Introduction to Video Classification Using Deep Learning

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Outline

- Introduction
- Datasets
- Approaches
- Transfer Learning

Introduction

Why Video?

- Most general way to perceive the world
- Temporal reasoning

Why Not Video?

- Computation (Depends on the number of frames)
- Data

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IMAGENET

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IMAGENET
- Progress

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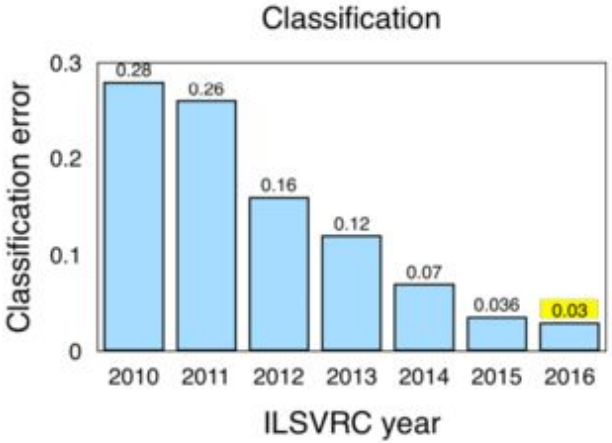

Why Not Video?

- Computation (Depends on the number of frames)
- Data 

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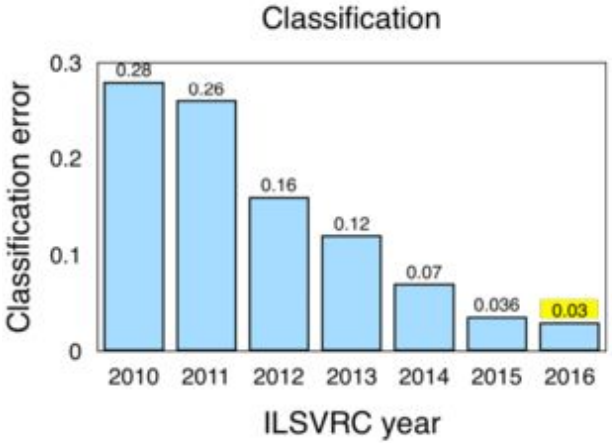
- Progress
- A lot of applications do not require temporal reasoning



Why Not Video?

- Computation (Depends on the number of frames)
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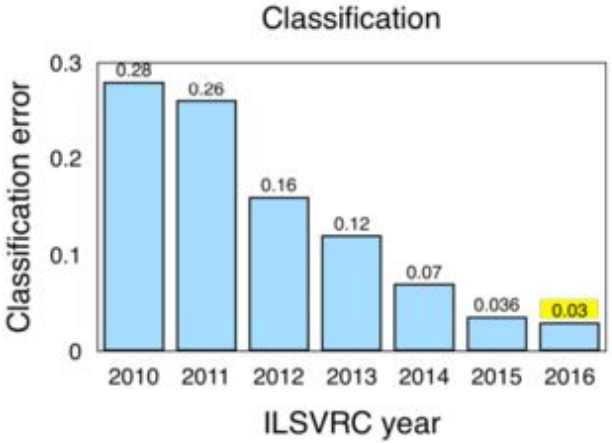
IMAGENET
- Progress

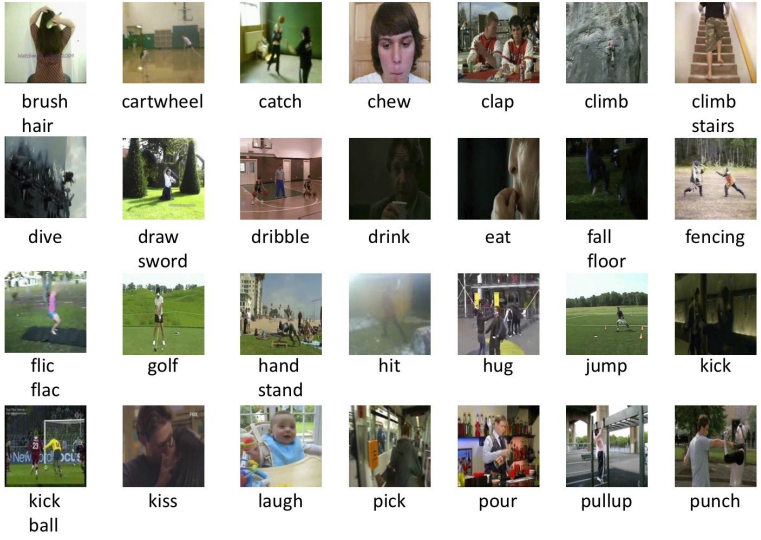


- A lot of applications do not require temporal reasoning
- Some applications that seem to require temporal reasoning can be solved using images

Datasets

HMDB-51

- A dataset of 6,766 videos collected from commercial movies as well as YouTube
- Contains 51 human motion classes
- Released November 2011 by Brown University



UCF-101

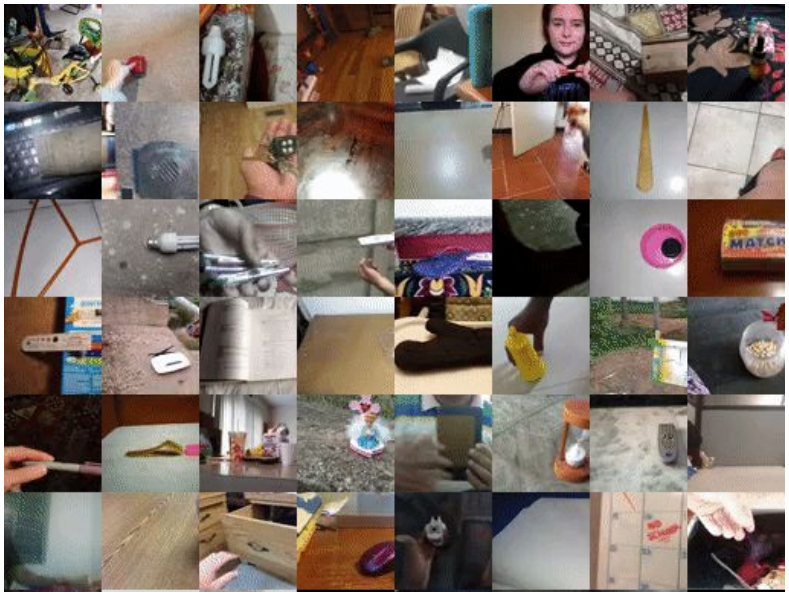
- A dataset of 13,320 videos collected from YouTube
- Contains 101 human actions classes
- Released November 2012 by University of Central Florida

Kinetics

- A dataset of 306,245 videos collected from YouTube
- Contains 400 human action classes
- Released May 2017 by Deepmind

Something-something

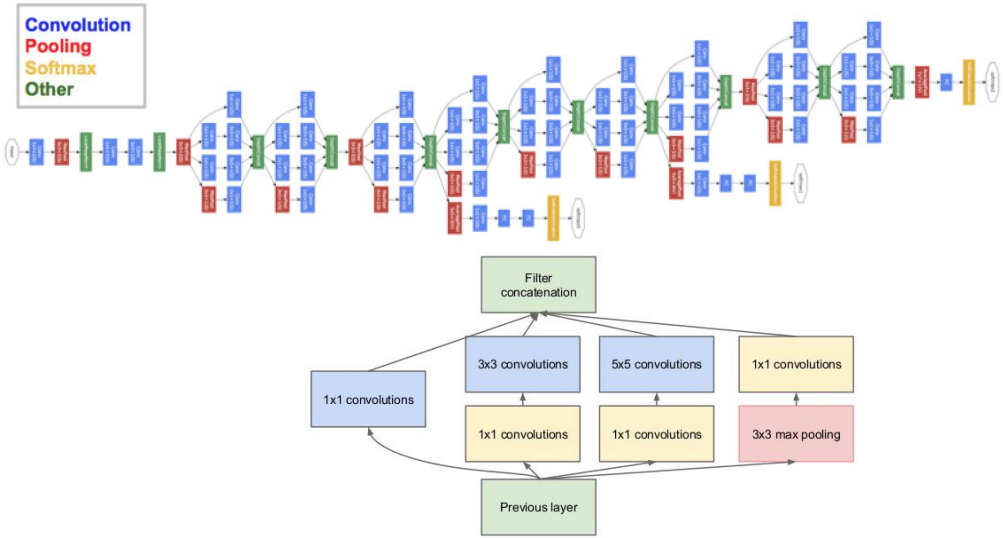
- A dataset of 108,499 videos collected using crowd workers
- Contains 174 common sense classes
- Released June 2017 by TwentyBN

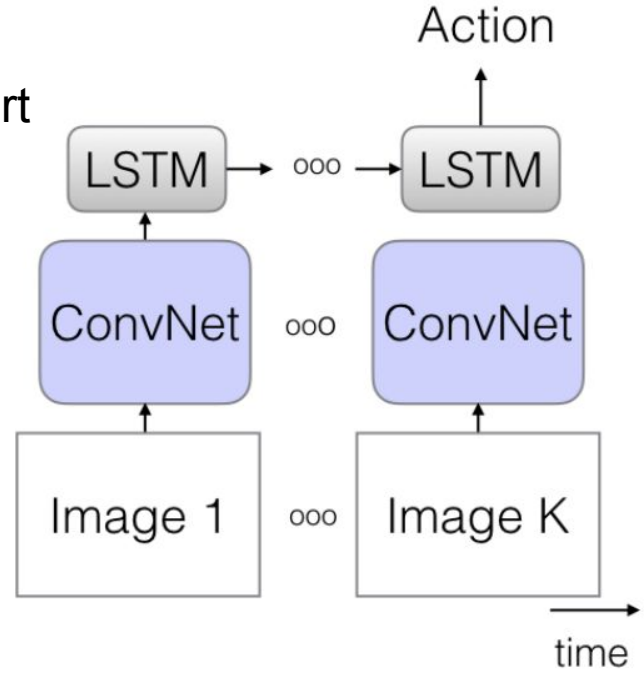


Approaches

LSTM

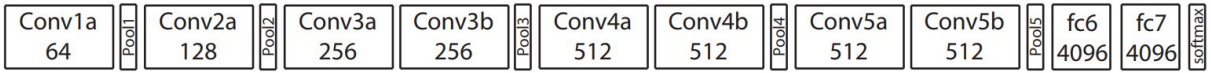
- ConvNet is Inception-V1
- LSTM aggregates video frames
- Only the output of the last frame is considered
- Input is 25 224x224 images sampled 5 frames apart

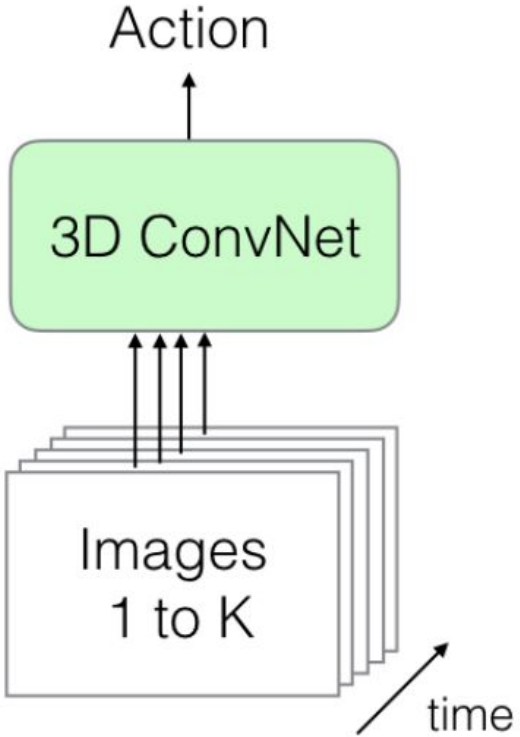




3D-ConvNet

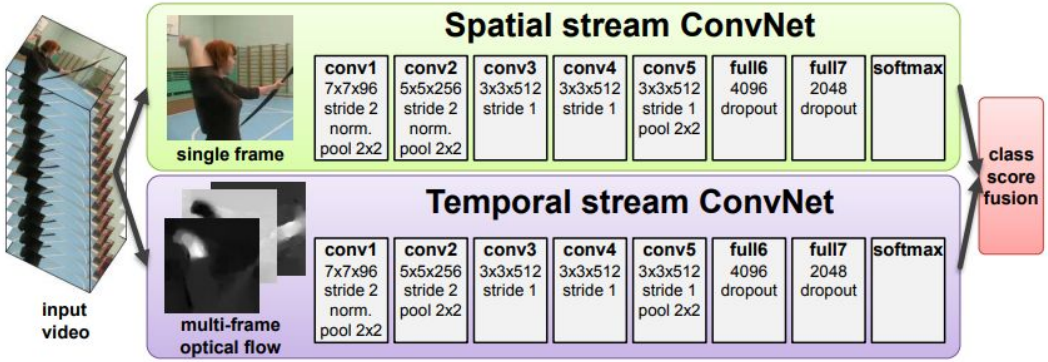
- 3D ConvNet based on work done by Du Tran, et al. 2015
- Input is 16 consecutive 112x112 images

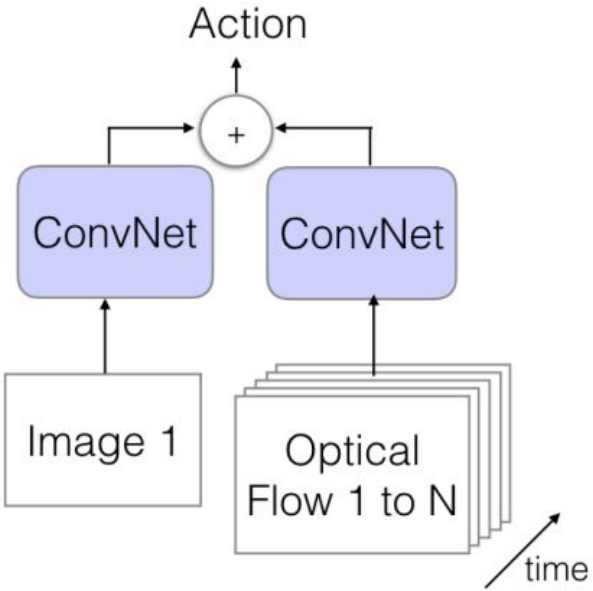




Two-Stream

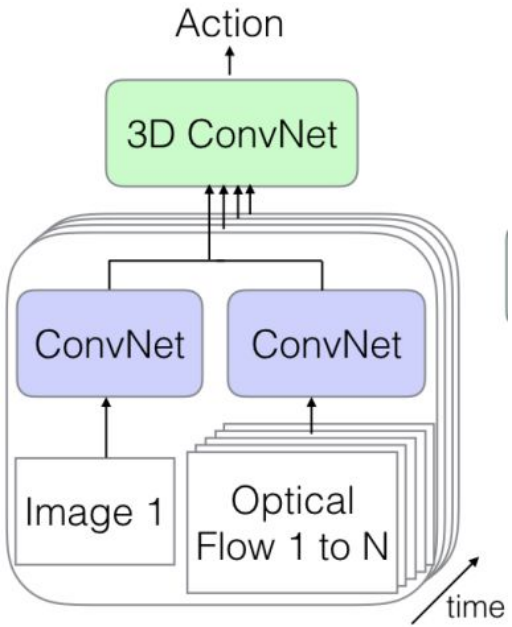
- ConvNet is based on work done by Simonyan and Zisserman, 2014 (ImageNet pretrained)
- Input is a 224x224 image + its 10 consecutive optical flow features





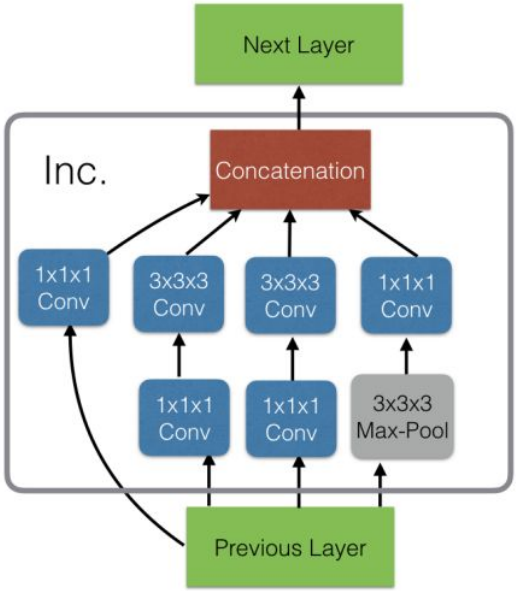
3D-Fused Two-Stream

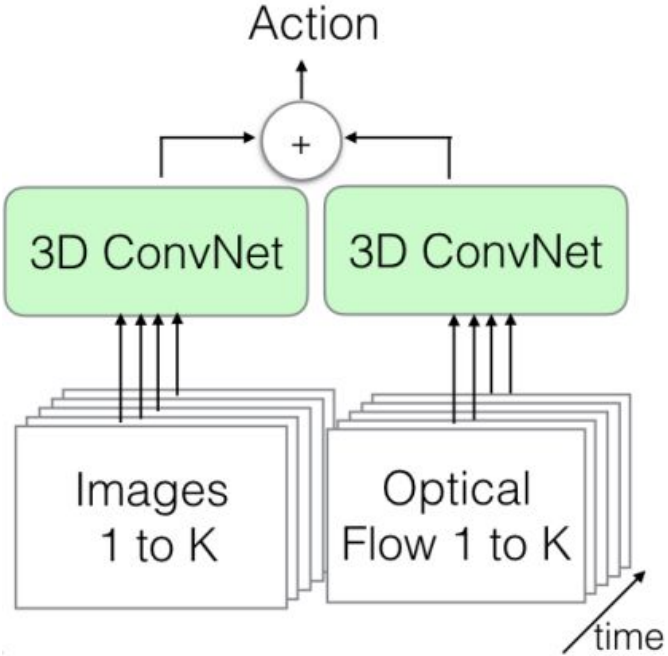
- ConvNet is Inception-V1
- Input is 5 224x224 images sampled 10 frames apart + 10 consecutive optical flow features for each image (so 50 in total)
- 3D ConvNet is 3x3x3 convolution with 512 channels followed by 3x3x3 maxpooling



Two-Stream 3D-ConvNet

- 3D ConvNet is inflated Inception-V1
- Input is 64 consecutive 224x224 images + their optical flow features





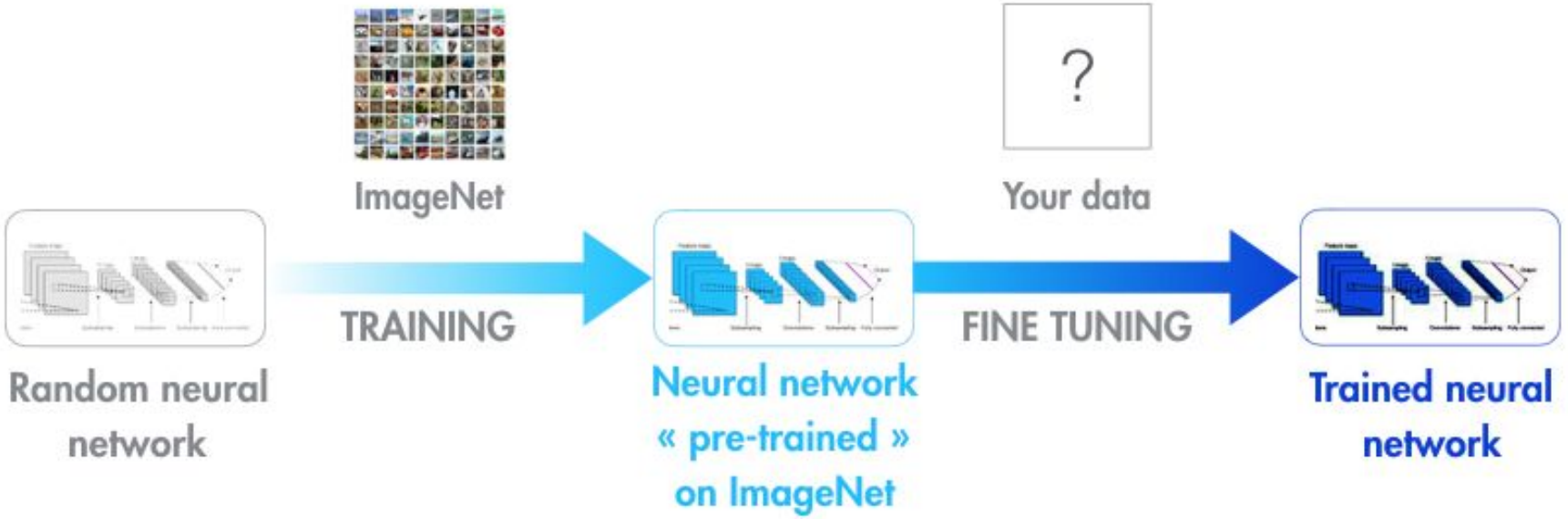
Results

- miniKinetics: Early version of Kinetics containing 213 classes with 120,000 videos

Architecture	UCF-101			HMDB-51			miniKinetics		
	RGB	Flow	RGB + Flow	RGB	Flow	RGB + Flow	RGB	Flow	RGB + Flow
(a) LSTM	81.0	–	–	36.0	–	–	69.9	–	–
(b) 3D-ConvNet	51.6	–	–	24.3	–	–	60.0	–	–
(c) Two-Stream	83.6	85.6	91.2	43.2	56.3	58.3	70.1	58.4	72.9
(d) 3D-Fused	83.2	85.8	89.3	49.2	55.5	56.8	71.4	61.0	74.0
(e) Two-Stream I3D	**84.5**	**90.6**	**93.4**	**49.8**	**61.9**	**66.4**	**74.1**	**69.6**	**78.7**

Transfer Learning

Concept


ImageNet
?
Your data
TRAINING
FINE TUNING
Random neural network
Neural network « pre-trained » on ImageNet
Trained neural network

Transfer Learning From MiniKinetics

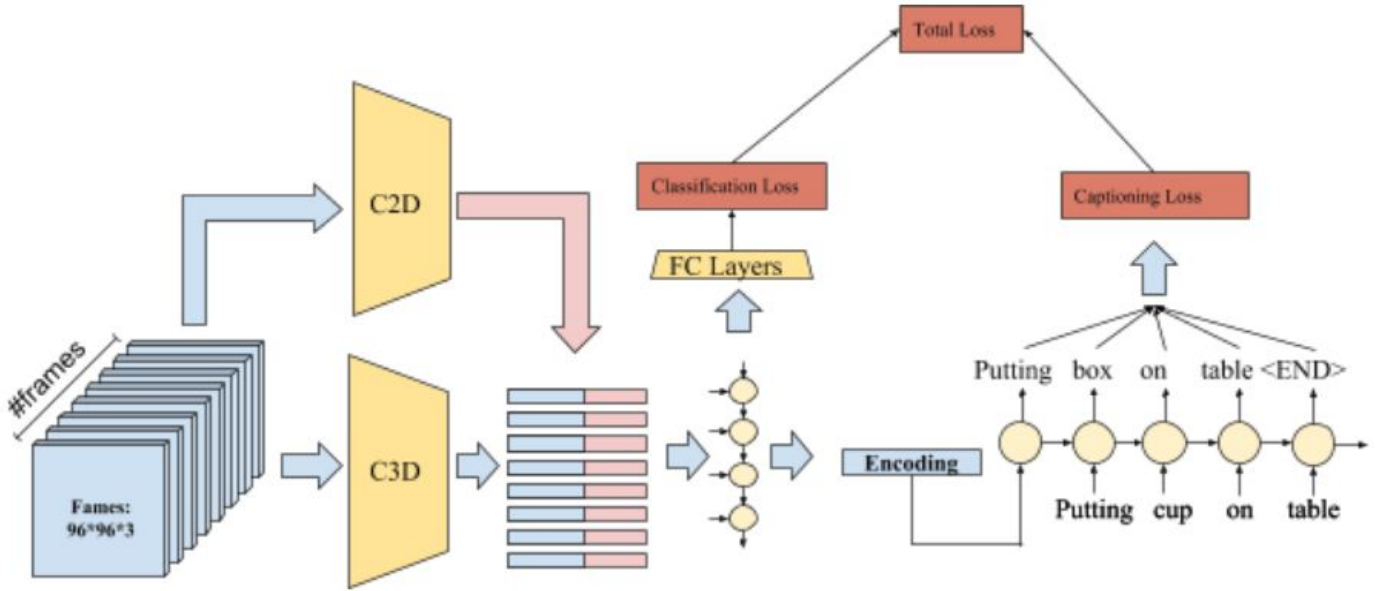
Architecture	UCF-101			HMDB-51		
	Original	Fixed	Full-FT	Original	Fixed	Full-FT
(a) LSTM	81.0 / 54.2	88.1 / 82.6	91.0 / 86.8	36.0 / 18.3	50.8 / 47.1	53.4 / 49.7
(b) 3D-ConvNet	– / 51.6	– / 76.0	– / 79.9	– / 24.3	– / 47.0	– / 49.4
(c) Two-Stream	91.2 / 83.6	93.9 / 93.3	94.2 / 93.8	58.3 / 47.1	66.6 / 65.9	66.6 / 64.3
(d) 3D-Fused	89.3 / 69.5	94.3 / 89.8	94.2 / 91.5	56.8 / 37.3	69.9 / 64.6	71.0 / 66.5
(e) Two-Stream I3D	93.4 / 88.8	97.7 / 97.4	98.0 / 97.6	66.4 / 62.2	79.7 / 78.6	81.2 / 81.3

Effect Of Dataset Size on Transfer Learning

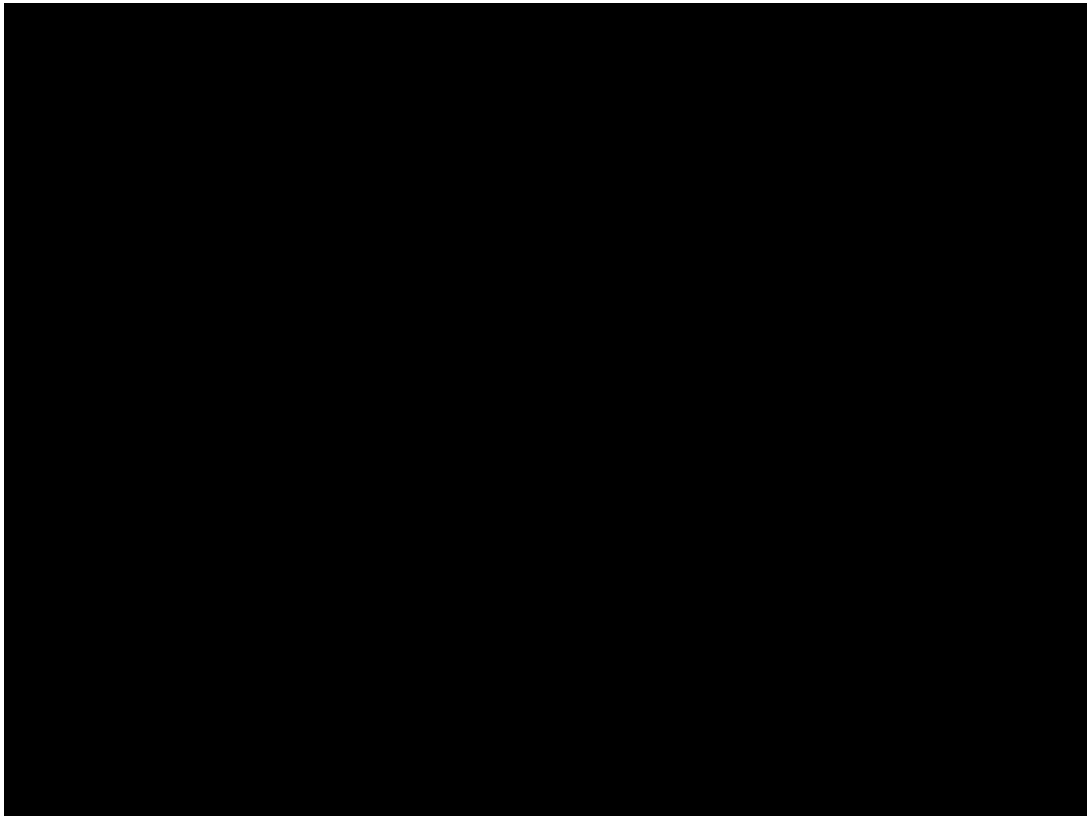
Model	UCF-101	HMDB-51
RGB-I3D, miniKinetics pre-training	91.8	66.4
RGB-I3D, Kinetics pre-training	95.4	74.5
Flow-I3D, miniKinetics pre-training	94.7	72.4
Flow-I3D, Kinetics pre-training	95.4	74.6
Two-Stream I3D, miniKinetics pre-training	96.9	76.3
Two-Stream I3D, Kinetics pre-training	**97.9**	**80.2**

Transfer Learning From One Task to Another

- Encoder Pretrained to perform classification
- Model was then tuned with 0.1 * Classification Loss + 0.9 * Captioning Loss



Demo



Thank You!

References

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