NORCE

Attention Boosted Deep Networks for Video Classification

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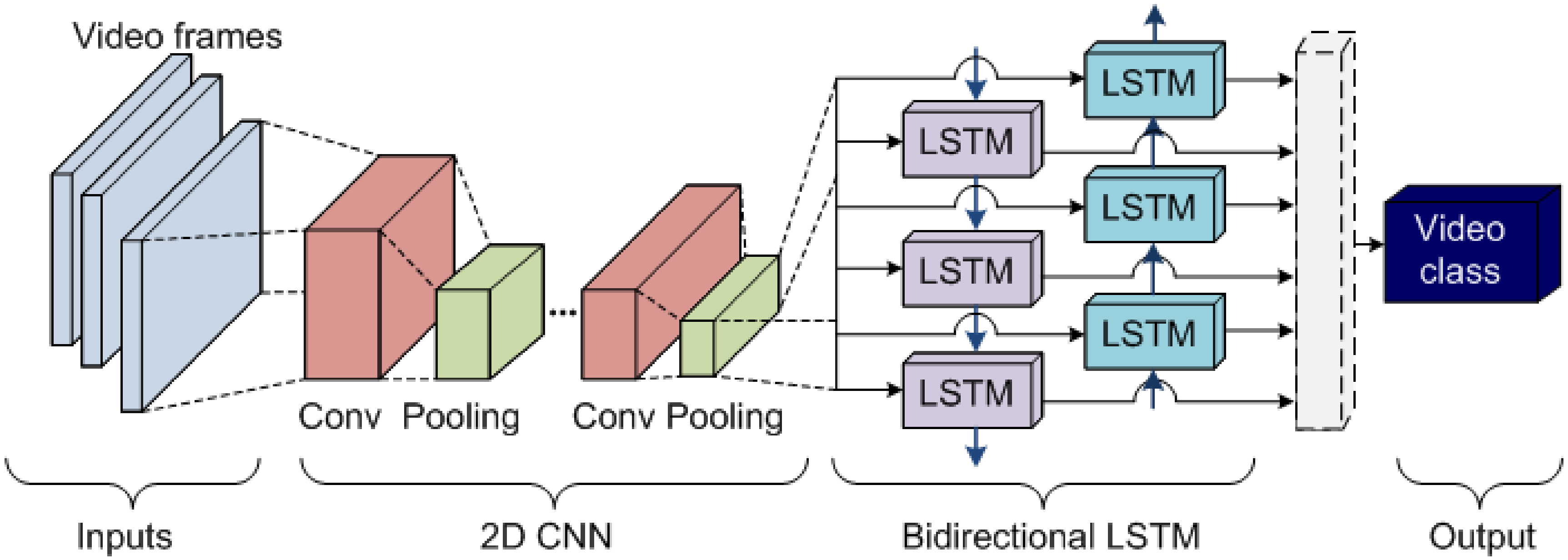
Attention mechanism

- HVS cannot process all visual information
- “Attend to” a certain part of visual stimuli while ignoring other perceptible information
- Attention in deep learning:
  - NLP (e.g., Transformer), visual signal process, etc.
  - Two commonly used attention functions:
    - Additive attention (D. Bahdanau et al.)
    - Dot-product

CNN and bi-LSTM for video classification (I)

- 2D-CNN serves as frame feature extractor
  - VGG / Inception / Resnet / Xception
  - ImageNet pretrained
- Video classes determined by frame contents and their relationships – modelled by LSTM
  - Viewers can retrospect the content in a reverse time order to obtain the full context when classifying video content – bidirectional LSTM
- **Main architecture: 2D-CNN + bi-LSTM**

CNN and bi-LSTM for video classification (II)

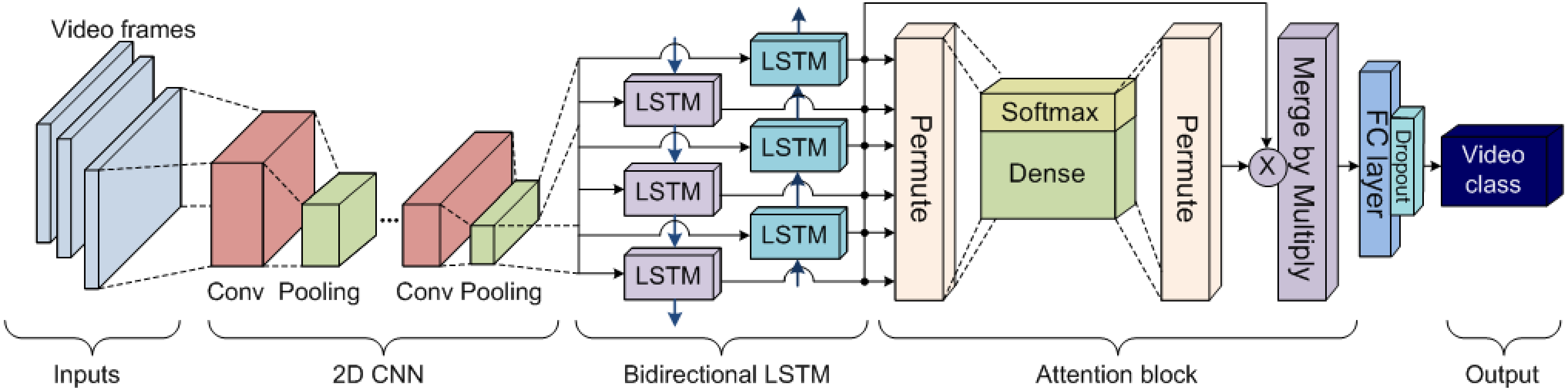


Simple attention block

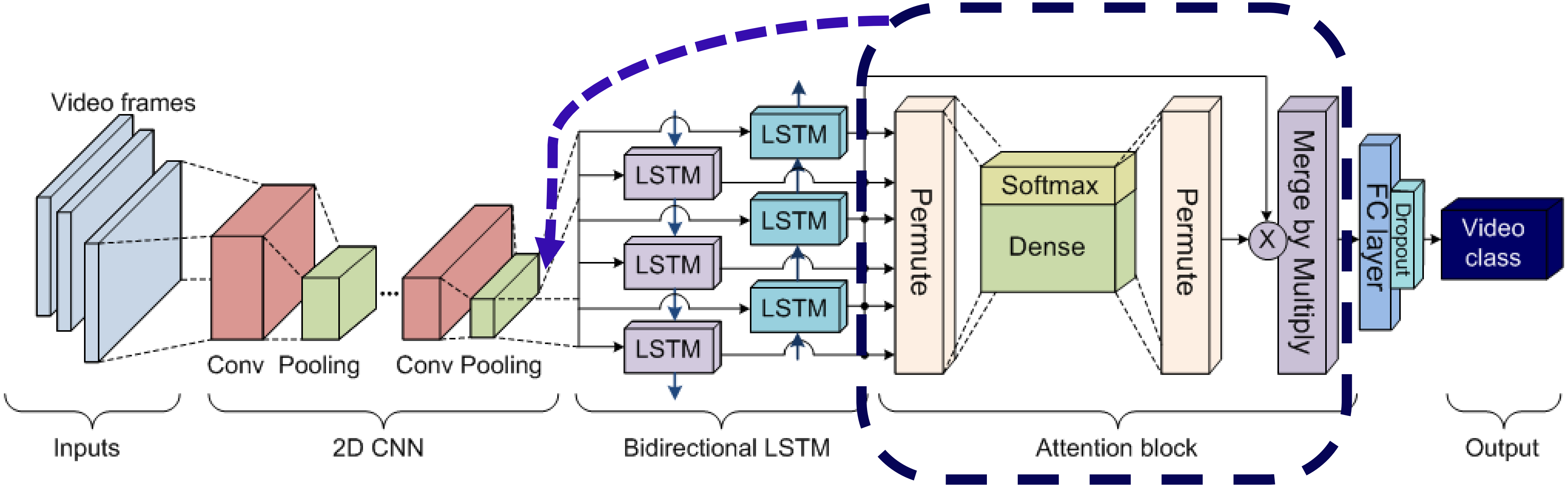
- Attention mechanism
  - Pay different attentions to different parts of input

- Can be modelled by a dense (fully-connected) layer using "softmax" as activation
  - Dense layer with same length as the input (output of bi-LSTM) length
  - Softmax limits the weights within (0, 1) with sum = 1

Attention integrated networks for video classification



Attention integrated networks for video classification

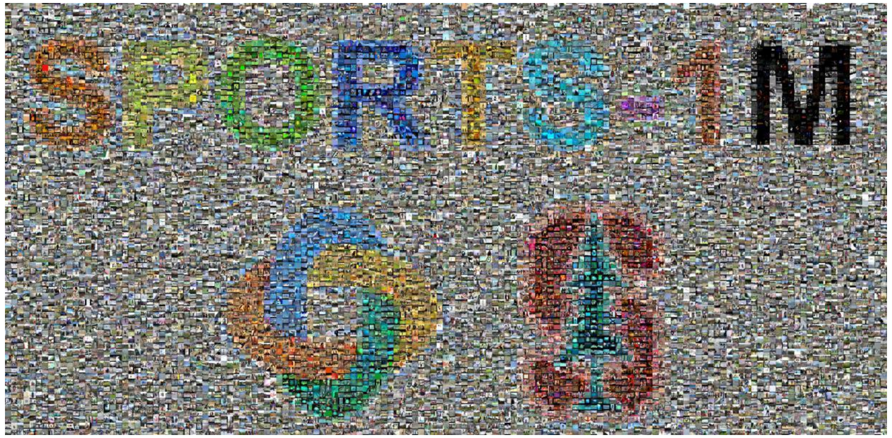


- Attention block can also apply prior to bi-LSTM layer

Network hyper-parameters

- A single bi-LSTM layer
- Unit number 256 chosen from selections [64, 128, 256, 512] in the experiments
- One frame / second employed due to frame redundancy
- Unit number in the dense layer in attention block is the average of all video frame numbers (temporal dimension of input)
- Unit number 512 for the last FC layer
- Dropout rate = 0.5

Experiment: Datasets



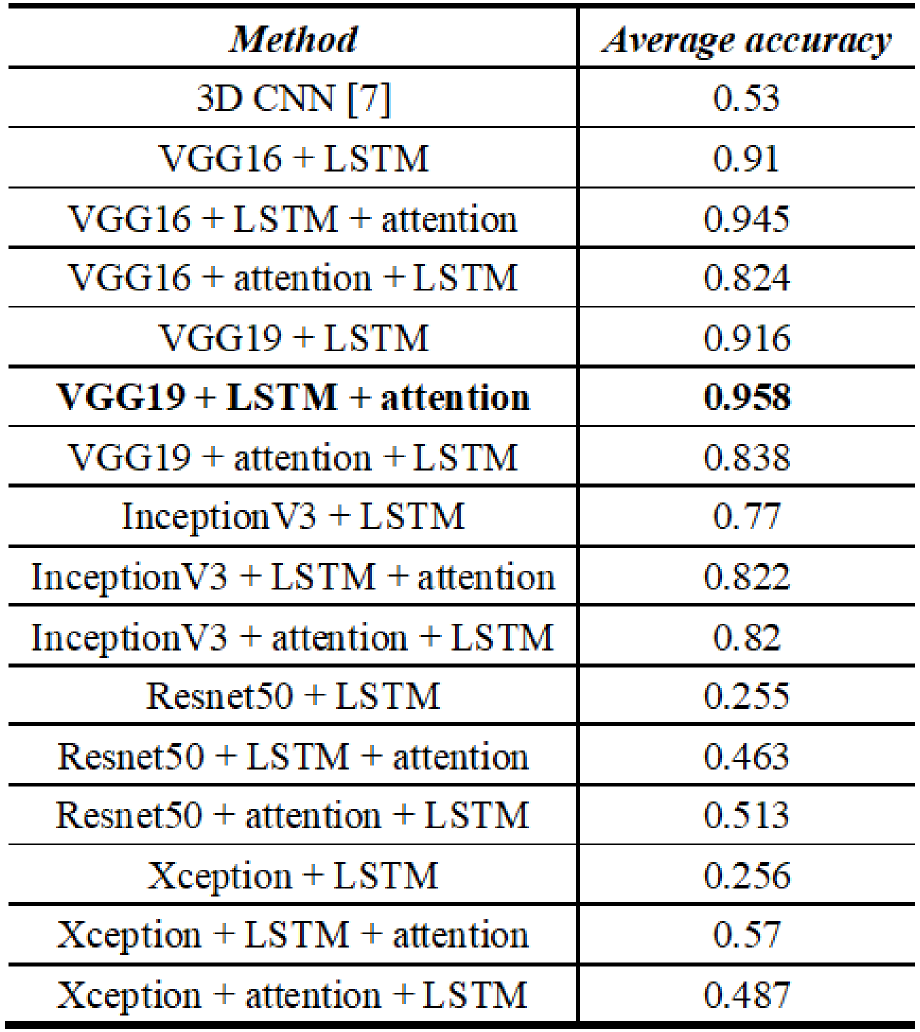
- UCF-101 action recognition dataset
  - 13,320 videos with 101 categories
- Subset of Sports-1M dataset (Sports-1M-99)
  - Video shorter than 20s in the first 99 categories from original 202 categories
  - Each category contains more than 100 videos
  - In total 18,319 videos

Experiments: Other models

- 3D-CNN model (S. Ji, W. Xu, M. Yang, and K. Yu, “3d Convolutional Neural Networks for human action recognition,” *IEEE Trans. on Pattern Analysis and Machine Intelligence*, vol. 35, no. 1, pp. 221–231, 2013)
- Variant CNNs: VGG16, VGG19, InceptionV3, Resnet50, Xception
  - CNN + attention + LSTM: attention prior to bi-LSTM
  - CNN + LSTM + attention: attention after bi-LSTM

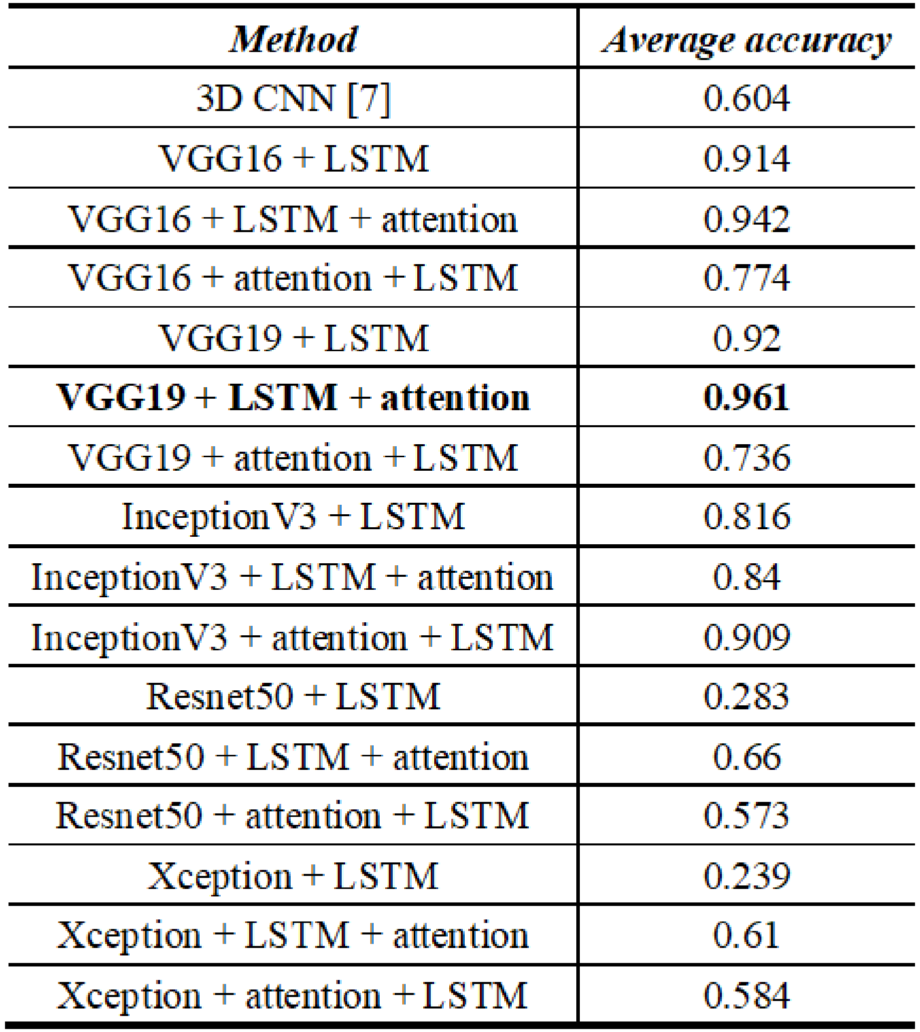
Experiments: Evaluation results

UCF-101



Method	*Average accuracy*
3D CNN [7]	0.53
VGG16 + LSTM	0.91
VGG16 + LSTM + attention	0.945
VGG16 + attention + LSTM	0.824
VGG19 + LSTM	0.916
VGG19 + LSTM + attention	**0.958**
VGG19 + attention + LSTM	0.838
InceptionV3 + LSTM	0.77
InceptionV3 + LSTM + attention	0.822
InceptionV3 + attention + LSTM	0.82
Resnet50 + LSTM	0.255
Resnet50 + LSTM + attention	0.463
Resnet50 + attention + LSTM	0.513
Xception + LSTM	0.256
Xception + LSTM + attention	0.57
Xception + attention + LSTM	0.487

Sports-1M-99



Method	*Average accuracy*
3D CNN [7]	0.604
VGG16 + LSTM	0.914
VGG16 + LSTM + attention	0.942
VGG16 + attention + LSTM	0.774
VGG19 + LSTM	0.92
VGG19 + LSTM + attention	**0.961**
VGG19 + attention + LSTM	0.736
InceptionV3 + LSTM	0.816
InceptionV3 + LSTM + attention	0.84
InceptionV3 + attention + LSTM	0.909
Resnet50 + LSTM	0.283
Resnet50 + LSTM + attention	0.66
Resnet50 + attention + LSTM	0.573
Xception + LSTM	0.239
Xception + LSTM + attention	0.61
Xception + attention + LSTM	0.584

Analysis and Conclusion

- Integrating attention can generally boost CNN + LSTM for video classification
  - Attention after LSTM better before
  - Probably due to dimension difference of input for attention block
- VGG16/19 > InceptionV3 > Resnet50 > Xception
- Attention before LSTM reduce accuracy on VGG16/19
  - Suspect due to late selection theory of attention mechanism
- CNN + LSTM better than 3D-CNN
  - No pretrain of 3D CNN
  - LSTM might better than 3D CNN on capturing long-term connections of frames

Source code published

N O R C E

SHENZHEN UNIVERSITY 深圳大學 1983

https://github.com/junyongyou/Attention-boosted-deep-networks-for-video-classificaton

Welcome to download and use.

Thank you for your attention!