Combining Multiple Sources of Knowledge in Deep CNNs for Action Recognition

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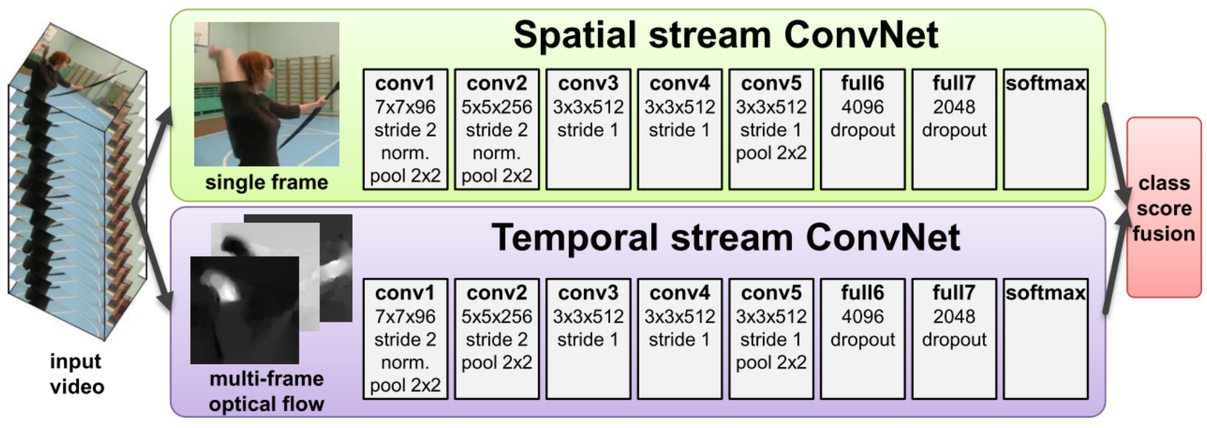
Motivation

Difficulties of learning spatio-temporal features with deep CNNs

- Existing datasets are not large enough and non-representative
- Training 3D deep CNN requires too many parameters causing high computational cost

Incorporating hand-crafted temporal features with spatial CNN features

- Two-stream CNN is promising solution, but each network was highly over-tuned to the particular input type (RGB and optical flow)



Two-stream convolutional neural network[1]

Proposed Techniques

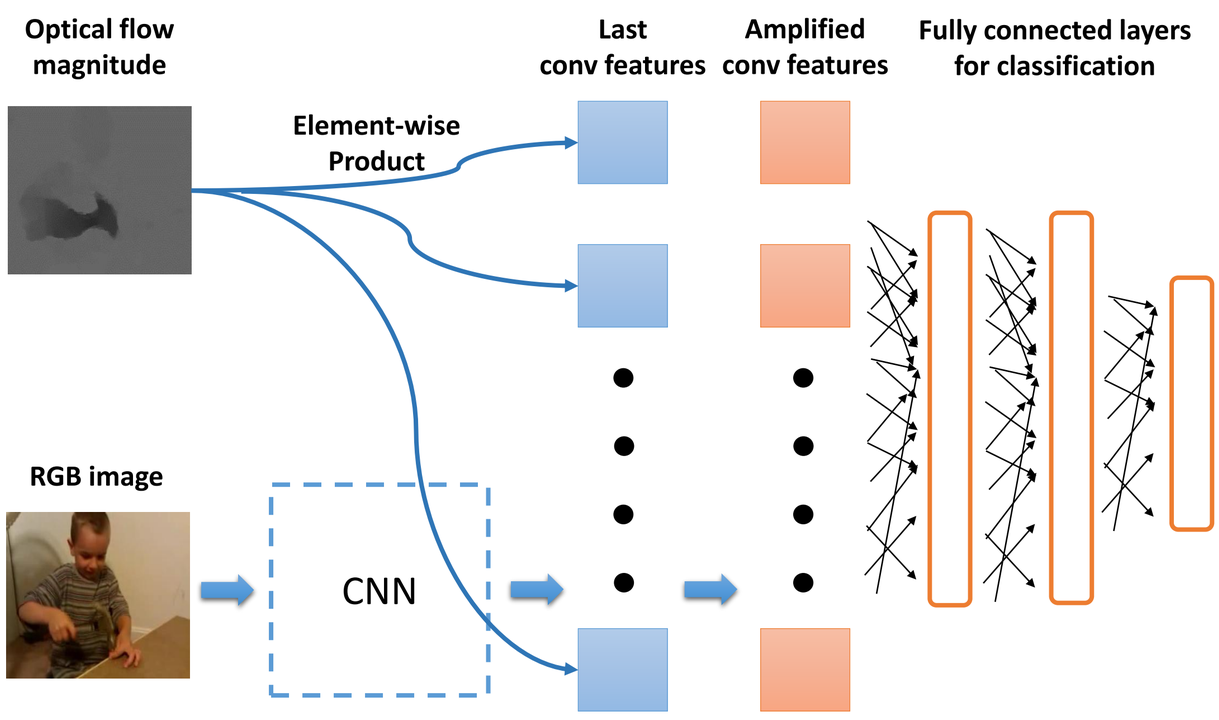
Feature amplification

- Amplifying spatial CNN features based on hand-crafted temporal features

Multiplicative fusion of two-stream networks

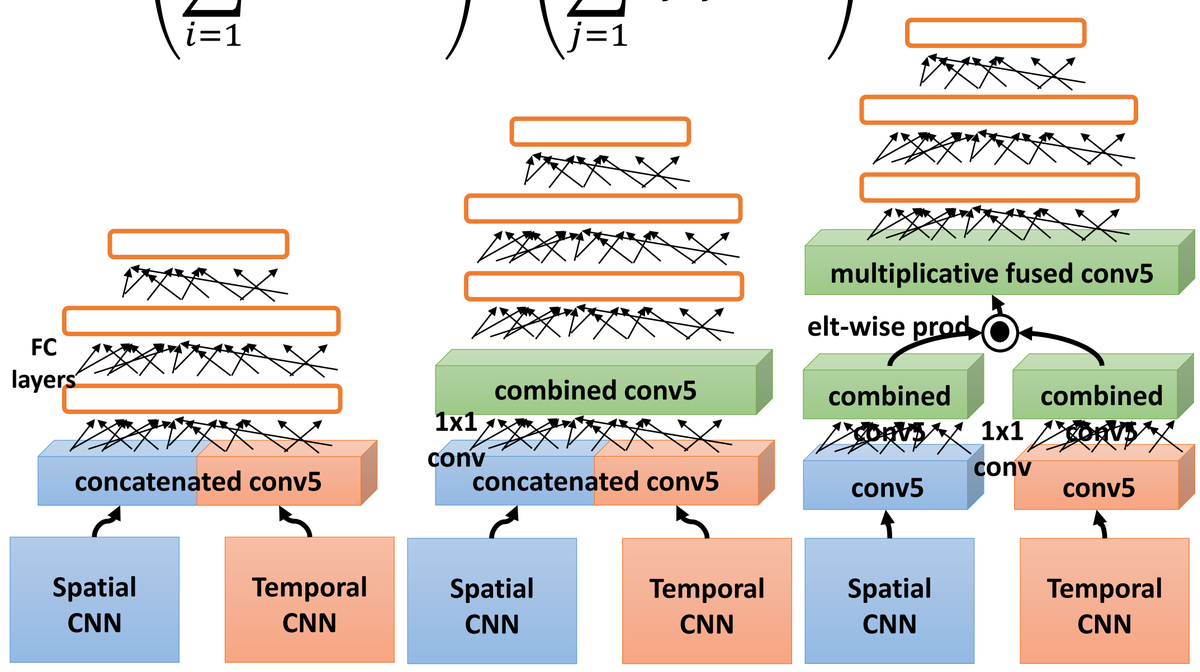
- Amplifying or suppressing the feature activations of each network based on their agreement
- Knowledge exchange between two networks

Feature Amplification



Multiplicative Fusion

$$c_k = \left(\sum_{i=1}^{M} \alpha_i a_i + \gamma_k\right) \odot \left(\sum_{j=1}^{N} \beta_j b_j + \delta_k\right)$$



Additive baseline fusion vs multiplicative fusion

Experiments on Video Classification

	UCF101		HMDB51	
	Base	Amp	Base	amp
T	80.3		47.3	
S	78.8	**81.0**	40.3	**44.9**
S + T	87.8	**88.5**	50.1	**54.5**

Feature amplification result

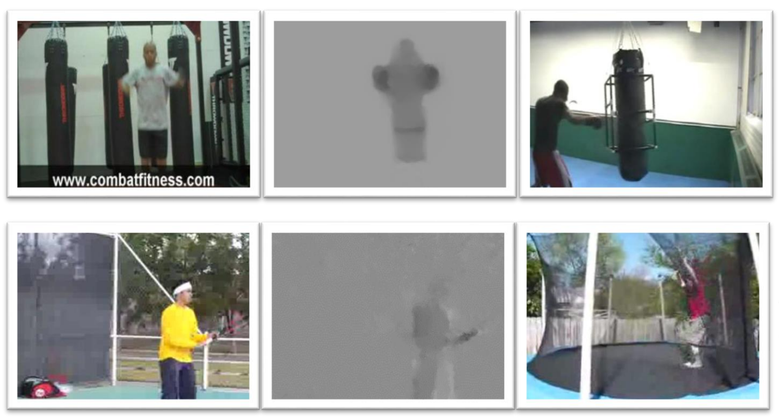
	UCF101	HMDB51
Base A	82.2	36.9
Base B	81.0	38.7
M-fuse(conv5)	**84.4**	**52.7**
M-fuse(fc7)	**87.6**	**53.3**

Multiplicative fusion result

	UCF101	HMDB51
S + T	87.8	50.1
S + T + m-fuse	88.3	54.4
S(amp) + T + m-fusion(conv5)	**88.9**	**56.2**
S(amp) + T + m-fusion(fc7)	**89.1**	**54.9**

Feature amplification and multiplicative fusion results

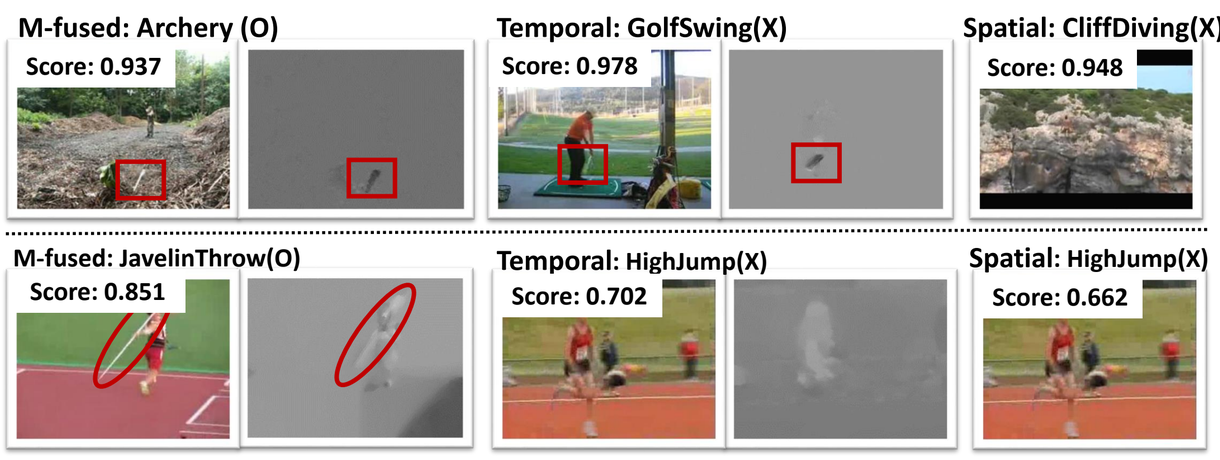
Examples of Classification



Amplified net: Jumping (O)
Spatial net: Boxing (X)

Amplified net: Tennis (O)
Spatial net: Trampoline jumping (X)

Effects of feature amplification



Effects of multiplicative fusion

Reference

K. Simonyan and A. Zisserman, Two-stream convolutional networks for action recognition in Videos, NIPS, 2014