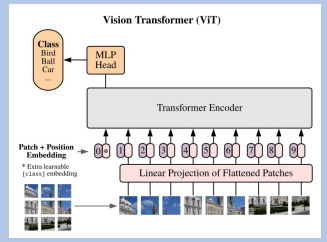
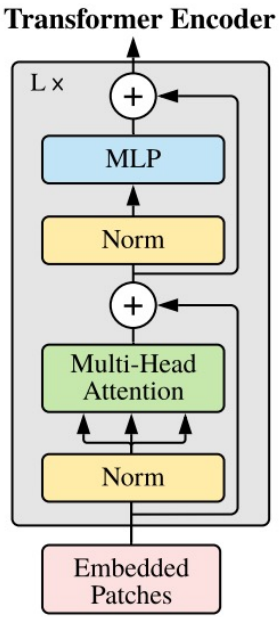
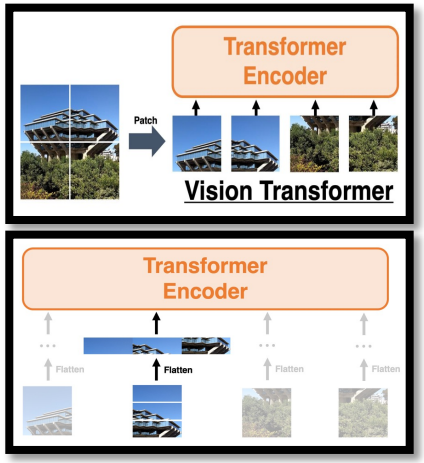
Outline

1. Attention and Vision Transformers (ViT)
   - NLP: Attention is all you need
   - Transformer Encoder ViT with Self Attention for image classification



Attention process in Vision





$$x \in \mathbb{R}^{H \times W \times C}$$

$$x_p \in \mathbb{R}^{N \times (P^2 \cdot C)}$$

$$N = HW/P^2$$

$$\mathbf{z}_0 = [\mathbf{x}_{\text{class}}; \mathbf{x}_p^1\mathbf{E}; \mathbf{x}_p^2\mathbf{E}; \cdots; \mathbf{x}_p^N\mathbf{E}] + \mathbf{E}_{pos}, \qquad \mathbf{E} \in \mathbb{R}^{(P^2 \cdot C) \times D},\ \mathbf{E}_{pos} \in \mathbb{R}^{(N+1) \times D}$$

CLS token

$$\mathbf{z}'_\ell = \text{MSA}(\text{LN}(\mathbf{z}_{\ell-1})) + \mathbf{z}_{\ell-1}, \qquad \ell = 1 \ldots L$$

$$\mathbf{z}_\ell = \text{MLP}(\text{LN}(\mathbf{z}'_\ell)) + \mathbf{z}'_\ell, \qquad \ell = 1 \ldots L$$

$$\mathbf{y} = \text{LN}(\mathbf{z}_L^0)$$

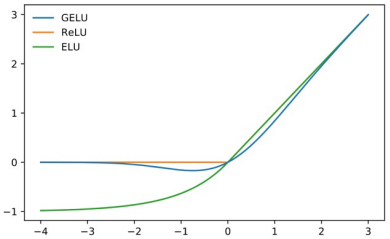
[class=CLS] token: a learnable embedding to the sequence of embedded patches

Layernorm (LN) before every block, and residual connections after every block

MSA: Multi Head Self Attention

MLP: two layers with a GELU non-linearity

Hybrid Architecture : Raw image patches --> Feature map of a CNN



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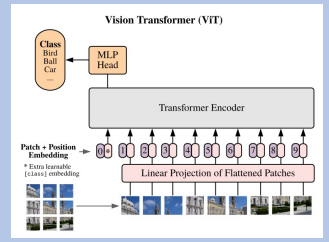
2. **Transformer Decoder** for downstream tasks



Outline

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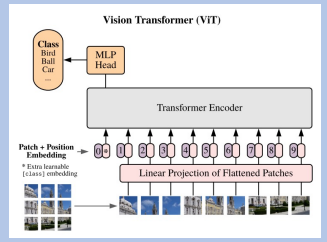
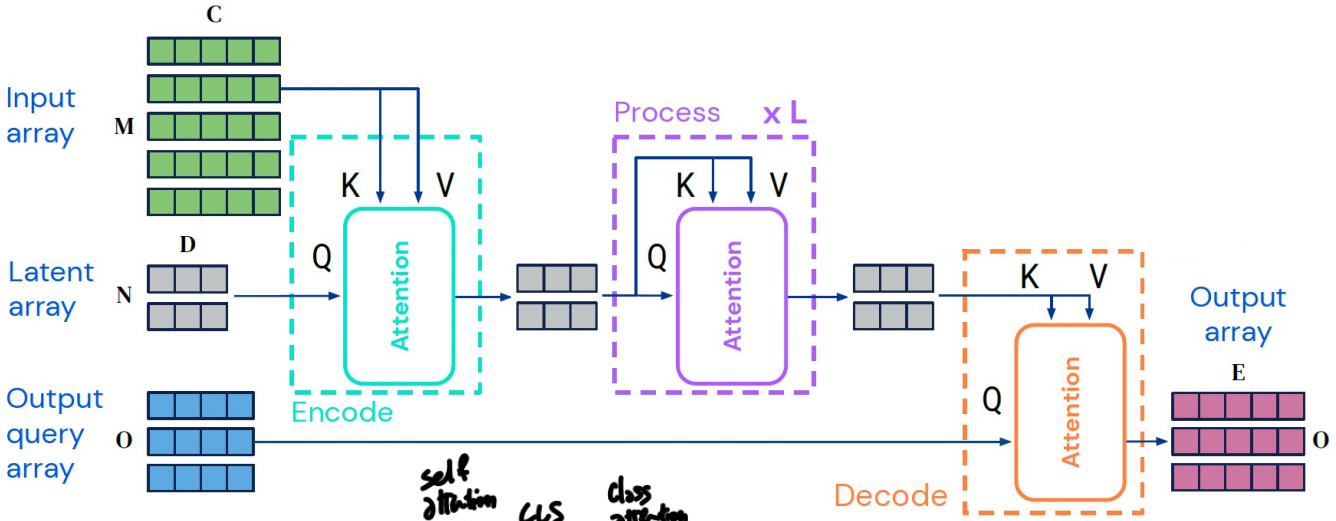


2. **Transformer Decoder** for downstream tasks
   - Detection
   - Segmentation
   - Continual Learning, …

General Decoder

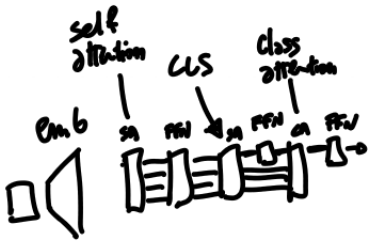
[Perceiver IO A General Architecture for Structured Inputs & Outputs ICLR22]



CLASS TOKEN

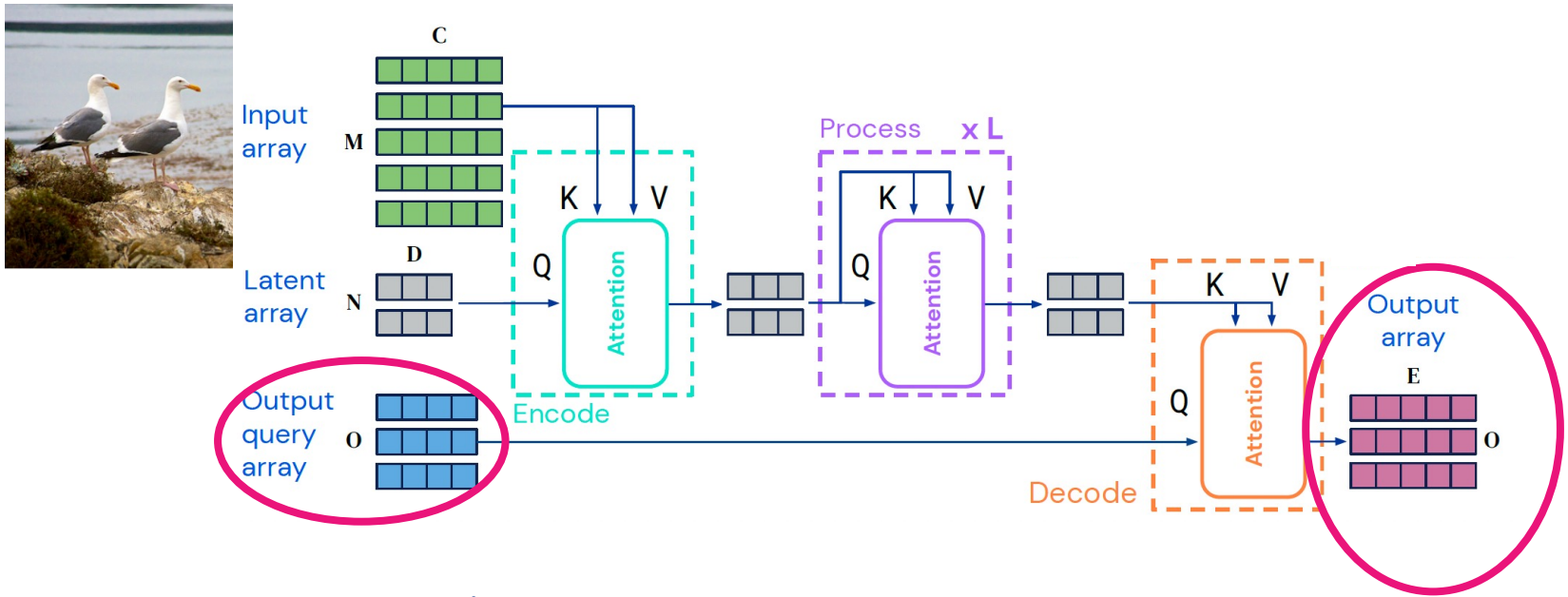
CLS can be used in many ways:

- since beginning
- from a hidden layer, like CaiT



General Decoder

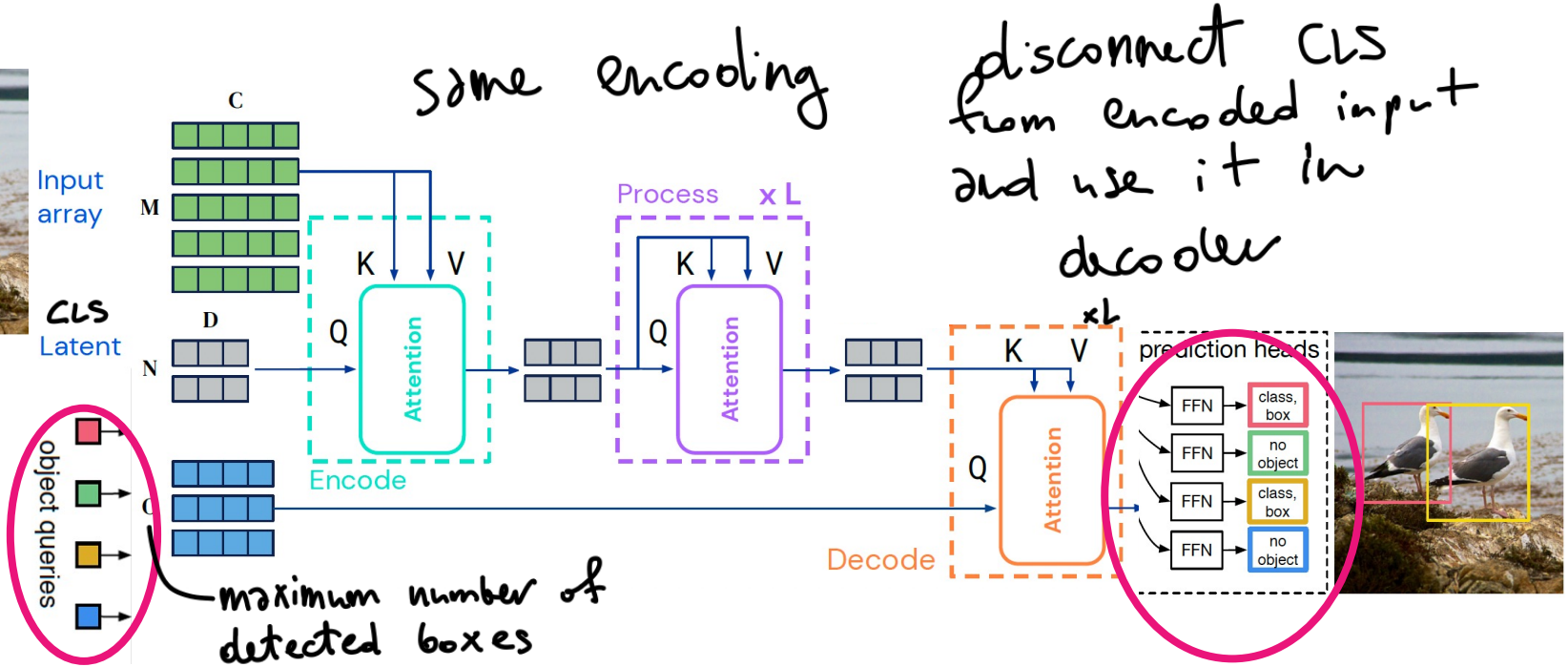
[Perceiver IO A General Architecture for Structured Inputs & Outputs ICLR22]



Output query array / Output array defines the downstream task: detection, segmentation …

General Decoder

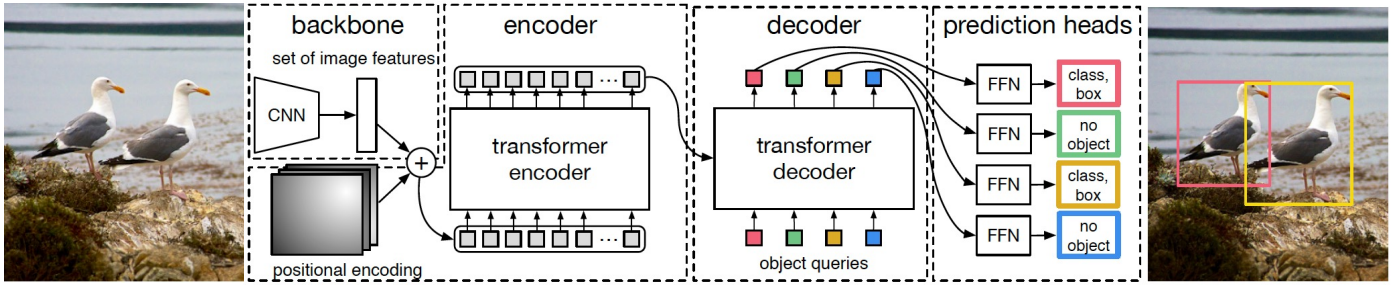
[Perceiver IO A General Architecture for Structured Inputs & Outputs ICLR22]

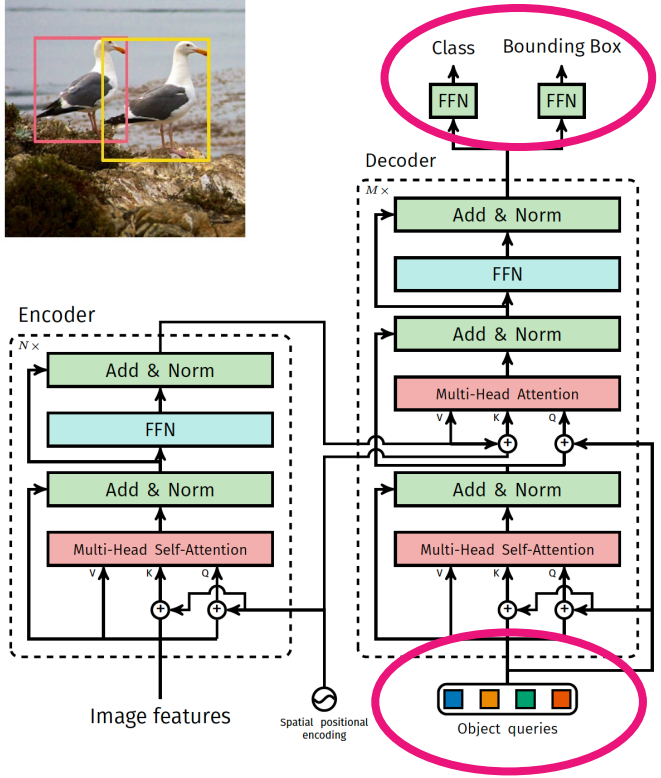


Output query array / Output array defines the downstream task: detection

Transformer Decoder for detection

Just another scheme for DETR model





Cornell University

arXiv > cs > arXiv:2005.12872

Computer Science > Computer Vision and Pattern Recognition

[Submitted on 26 May 2020 (v1), last revised 28 May 2020 (this version, v3)]

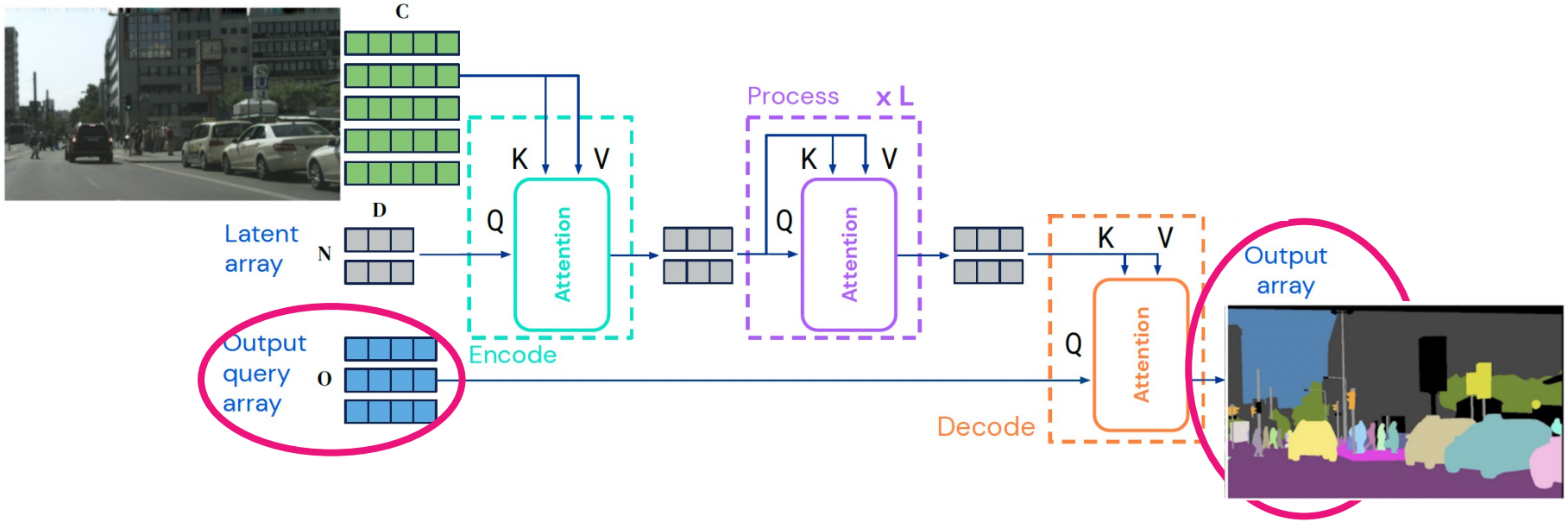
End-to-End Object Detection with Transformers

Nicolas Carion, Francisco Massa, Gabriel Synnaeve, Nicolas Usunier, Alexander Kirillov, Sergey Zagoruyko

We present a new method that views object detection as a direct set prediction problem. Our approach streamlines the detection pipe hand-designed components like a non-maximum suppression procedure or anchor generation that explicitly encode our prior knowl the new framework, called DEtection TRansformer or DETR, are a set-based global loss that forces unique predictions via bipartite ma

General Decoder

[Perceiver IO A General Architecture for Structured Inputs & Outputs ICLR22]



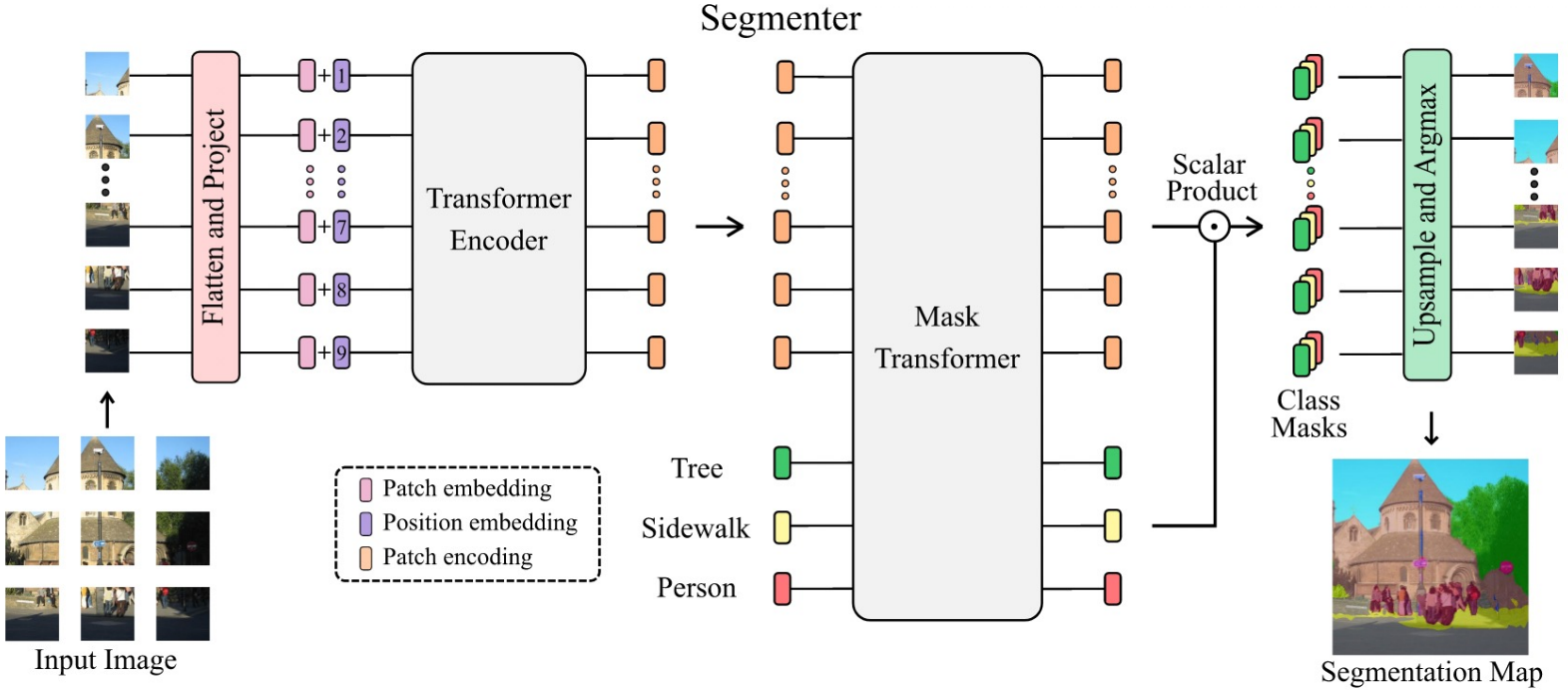
Output query array / Output array defines the downstream task: segmentation …

General Decoder: or not!

This ICCV paper is the Open Access version, provided by the Computer Vision Foundation.
Except for this watermark, it is identical to the accepted version;
the final published version of the proceedings is available on IEEE Xplore.

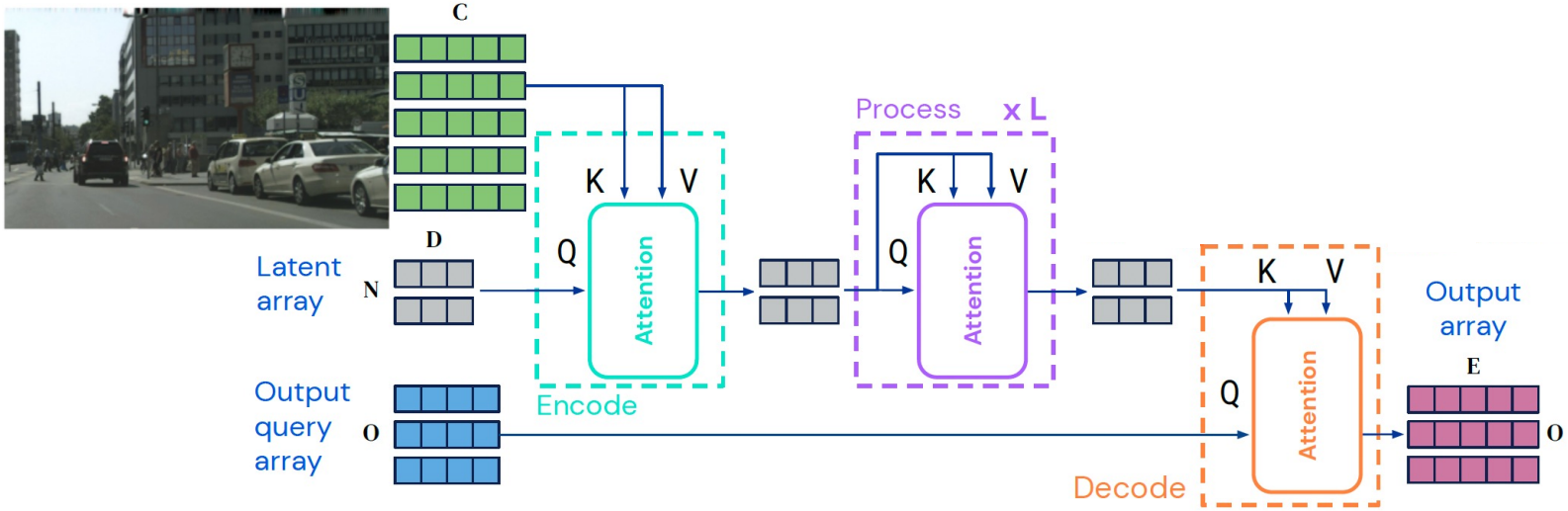
Segmenter: Transformer for Semantic Segmentation

Robin Strudel* Inria†
Ricardo Garcia* Inria†
Ivan Laptev Inria†
Cordelia Schmid Inria†



General Decoder

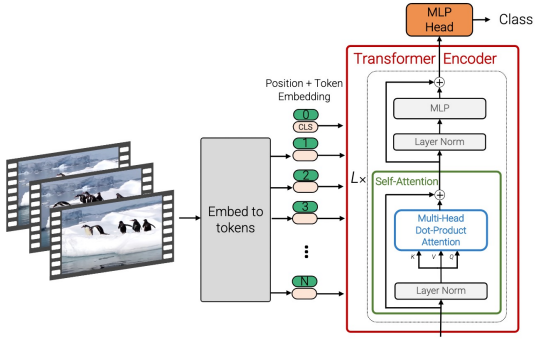
[Perceiver IO A General Architecture for Structured Inputs & Outputs ICLR22]

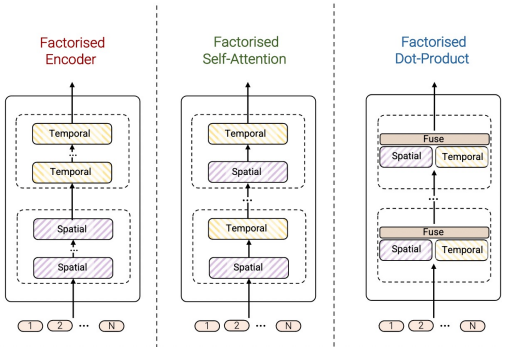


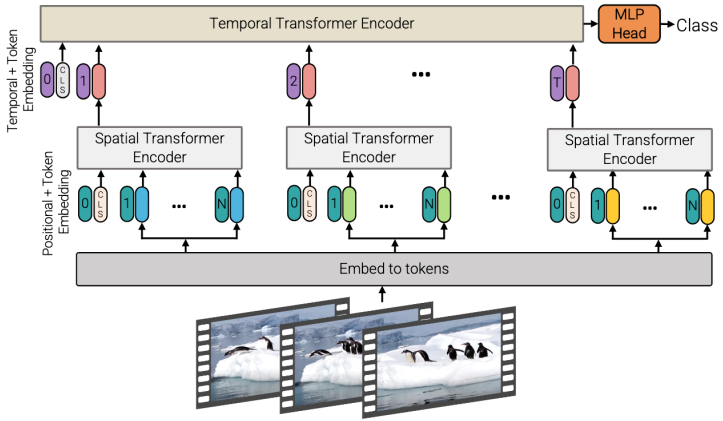
Output query array / Output array defines the downstream task: continual learning

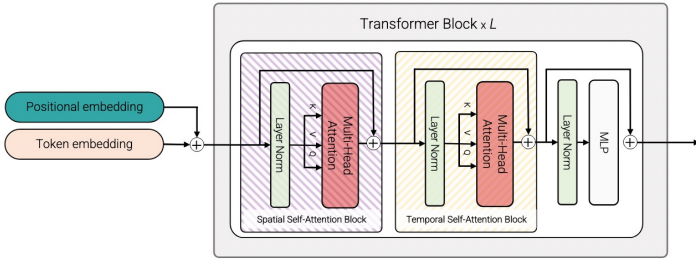
Video Transformer

[ViViT: A Video Vision Transformer ICCV 2021]



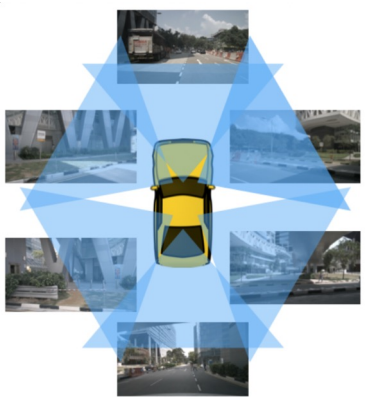






General Encoder / Decoder

Input array = N cameras



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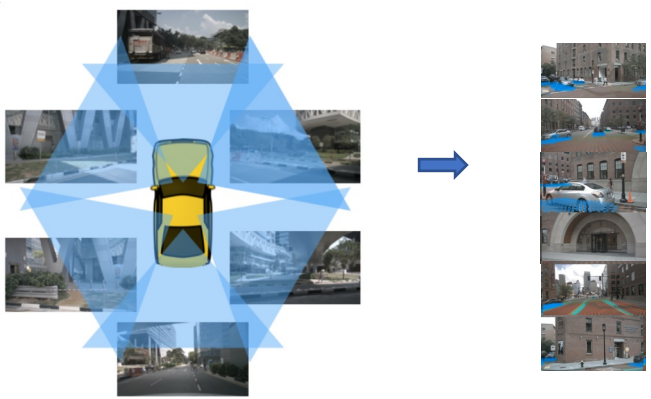

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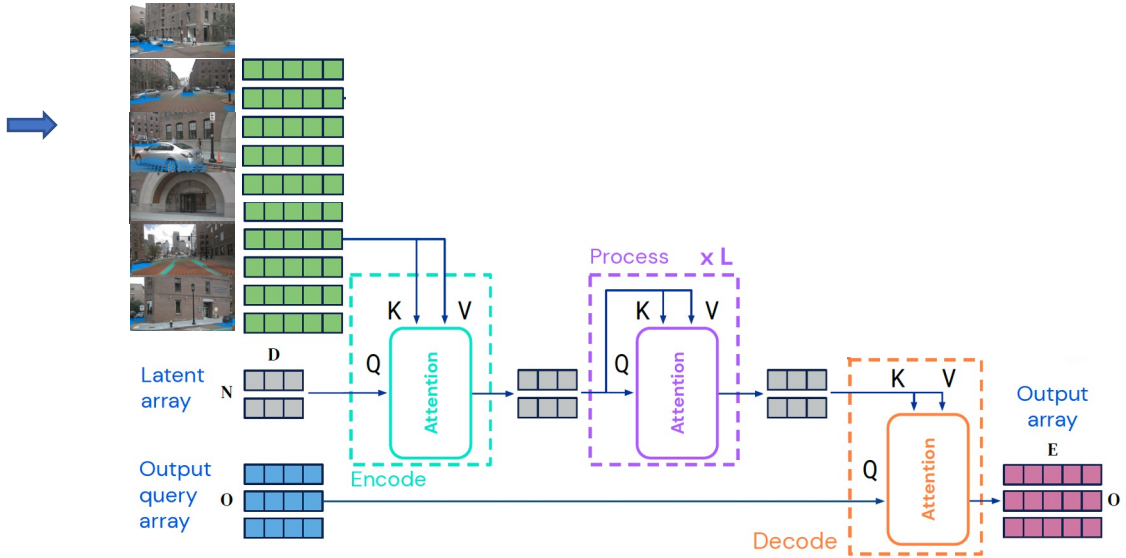
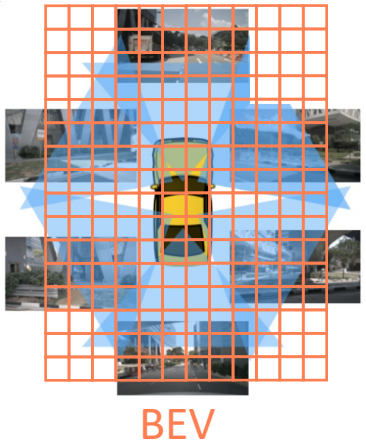
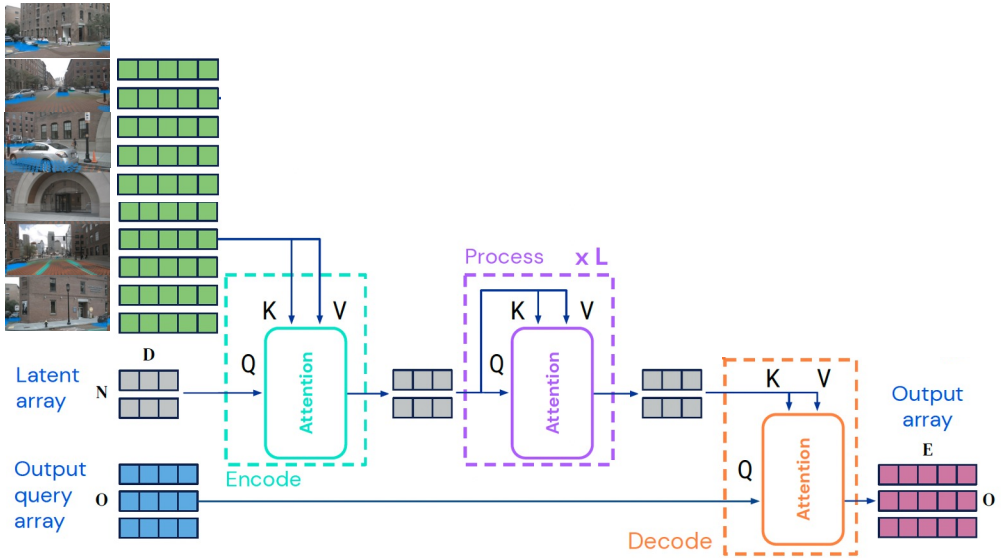


General Encoder / Decoder

Input array = N cameras

Output array = Bird Eye View (BEV) representation





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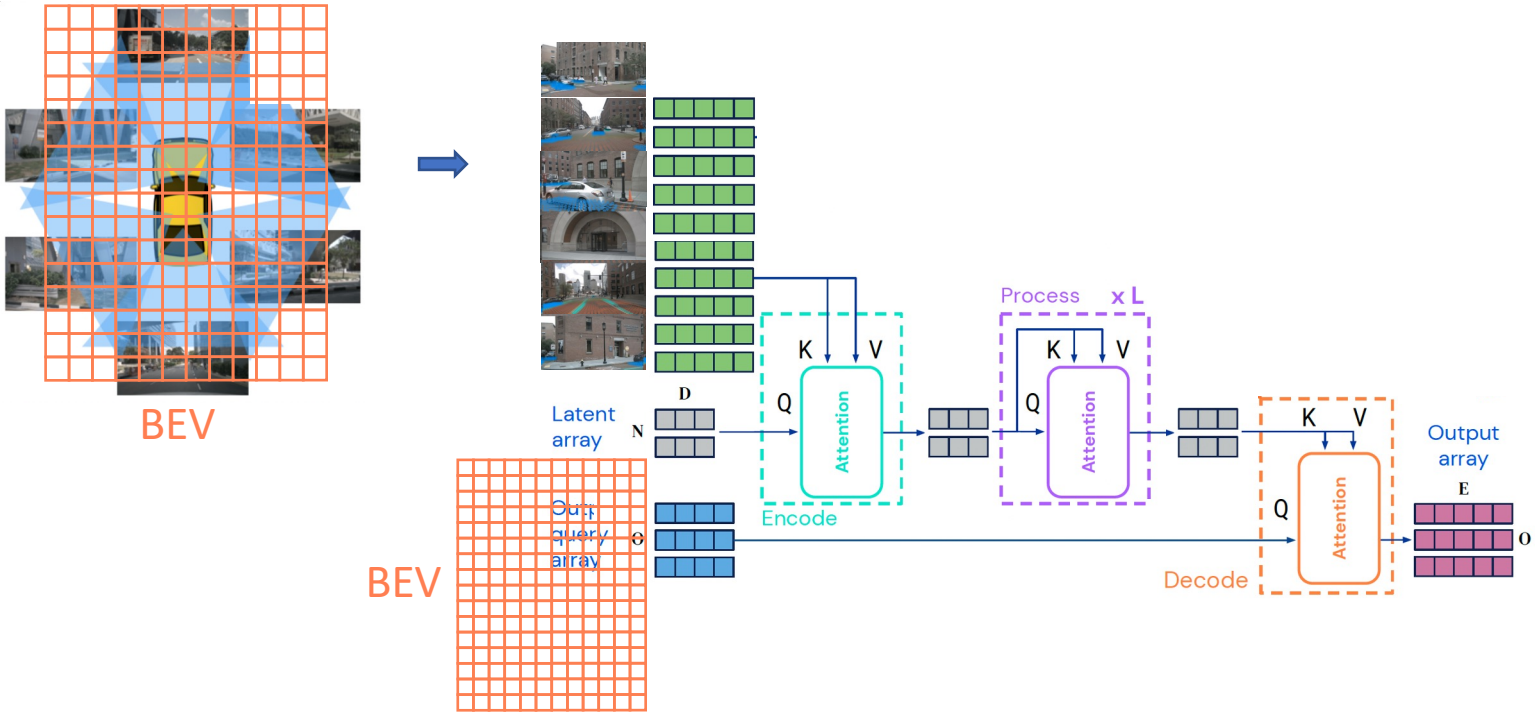

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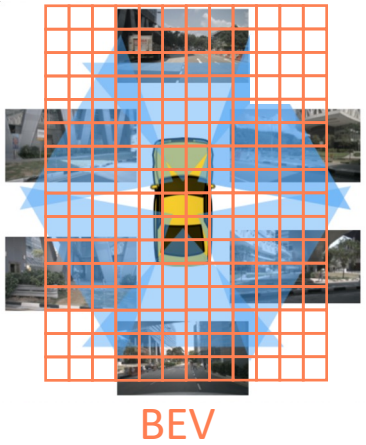

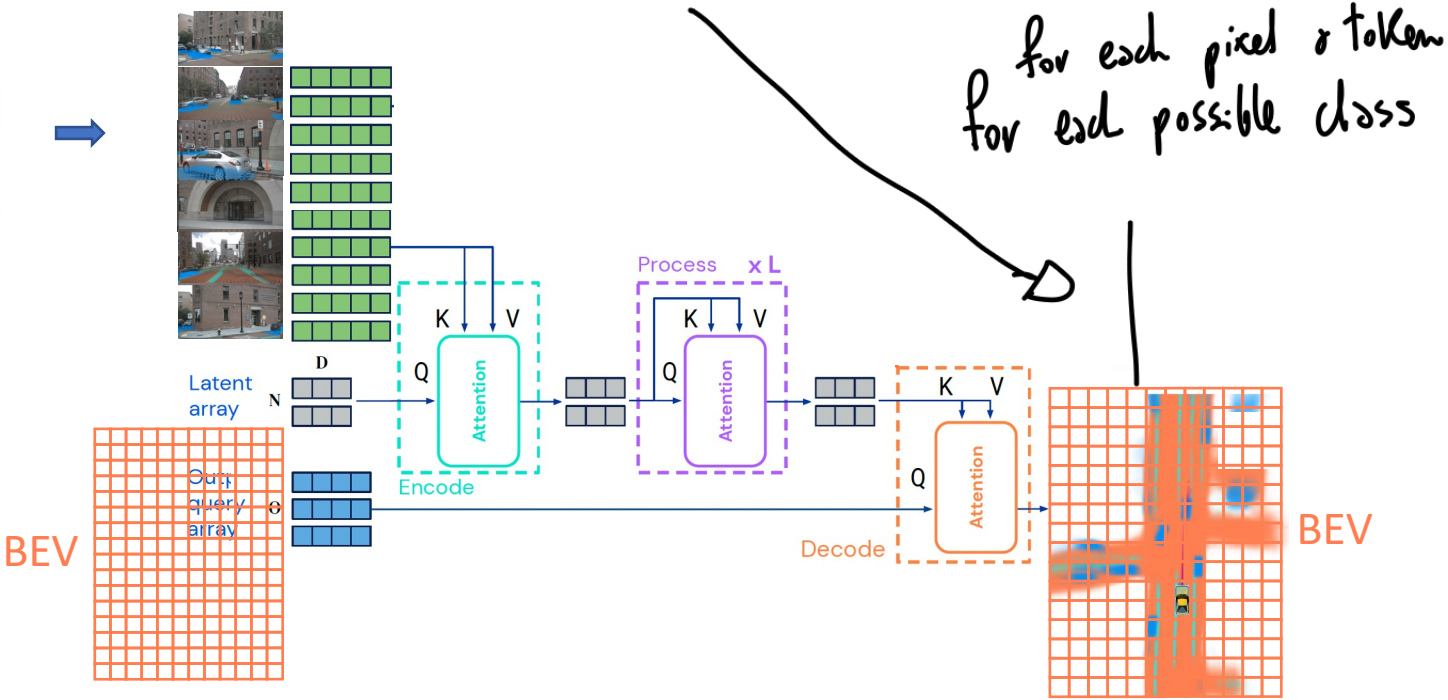

Vision Transformers

Global Attention mechanism at every layer of the deep archi

Very **competitive architectures** in image classification with the best Convnets

Fusion/Merging by mixing thanks to cross attention process

Somehow universal deep structure around encoding/decoding for many vision tasks as classification (1 class token), object detection, segmentation, …