Task-Driven Dynamic Fusion: Reducing Ambiguity in Video Description

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Problem

Description ambiguity:

- **Recognition error**

- **Ground truth:** guys on mat wrestling
- **LSTM:** a group of people are dancing on a track

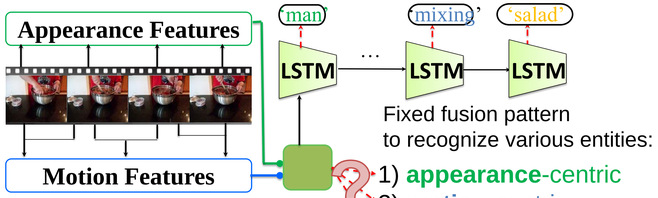
- **Detail deficiency**

- **Ground truth**: a person is mixing a bowl of food
- **LSTM:** a person is cooking

Motivation

Previous work:

- **Weakness inherent in static fusion methods**



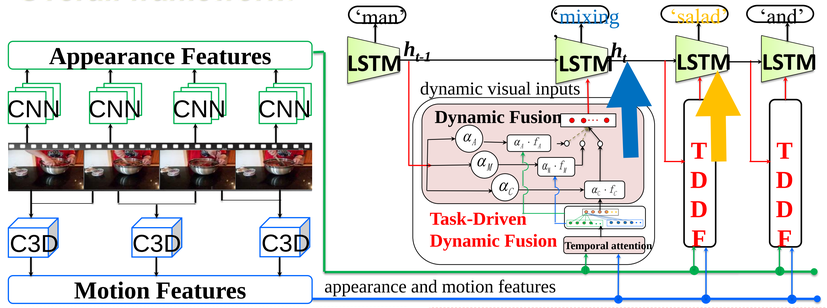
Our idea:

- **Task-driven dynamic fusion**

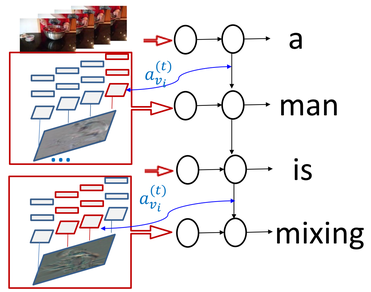
Adaptively choose different fusion patterns according to task status.
Attend to certain visual cues to promote the recognition of
1) **appearance**-centric, 2) **motion**-centric and 3) **correlation**-centric entities.

Approach

Overall framework:



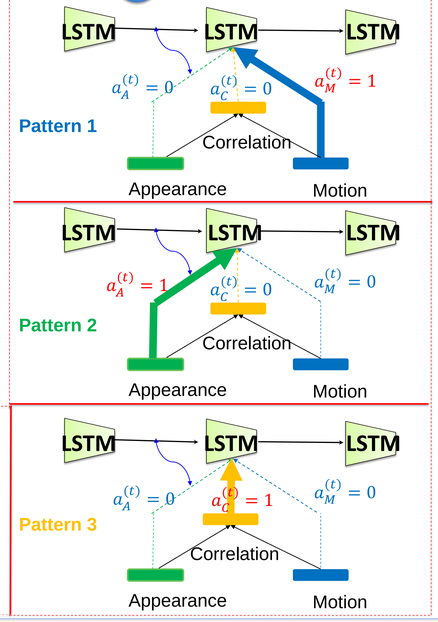
1 Temporal attention



Temporal attention weights:

$$a_{v_i}^{(t)} = f(h_{t-1}, v_i) = W_a \tanh(W_h h_{t-1} + W_v v_i)$$

2 Dynamic fusion



Three different fusion patterns are designed to support the recognition of appearance-centric, motion-centric and correlation-centric entities.

Feature channel fusion weights:

$$a_{p_i}^{(t)} = f_{p_i}(h_{t-1}) = s_{pi}^{(t)} c_{pi}$$

Results

MSVD dataset

	METEOR	(%↑)	CIDEr	(%↑)	BLEU4	(%↑)
VGG	0.302	-	0.563	-	0.416	-
C3D	0.303	-	0.542	-	0.412	-
CON(VGG+C3D)	0.317	(4.6%↑)	0.652	(15.8%↑)	0.428	(2.9%↑)
MAX-2(VGG+C3D)	0.308	(1.7%↑)	0.558	(-0.9%↑)	0.417	(0.2%↑)
SUM-2(VGG+C3D)	0.307	(1.3%↑)	0.654	(16.1%↑)	0.438	(5.3%↑)
MAX-3(VGG+C3D)	0.313	(3.3%↑)	0.663	(17.7%↑)	0.452	(8.6%↑)
SUM-3(VGG+C3D)	0.314	(3.6%↑)	0.602	(6.9%↑)	0.440	(5.8%↑)
TA [34]	0.296	-	0.517	-	0.419	-
LSTM-E [18]	0.310	(3.7%↑)	-	-	0.453	(8.6%↑)
h-RNN [36]	0.326	(4.8%↑)	0.658	(6.0%↑)	**0.499**	(2.2%↑)
HRNE [17]	0.331	-	-	-	0.438	-
TDDF(VGG+C3D)	**0.333**	**(10.0%↑)**	**0.730**	**(29.7%↑)**	0.458	**(10.1%↑)**

MSR-VTT-10K dataset

	BLEU4	(%↑)	METEOR	(%↑)	CIDEr	(%↑)
VGG	0.338	-	0.263	-	0.384	-
C3D	0.363	-	0.263	-	0.397	-
GoogLeNet	0.328	-	0.268	-	0.398	-
v2t_nagvigator [4]	0.408	-	0.282	-	0.448	-
SA-LSTM(VGG+C3D) [10]*	0.405	(0.9%↑)	0.299	(1.7%↑)	-	-
TDDF(GoogLeNet+C3D)	0.372	(2.5%↑)	0.277	(3.3%↑)	0.441	**(10.8%↑)**
TDDF(VGG+C3D)	0.373	**(2.7%↑)**	0.278	**(5.7%↑)**	0.438	(10.3%↑)

Qualitative results

Ground truth: A woman is giving a cooking instructional video
CON: A woman is cooking a dish in a pan
TDDF: A woman adds ingredients to a pot of water

Ground truth: Two football players are running
CON: A person is explaining something
TDDF: Football players playing football

Ground truth: A man is playing with his engine
CON: A man is working on a car
TDDF: A man is fixing a car engine