Deep Learning

Midterm Assignment: Image Captioning Solution

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Outline

What is this?

An image captioning system, using ResNet50 and VGG19, both of with them attention. This submission uses Flikcr8K[1] for it's dataset.

Note

The snippets of code are coming from the original notebook. It's advised to look at it for a better understanding.

[1] https://github.com/jbrownlee/Datasets/releases/tag/Flickr8k

What is image captioning?

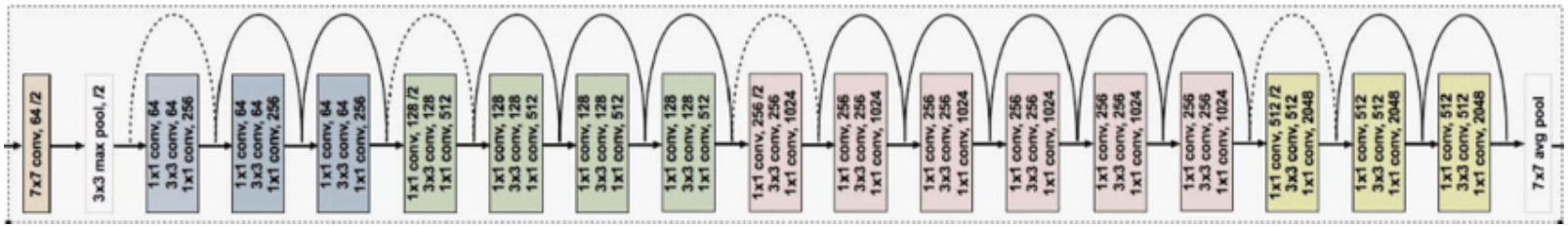
- A process of generating natural language descriptions for images.
- It has been successful in making accurate and meaningful captions.
- Applications can include:
  - Image search engines
  - Healthcare (Things like X-rays, MRI and CT scans)
  - Enable machines to understand and describe visual content.

Context

- Image captioning has been a thing in the 1960s and 1970s
- Basic objects and shapes were done.
- 2000s: Natural language descriptions considered.
- 2014: Show and Tell
  - Used CNN and LSTM.
- Also included deep learning models and large-scale image caption datasets
  - ImageNet, for instance.

ResNet50V2: What is it?

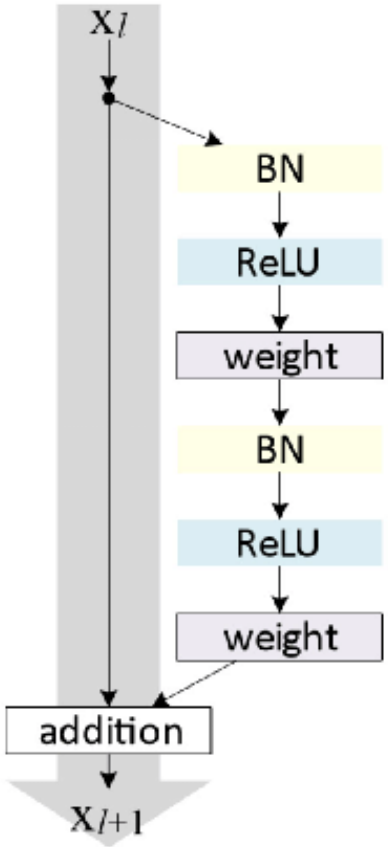
- The second version of ResNet50 thinks to improvements over the original Resnet50.
- Fewer parameters, optimizations for modern hardware, etc.



(This is ResNet50)

High-level view of how ResNet50V2 works

- Multiple residual blocks, each having several convolutional layers.
- The output is passed to a skip connection to learn the original input.
- Lastly, it outputs a probability distribution model over a predefined set.



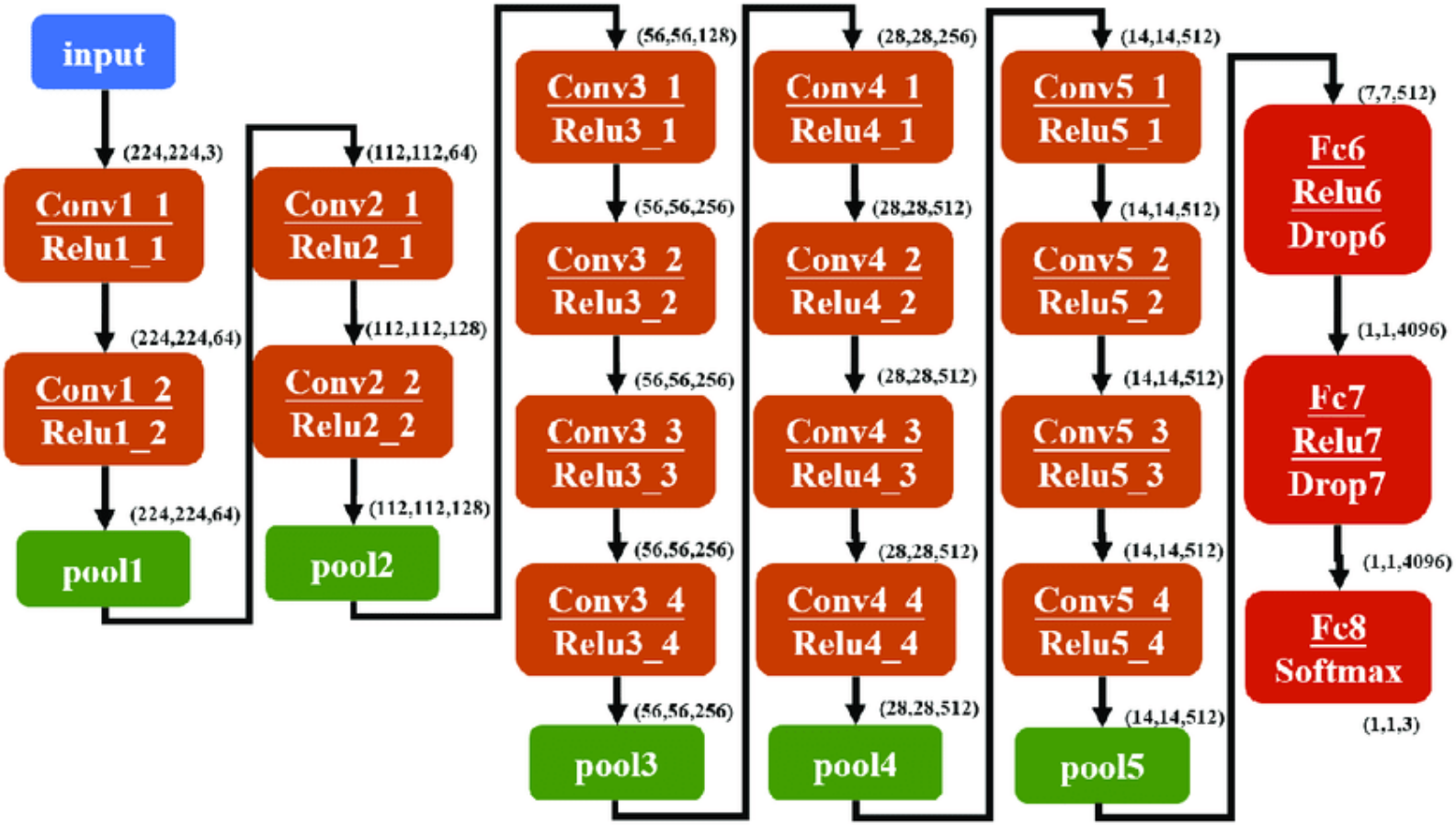
VGG19: What is it?

- Named after it's creators: The **V**isual **G**eometry **G**roup at the University of Oxford.
- A **c**onvulutional **n**eutral **n**etwork.
- An extension of VGG16, adding 3 fully connected layers along with the original 16 convolutionals.

VGG19: How it works

- Convolutional layers for feature extraction from an input.
- Passed through fully connected layers to classify the input.
- Using a variety of techniques for improvements.
  - Dropout
  - Batch normalization
  - Data augmentation

VGG19: Typical example



[1]

[1] https://www.researchgate.net/figure/Detailed-architecture-diagram-of-the-VGG19-network-Detailed-architecture-diagram-of-the_fig3_357830513/actions#reference

How do we evaluate it?

- It's crucial to determine the accuracy of any model.
- Involves comparing model-generated captions with a set of references.
- Here, many candiates are good for this.
  - ROUGE
  - METEOR
  - CIDEr
- Here, we'll be using BLEU score.

BLEU score: How it works

- Calculated computing the n-gram precision of the captions.

$$\text{BLEU} = \text{BP} \cdot \exp\left(\frac{1}{n}\sum_{i=1}^{n}\log p_i\right)$$

- Followed by a brevity penalty.

$$\text{BP} = \begin{cases} 1 & \text{if } c > r \\ e^{1-\frac{r}{c}} & \text{if } c \leq r \end{cases}$$

BLEU score's Pros and Cons

- It's widely accepted
- Easy to compute
- Quantitative measure
- *Has problems with sementics and is length-sensitive*

Set up

- Our dataset will be the Flickr8K[1], with it's images and captions
- We'll be using VGG19 and ResNet50V2, both with Attention.

[1] https://github.com/jbrownlee/Datasets/releases/tag/Flickr8k

The training

- Training will be at 10 epochs
- Both of them trained similarly, each being 10 minutes
- But there is a catch for time, since there is also:
  - Feature extraction (15 minutes)
  - Validation (7 minutes)

The results

- Overall, both models perform well enough, but it could be better.
- The current implementation of how to do BLEU score warrants further testing and evaluation
  - Since it uses the averages of all trials
  - Meaning that the results is about $\approx 0.4 - 0.5$ on both, on 10 captions.
  - Ignoring that, each would be about around $\approx 0.5 - 0.8$

Anything to talk about?