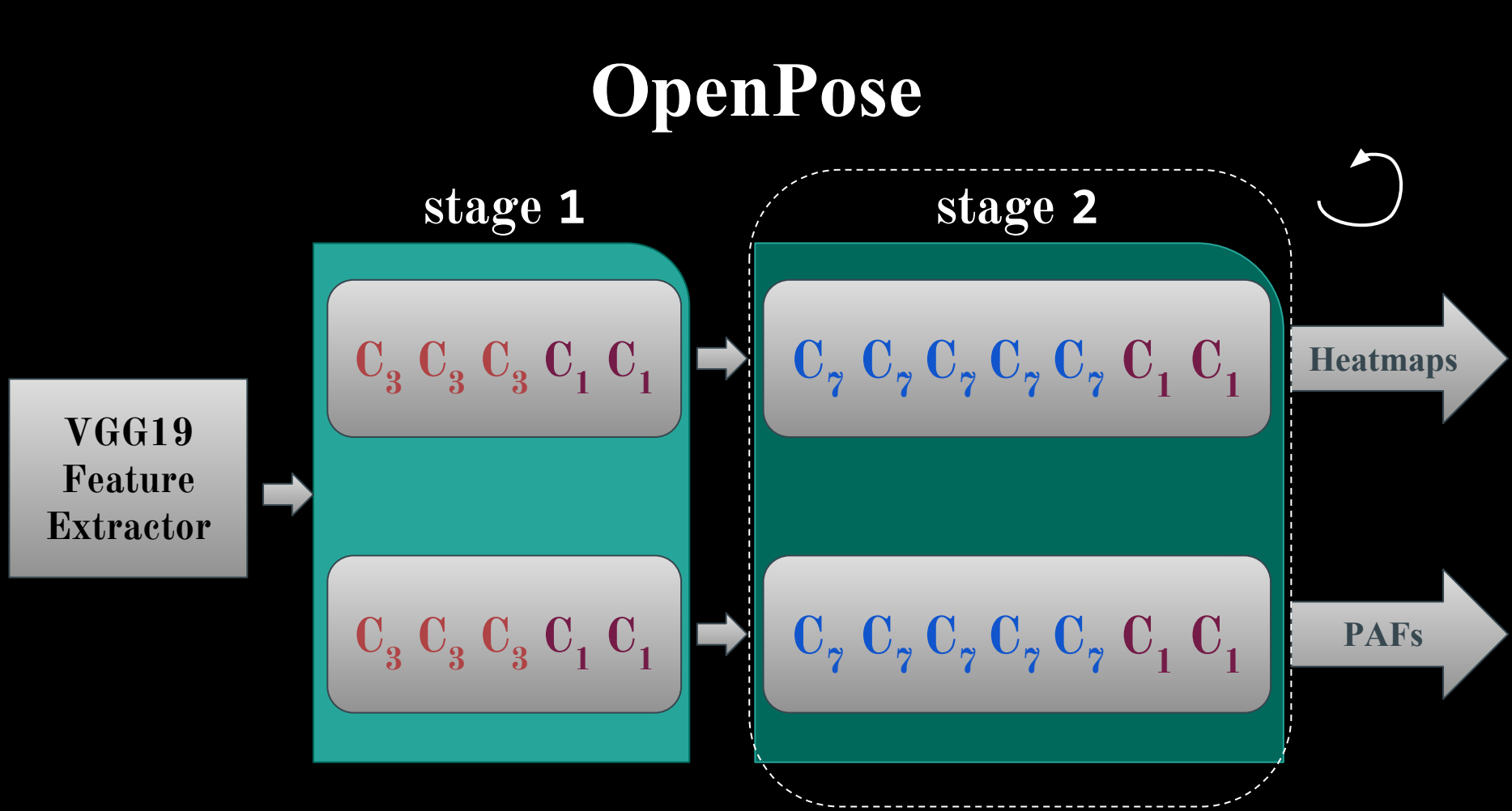


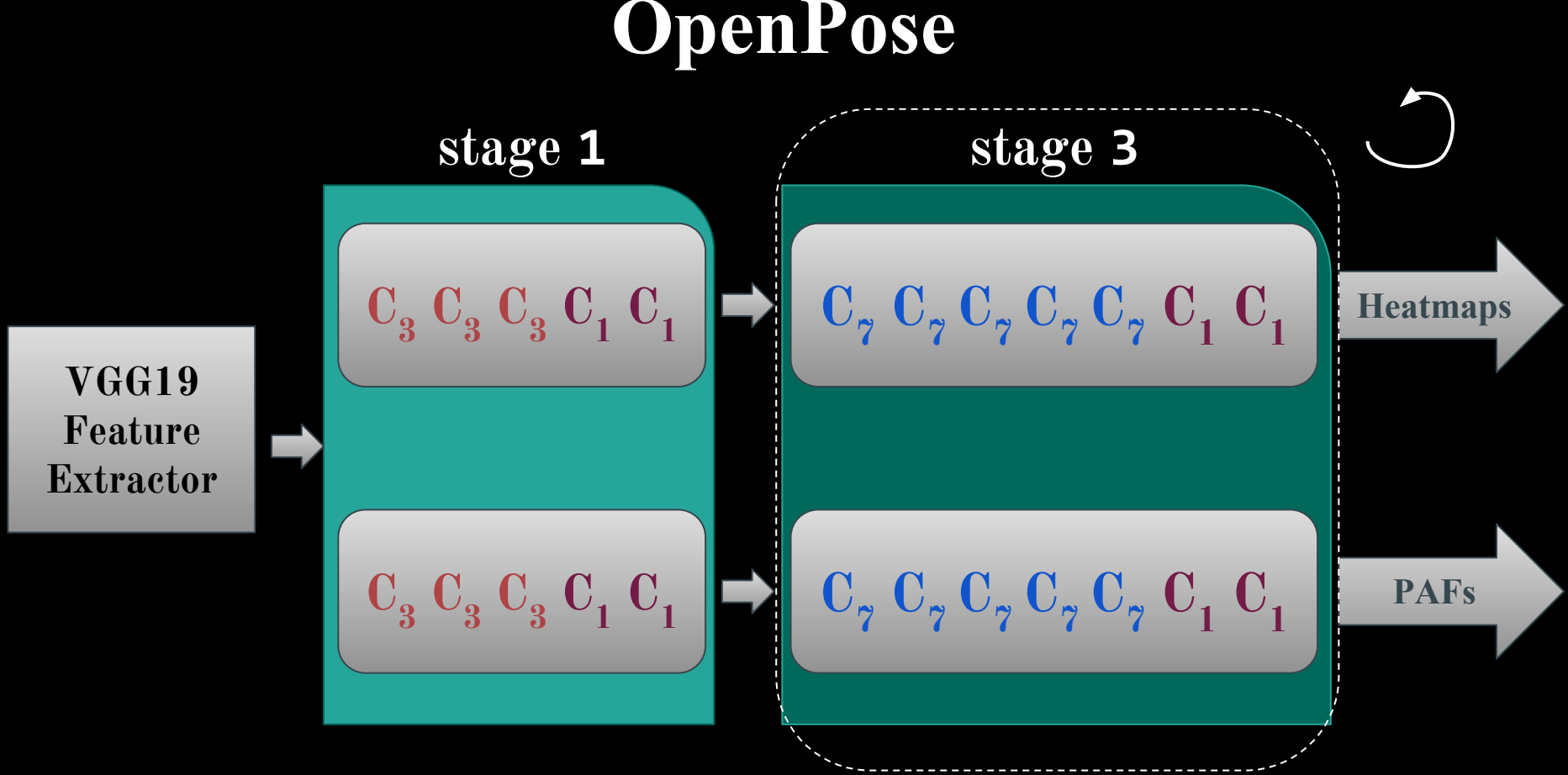
OpenPose

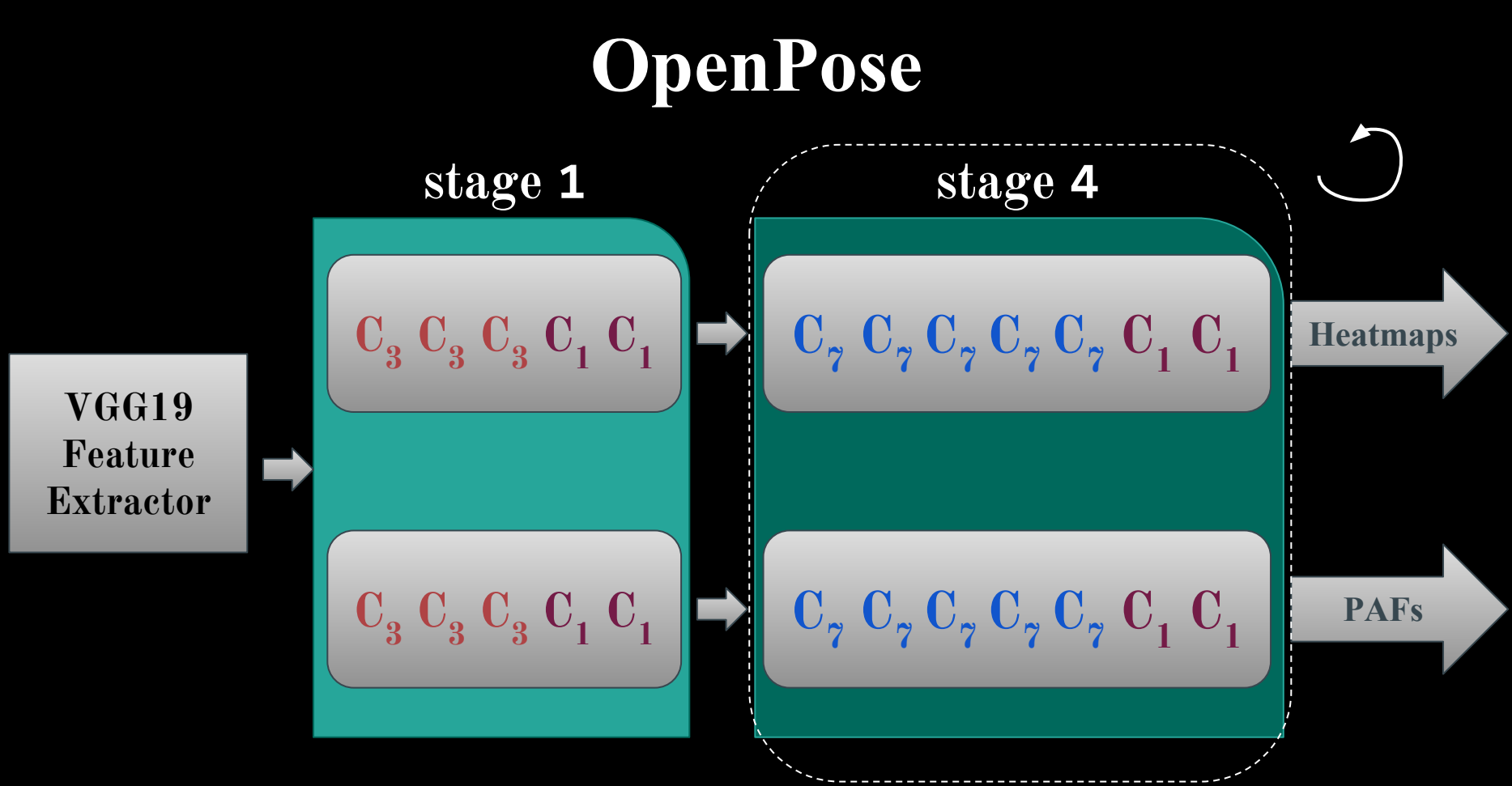

stage 1
VGG19 Feature Extractor
C_3 C_3 C_3 C_1 C_1
C_3 C_3 C_3 C_1 C_1
Heatmaps
PAFs

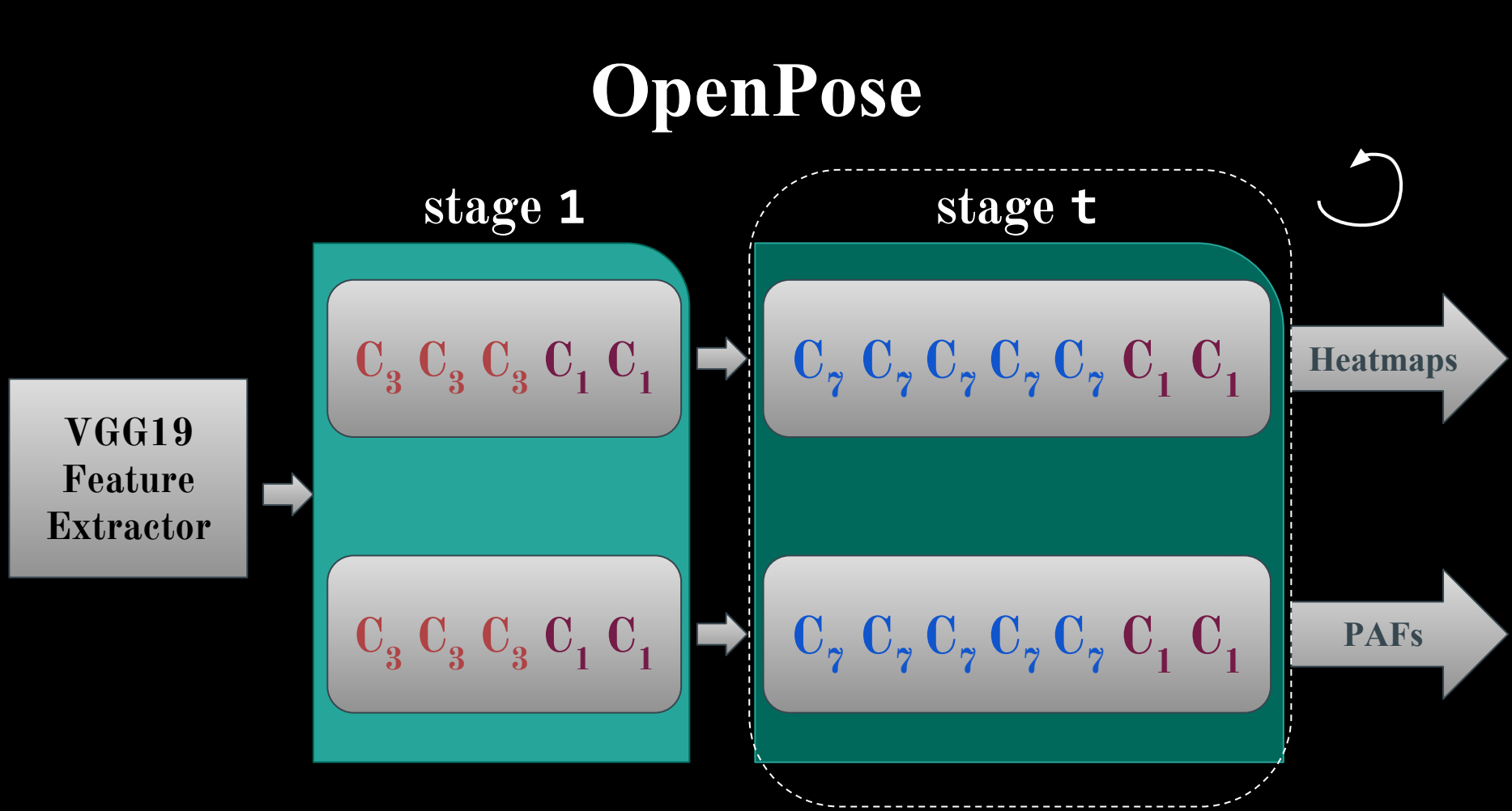
OpenPose


stage 1
stage 2
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs

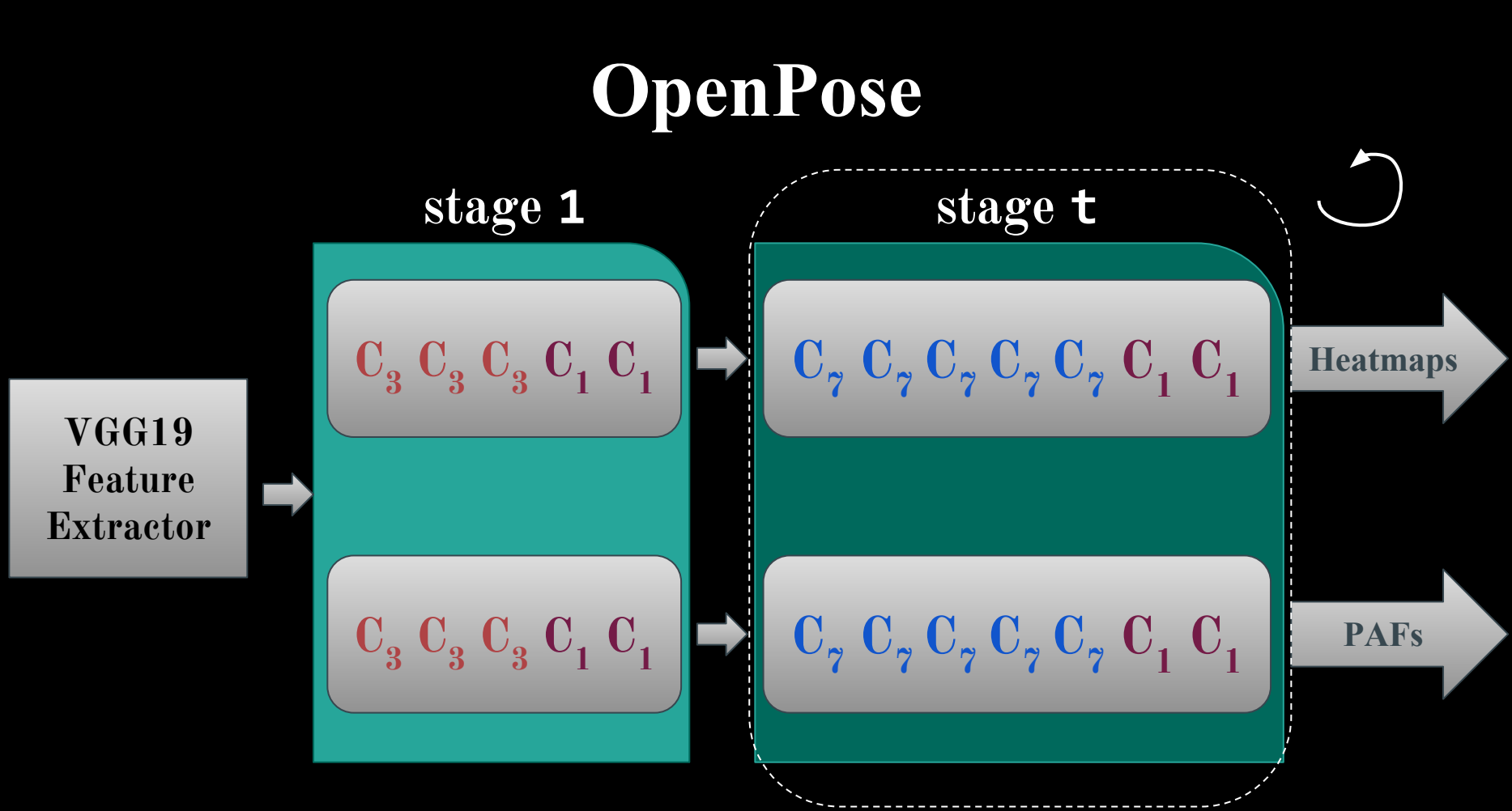

OpenPose
stage 1
stage 2
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs

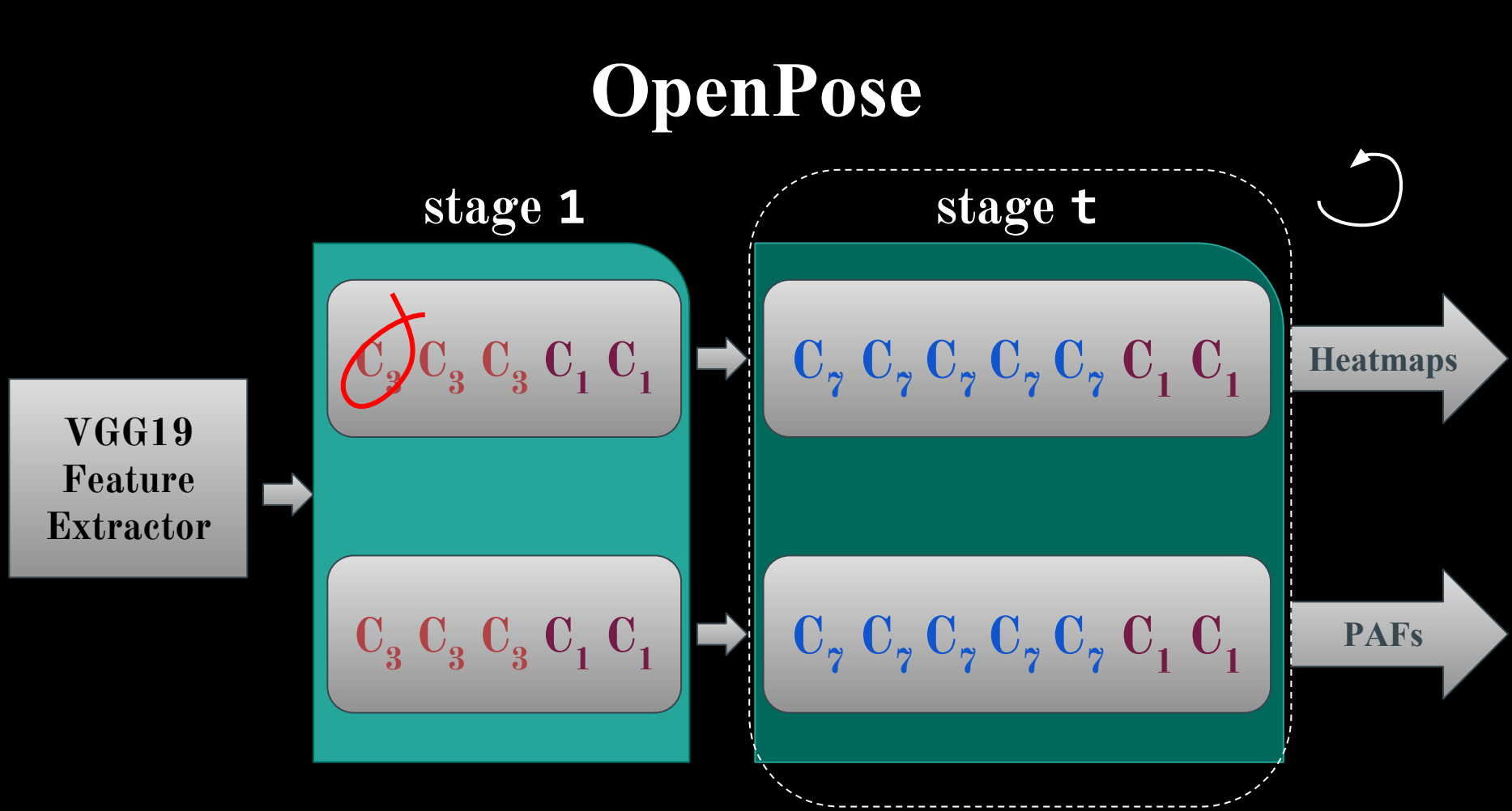

OpenPose
stage 1
stage 3
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs

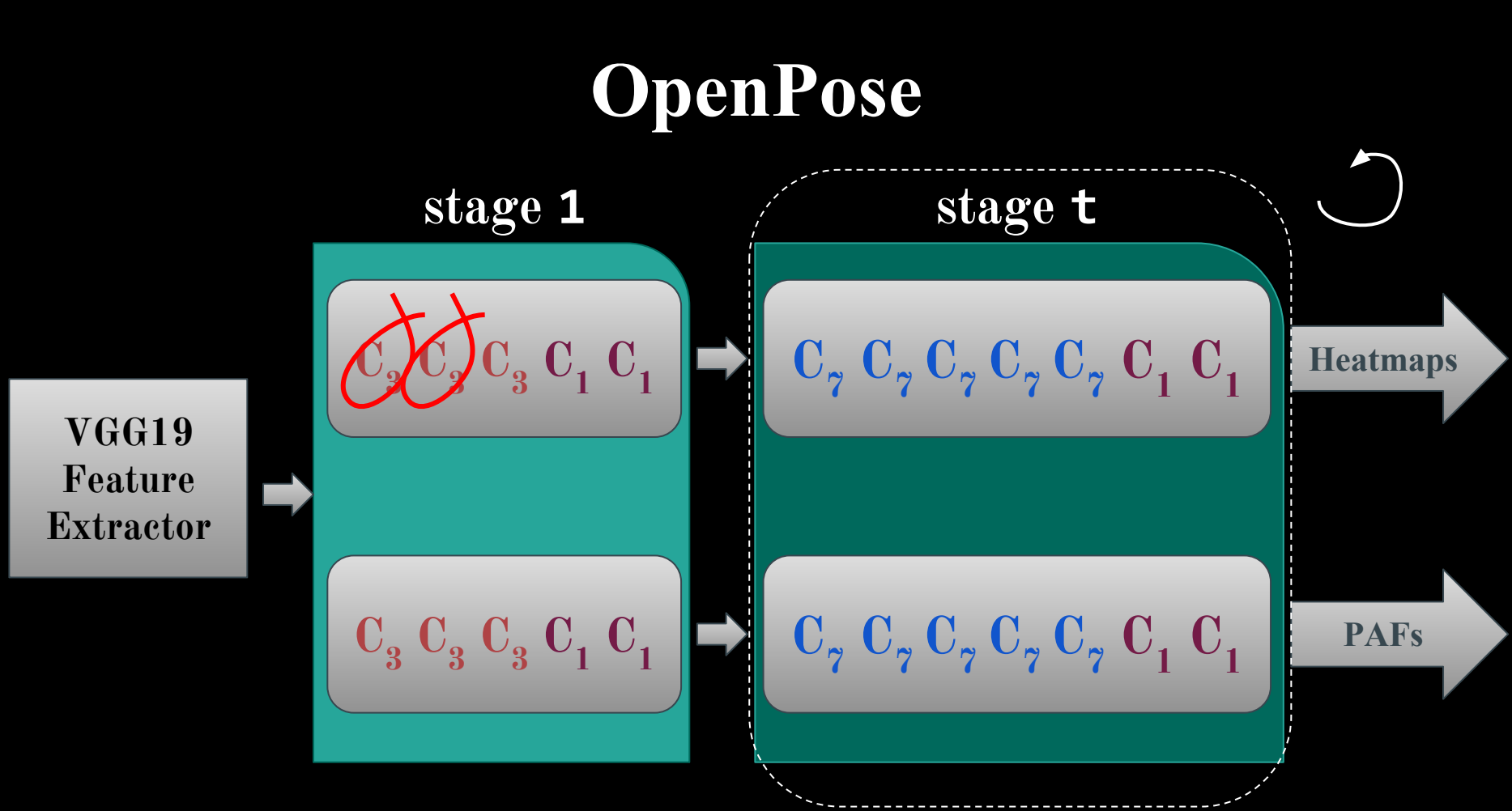

OpenPose
stage 1
stage 4
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs

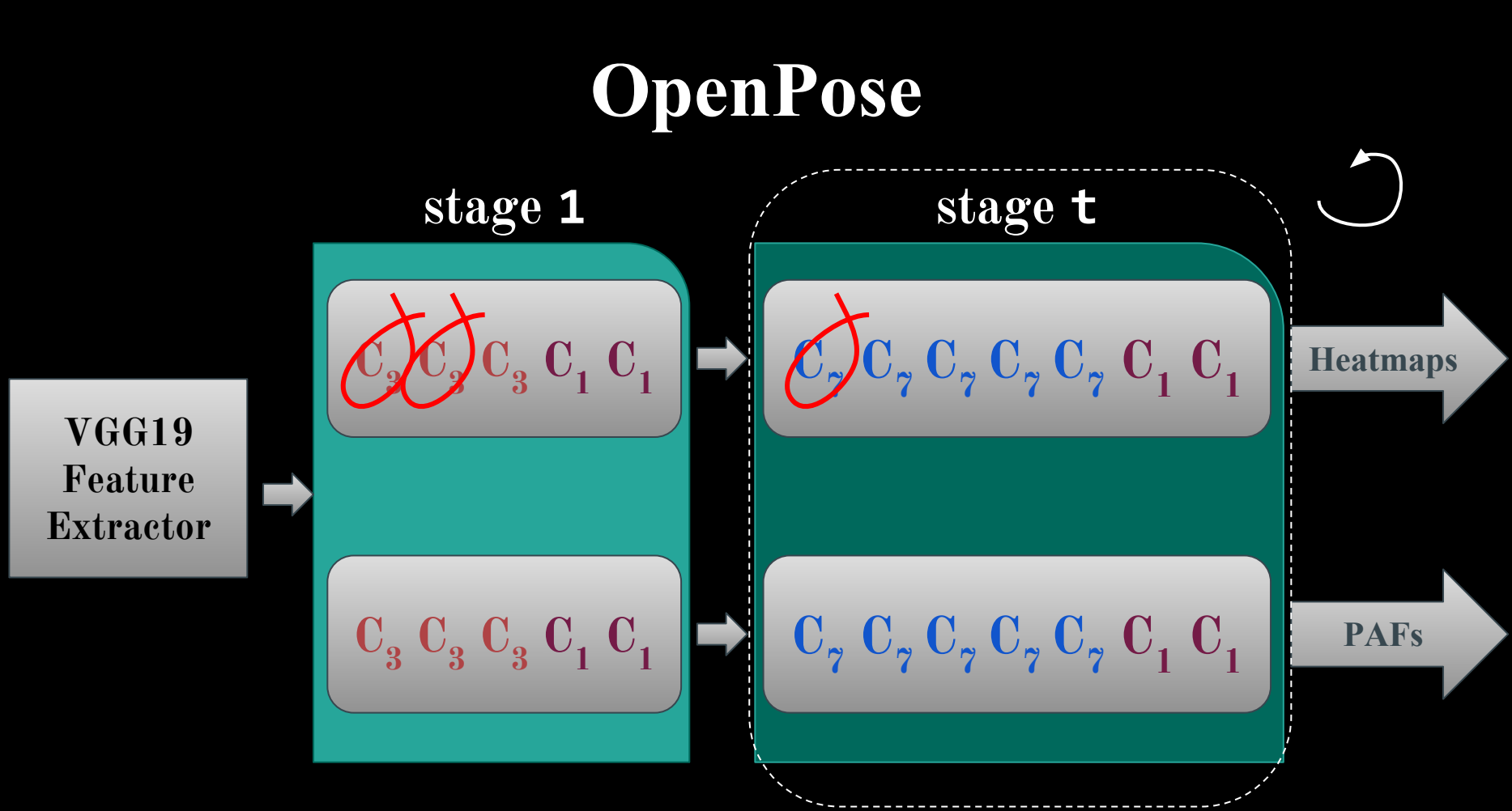

OpenPose
stage 1
stage t
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs

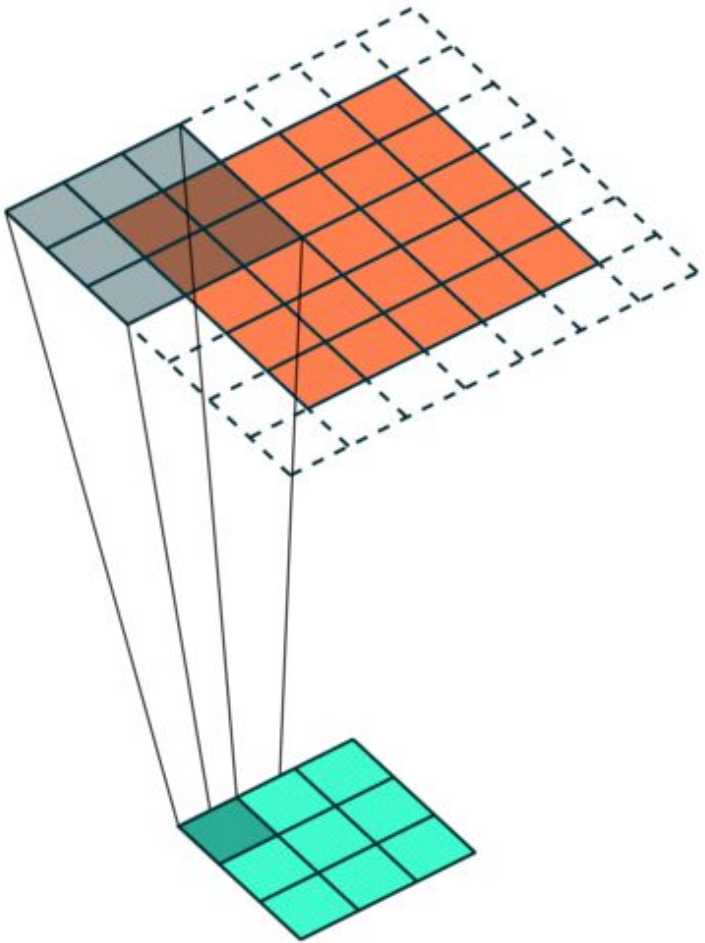
Let’s make this faster


OpenPose
stage 1
stage t
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs


OpenPose
stage 1
stage t
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs

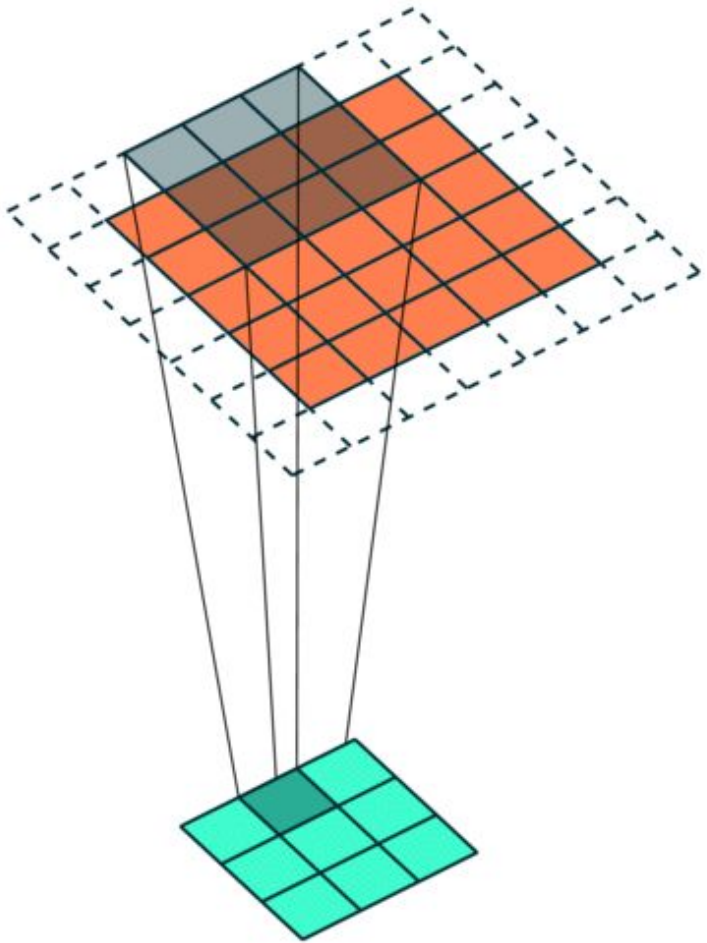

OpenPose
stage 1
stage t
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs


OpenPose
stage 1
stage t
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs



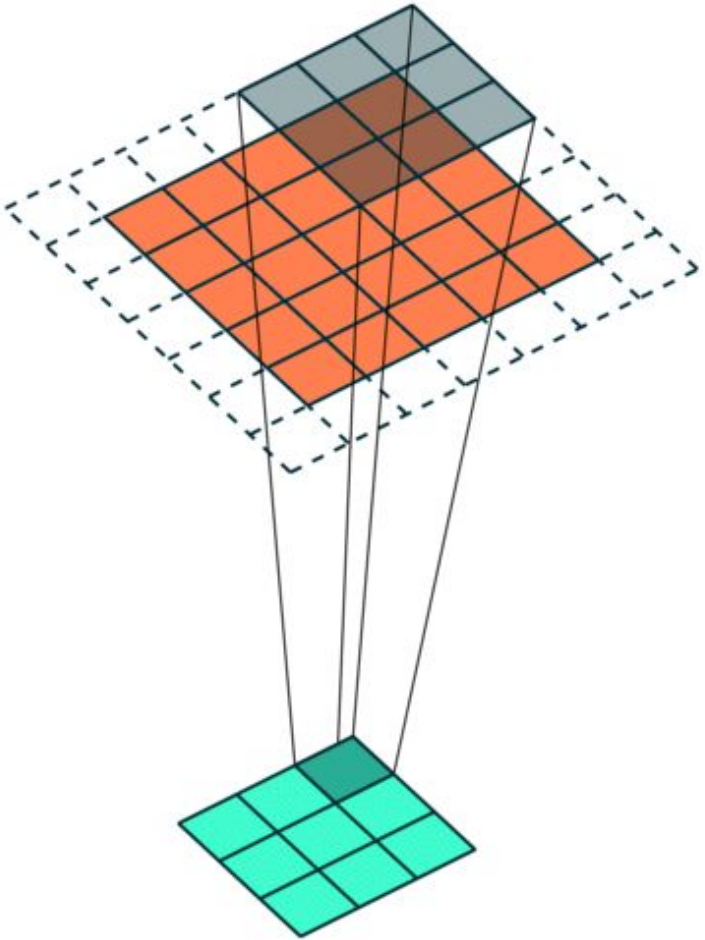
Fully Convolutional Network

The smaller the input image, the less operations we need to perform



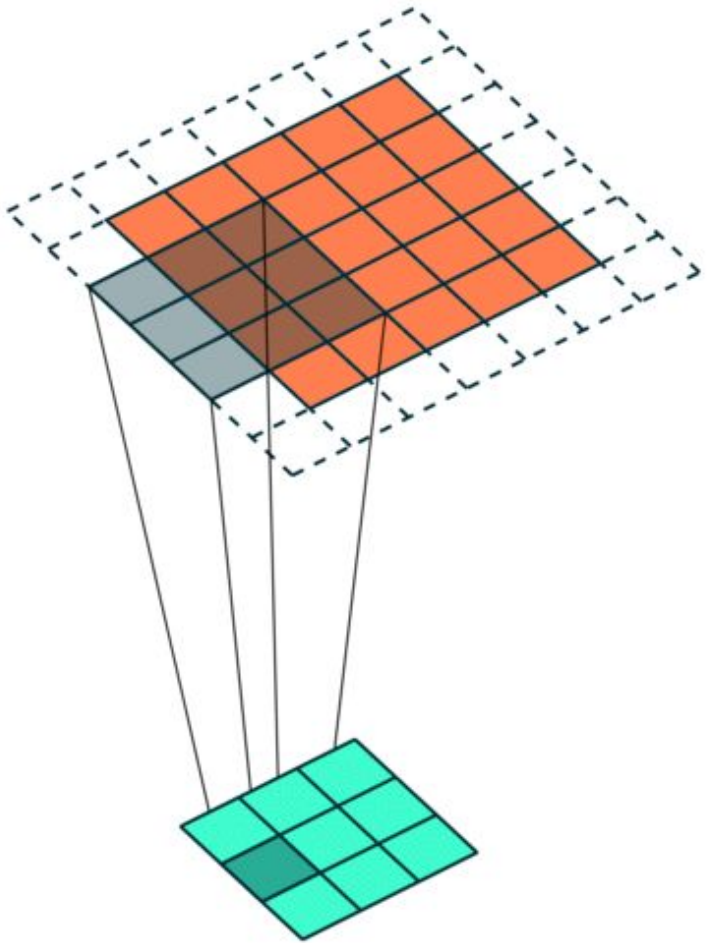
Fully Convolutional Network

The smaller the input image, the less operations we need to perform



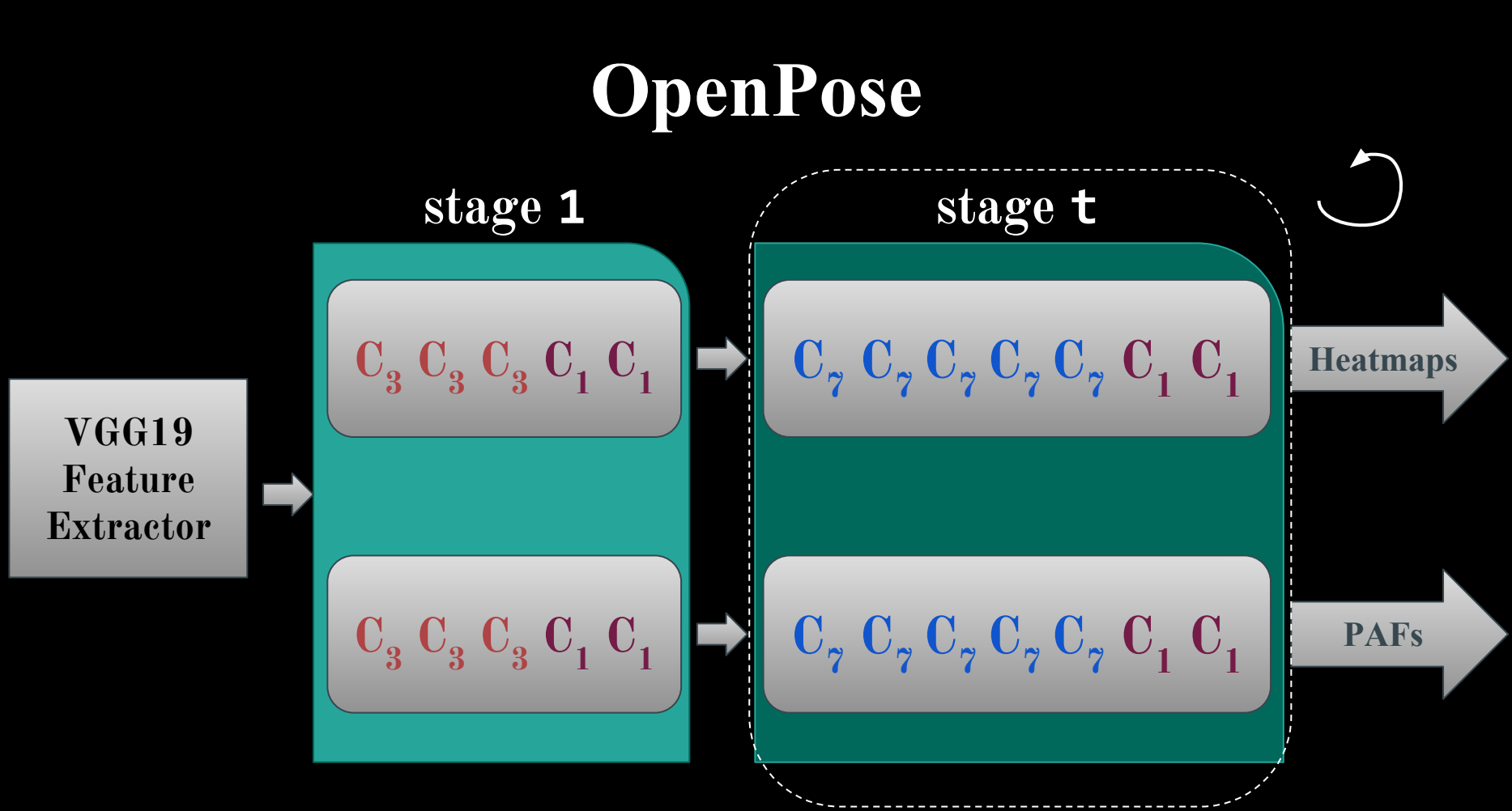
Fully Convolutional Network

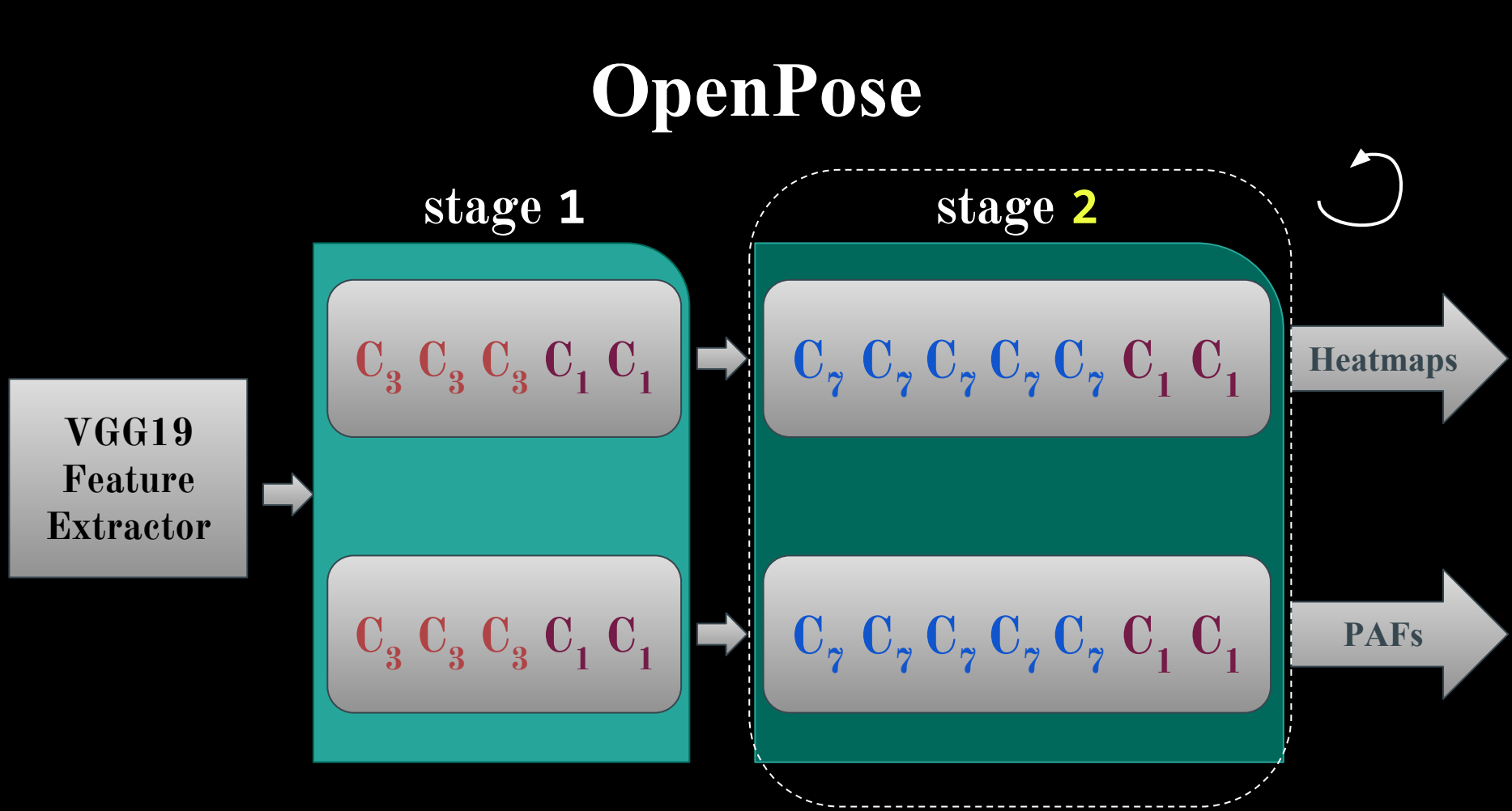
The smaller the input image, the less operations we need to perform

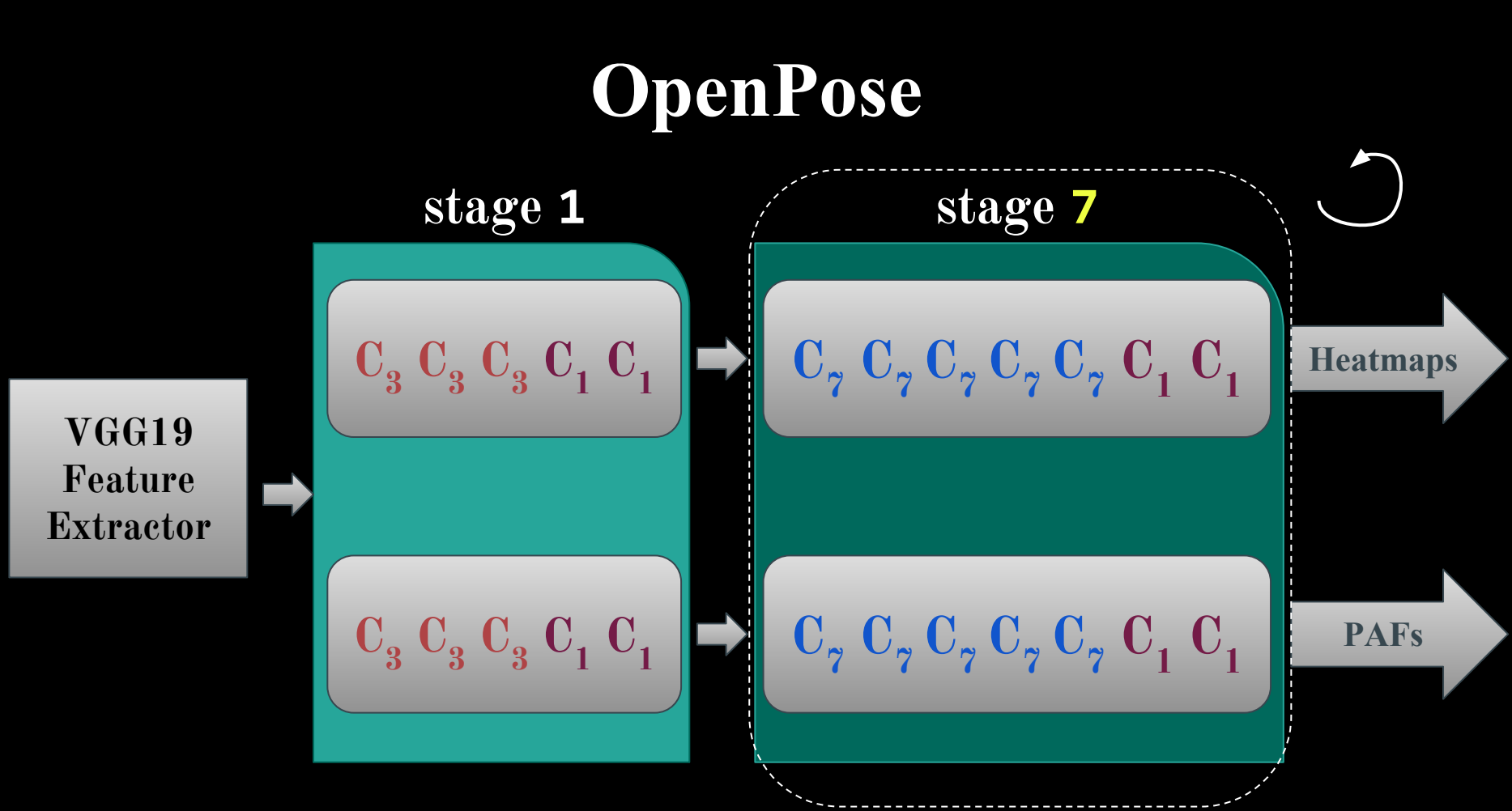


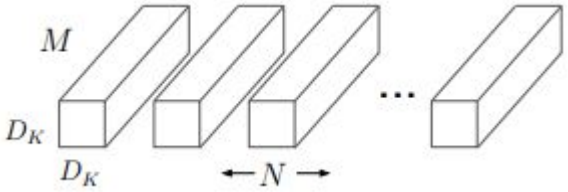
Fully Convolutional Network

The smaller the input image, the less operations we need to perform

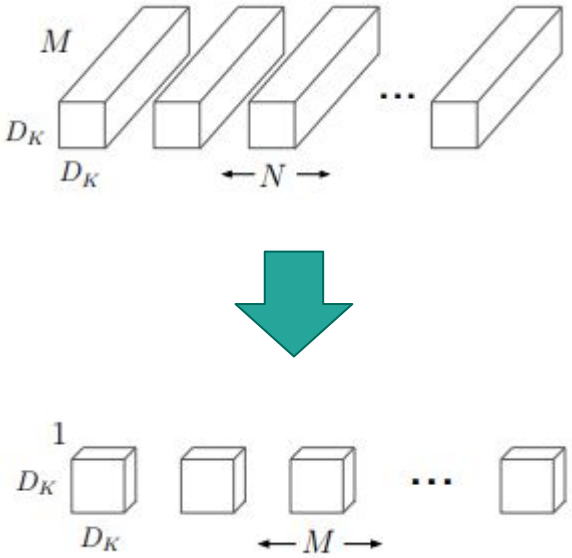

OpenPose
stage 1
stage t
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs


OpenPose
stage 1
stage 2
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs

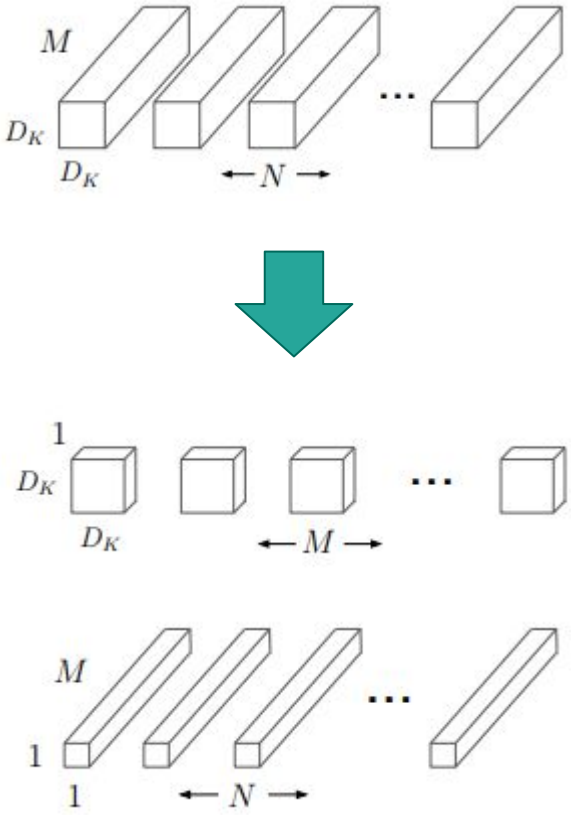

OpenPose
stage 1
stage 7
VGG19
Feature
Extractor
C3 C3 C3 C1 C1
C3 C3 C3 C1 C1
C7 C7 C7 C7 C7 C1 C1
C7 C7 C7 C7 C7 C1 C1
Heatmaps
PAFs



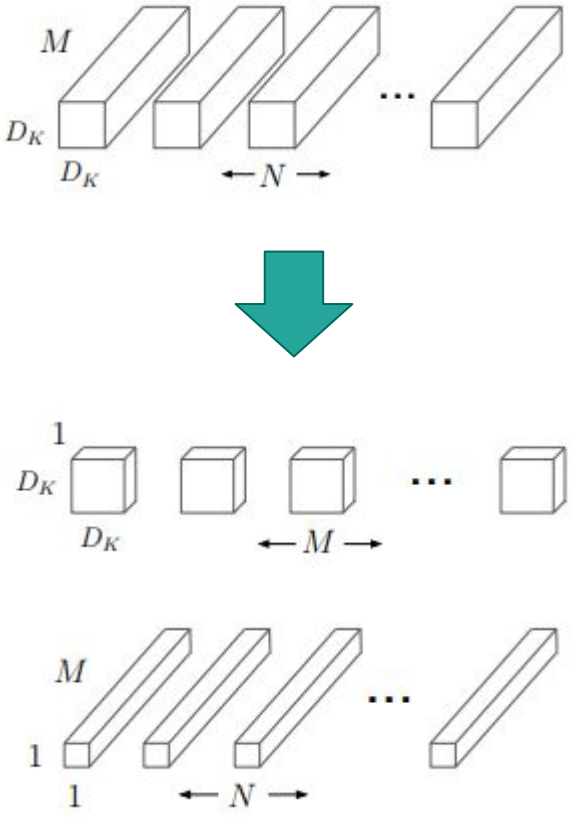
Standard Convolution



Depthwise Convolution



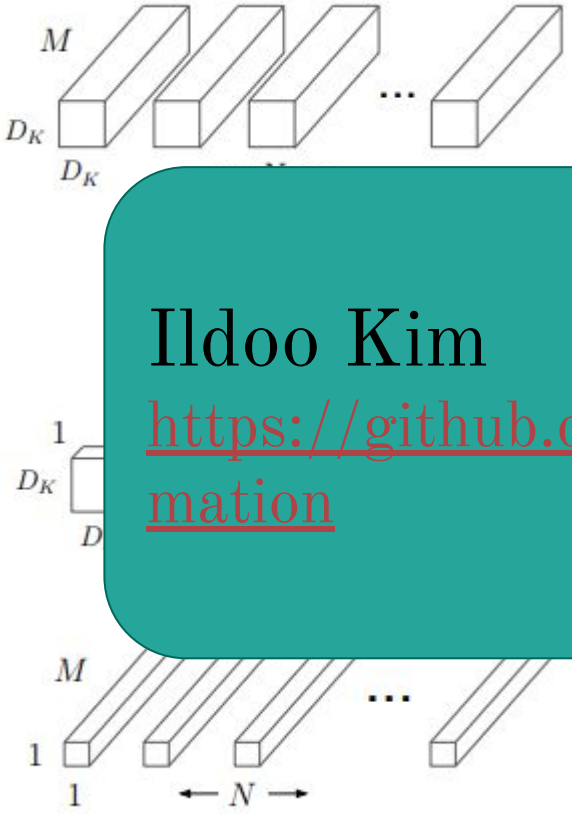
Depthwise Convolution



Depthwise Convolution

Changing a kernel of size KxKxM to M kernels of size KxK, reduce the operations in almost K^2

https://arxiv.org/pdf/1704.04861.pdf



Depthwise Convolution

nel of size

ernels of size

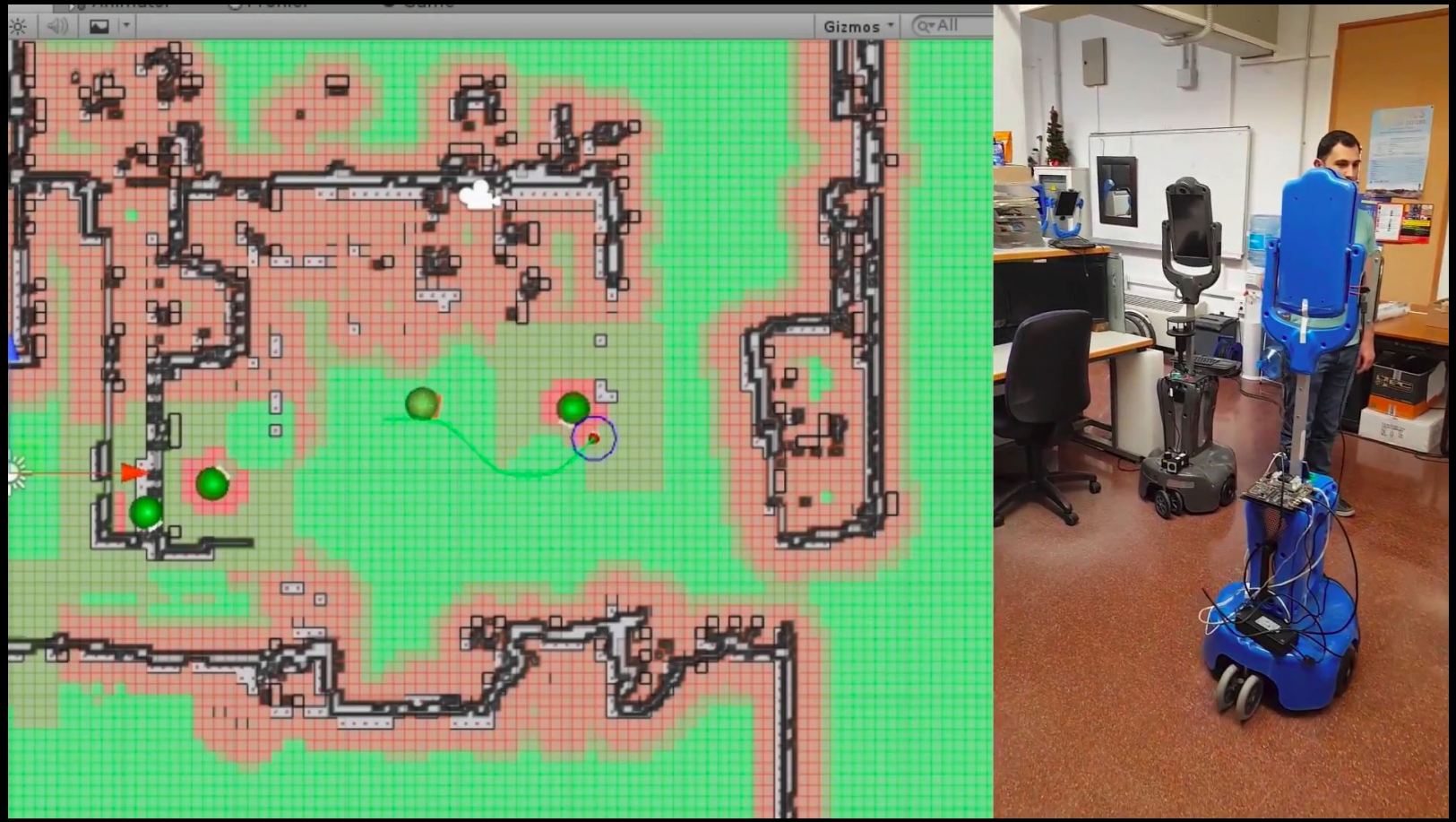
e operations

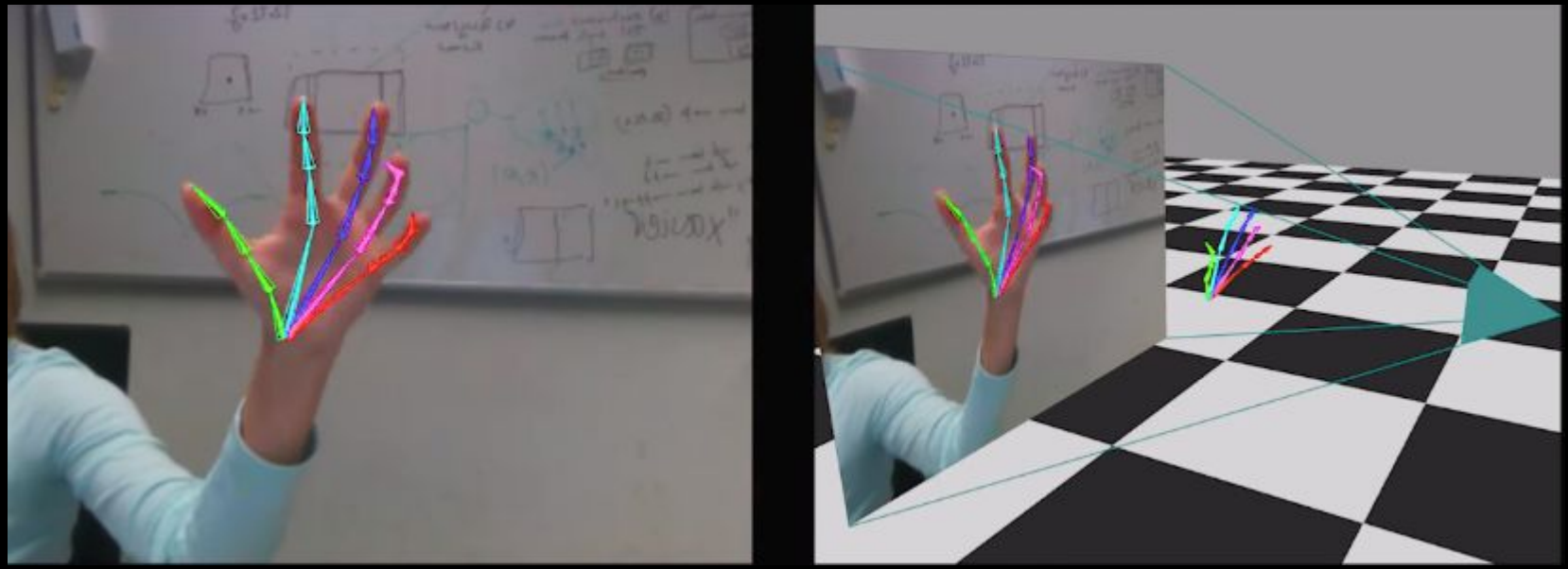
https://arxiv.org/pdf/1704.04861.pdf

Ildoo Kim

https://github.com/ildoonet/tf-pose-estimation

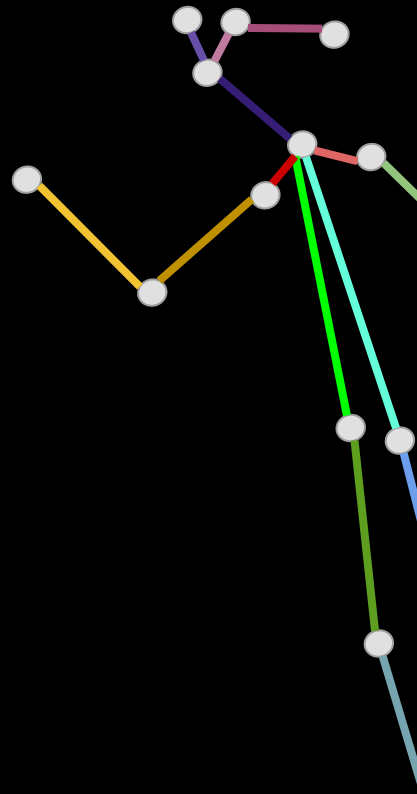
Let’s play


Gizmos
All



https://arxiv.org/pdf/1712.01057.pdf

https://arxiv.org/pdf/1808.07371.pdf



Thank you!!