

# Transformers

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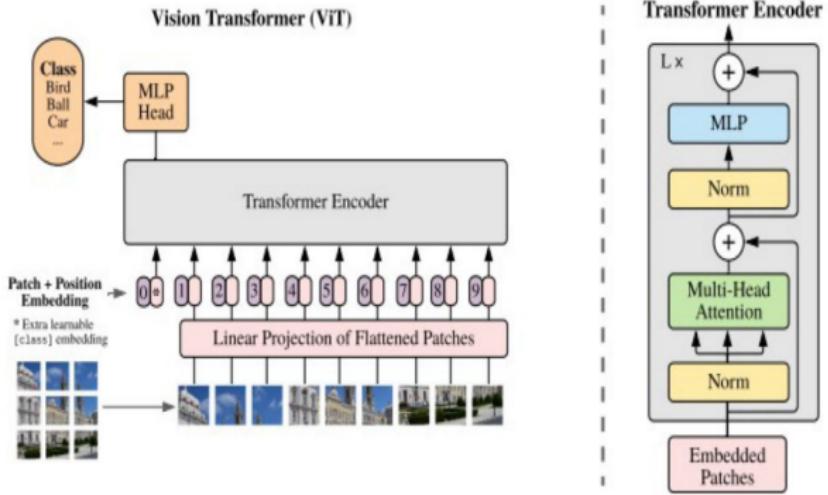
# Vision Transformer (ViT)

A. Dosovitskiy, L. Beyer, A. Kolesnikov, D. Weissenborn, X. Zhai, T. Unterthiner, M. Dehghani, M. Minderer, G. Heigold, S. Gelly, et al., "An image is worth 16x16 words: Transformers for image recognition at scale," arXiv preprint arXiv:2010.11929, 2020. ([ICLR 2021; 26,938 citations!](#))

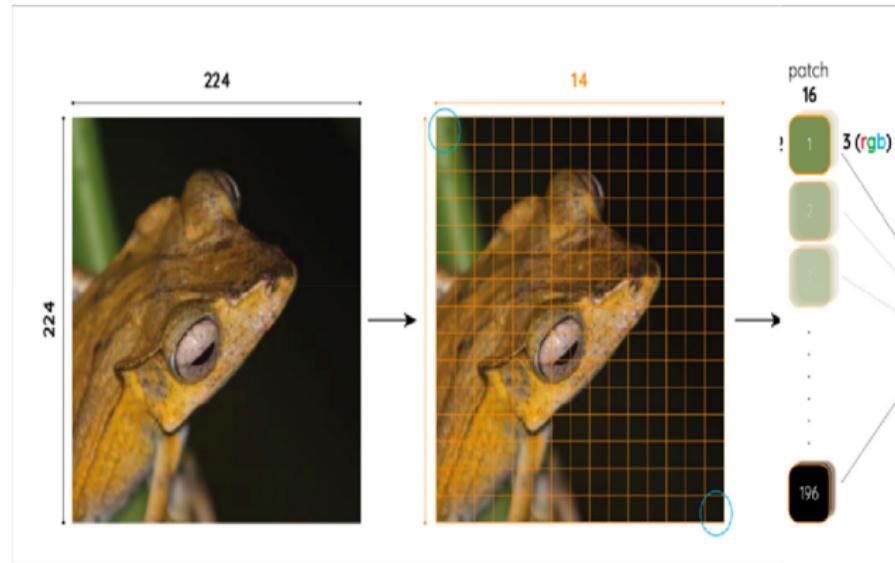
# Vision Transformer (ViT)

- Naive application of self-attention to images requires high computation
- Divide an image into 16x16 patches (tokens)
- Transformers need to be trained on large datasets
- ViT attains excellent results when pre-trained on JFT-300M
  - 88:55% on ImageNet,
  - 90:72% on ImageNet-Real,
  - 94:55% on CIFAR-100,
  - 77:63% on the VTAB suite of 19 tasks

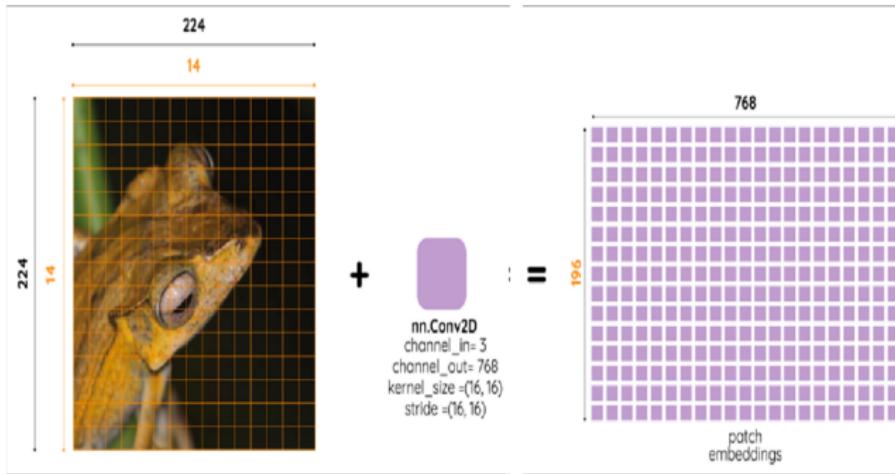
# Vision Transformer (ViT)



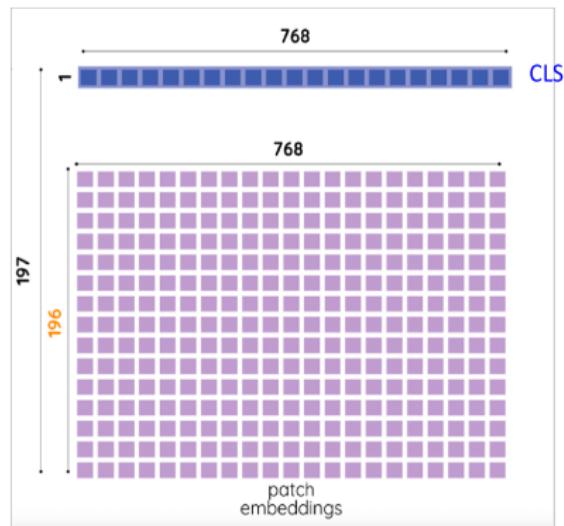
# Divide image into 16x16 patches



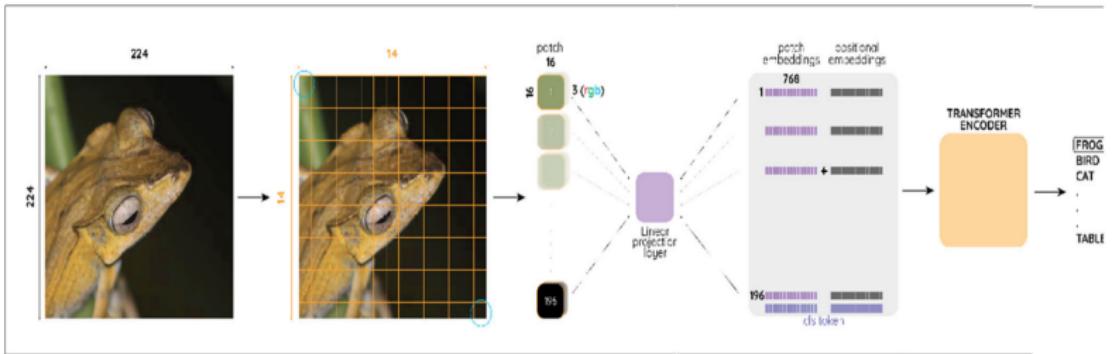
# Generate embedding for each patch



# CLS (Classification) Token



# Complete ViT



# VIT Model Variants

Model	Layers	Hidden size $D$	MLP size	Heads	Params
ViT-Base	12	768	3072	12	86M
ViT-Large	24	1024	4096	16	307M
ViT-Huge	32	1280	5120	16	632M

Table 1: Details of Vision Transformer model variants.

# Results

	Ours-JFT (ViT-H/14)	Ours-JFT (ViT-L/16)	Ours-I21k (ViT-L/16)	BiT-L (ResNet152x4)	Noisy Student (EfficientNet-L2)
ImageNet	<b>88.55</b> ± 0.04	87.76 ± 0.03	85.30 ± 0.02	87.54 ± 0.02	88.4/88.5*
ImageNet ReaL	<b>90.72</b> ± 0.05	90.54 ± 0.03	88.62 ± 0.05	90.54	90.55
CIFAR-10	<b>99.50</b> ± 0.06	99.42 ± 0.03	99.15 ± 0.03	99.37 ± 0.06	—
CIFAR-100	<b>94.55</b> ± 0.04	93.90 ± 0.05	93.25 ± 0.05	93.51 ± 0.08	—
Oxford-IIIT Pets	<b>97.56</b> ± 0.03	97.32 ± 0.11	94.67 ± 0.15	96.62 ± 0.23	—
Oxford Flowers-102	99.68 ± 0.02	<b>99.74</b> ± 0.00	99.61 ± 0.02	99.63 ± 0.03	—
VTAB (19 tasks)	<b>77.63</b> ± 0.23	76.28 ± 0.46	72.72 ± 0.21	76.29 ± 1.70	—
TPUv3-core-days	2.5k	0.68k	0.23k	9.9k	12.3k

# Attention

Input      Attention



# Vision Transformer (ViT)

