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WASHINGTON
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https://cvpr20-video.mxnet.io/

Tutorial on Video Modeling

Decord: an efficient video reader for deep learning

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Motivation

- Videos have redundant frames, need video reader

Videos ---> Raw frames ----> Network training

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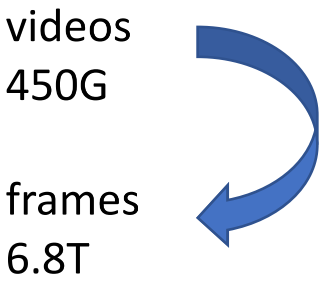


videos
450G

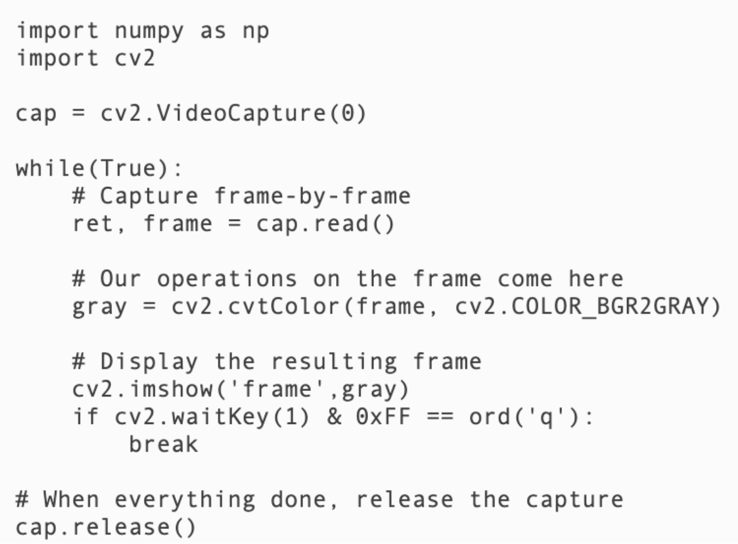
frames
6.8T

- ➢ Pre-processing takes time
- ➢ Data storage is huge
- ➢ IO bottleneck during training

Videos ---> Network training

Motivation

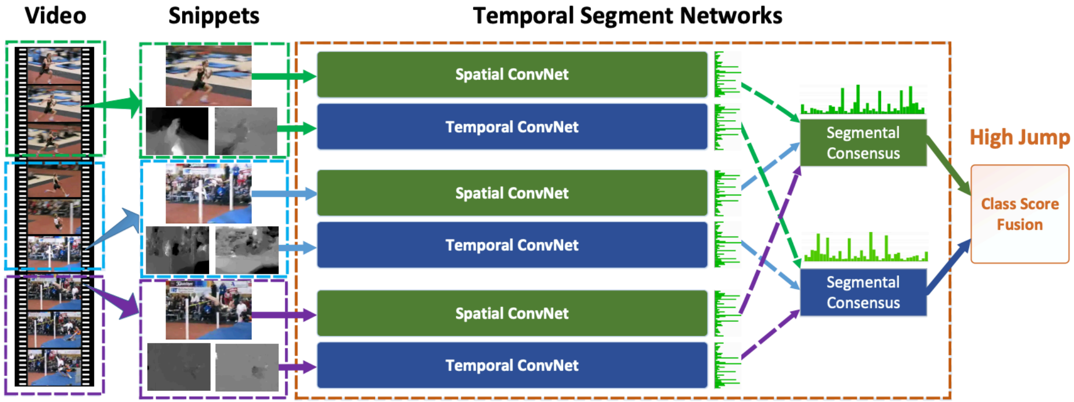
- Slowness in random access



```
import numpy as np
import cv2

cap = cv2.VideoCapture(0)

while(True):
    # Capture frame-by-frame
    ret, frame = cap.read()

    # Our operations on the frame come here
    gray = cv2.cvtColor(frame, cv2.COLOR_BGR2GRAY)

    # Display the resulting frame
    cv2.imshow('frame',gray)
    if cv2.waitKey(1) & 0xFF == ord('q'):
        break

# When everything done, release the capture
cap.release()
```

Motivation

- Slowness in random access



Segment1: index 9
Segment2: index 51
Segment3: index 102

Random access > sequential read

Wang etal, Temporal Segment Networks: Towards Good Practices for Deep Action Recognition, ECCV 2016

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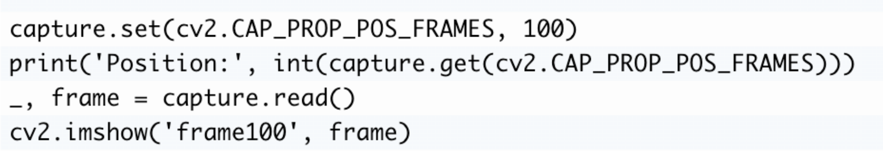
Motivation

- ➢ Lack of flexibility or good user experience in terms of video handling

OpenCV



```
capture.set(cv2.CAP_PROP_POS_FRAMES, 100)
print('Position:', int(capture.get(cv2.CAP_PROP_POS_FRAMES)))
_, frame = capture.read()
cv2.imshow('frame100', frame)
```

Decord

frame = vr[99]

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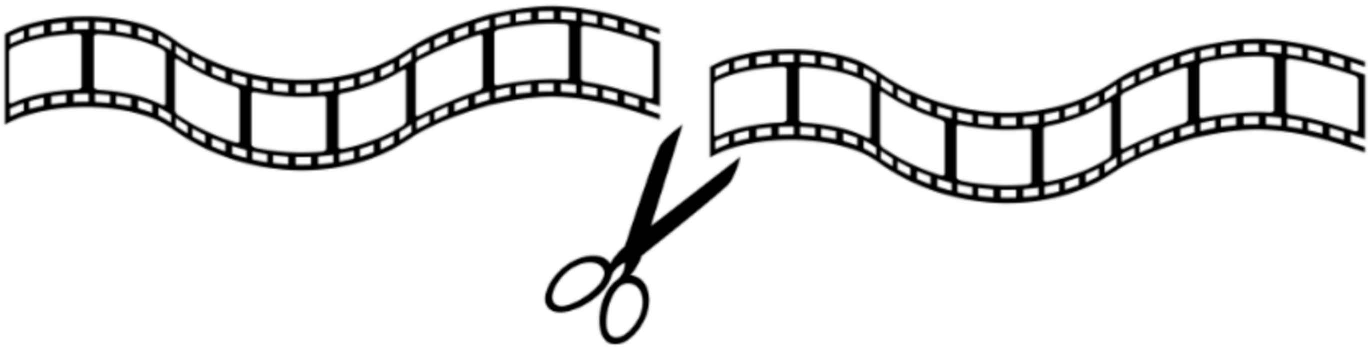
Decord



Decord: provide smooth experiences similar to random image loader for deep learning.

Installation

```
pip install decord
```

Supports Windows/Mac/Linux

Need to build from source to enable GPU support

Ease of Usage

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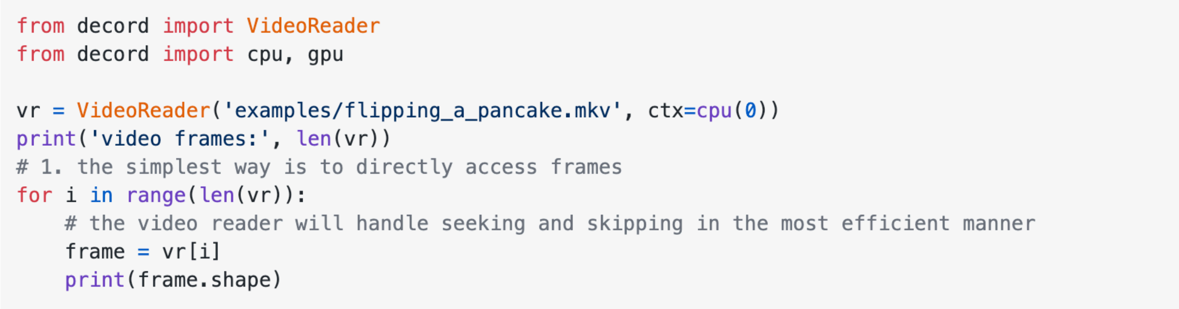
Usage

Pythonic interface

Easy to get video duration

Direct access to any frames by list indexing



```python
from decord import VideoReader
from decord import cpu, gpu

vr = VideoReader('examples/flipping_a_pancake.mkv', ctx=cpu(0))
print('video frames:', len(vr))
# 1. the simplest way is to directly access frames
for i in range(len(vr)):
    # the video reader will handle seeking and skipping in the most efficient manner
    frame = vr[i]
    print(frame.shape)
```

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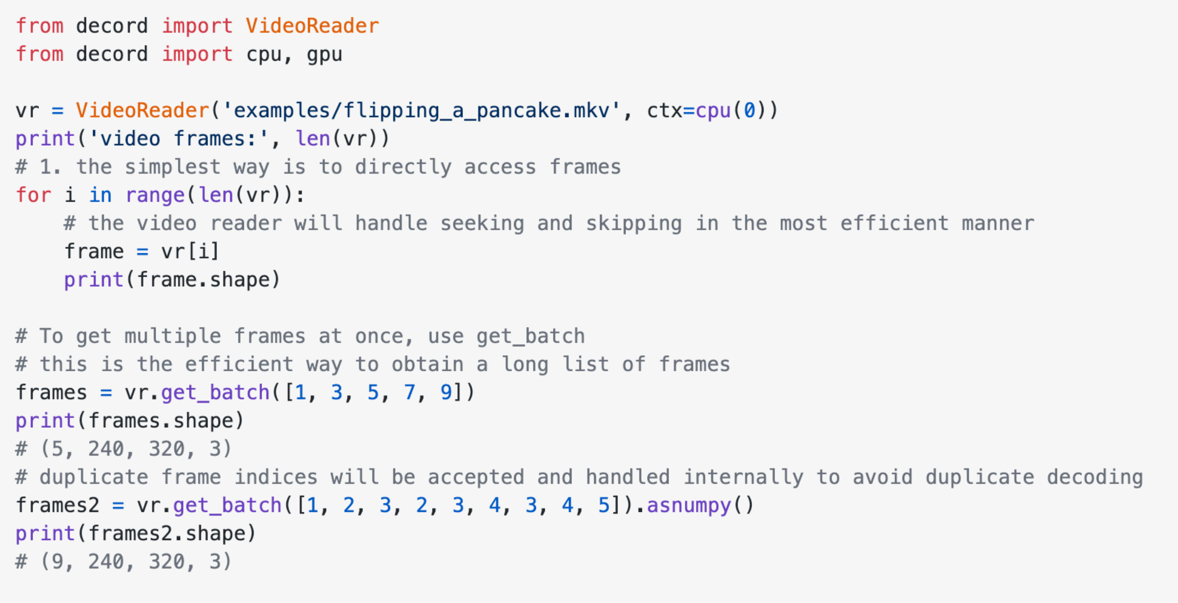
Usage

Batch read frames



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# 1. the simplest way is to directly access frames
for i in range(len(vr)):
    # the video reader will handle seeking and skipping in the most efficient manner
    frame = vr[i]
    print(frame.shape)

# To get multiple frames at once, use get_batch
# this is the efficient way to obtain a long list of frames
frames = vr.get_batch([1, 3, 5, 7, 9])
print(frames.shape)
# (5, 240, 320, 3)
# duplicate frame indices will be accepted and handled internally to avoid duplicate decoding
frames2 = vr.get_batch([1, 2, 3, 2, 3, 4, 3, 4, 5]).asnumpy()
print(frames2.shape)
# (9, 240, 320, 3)
```

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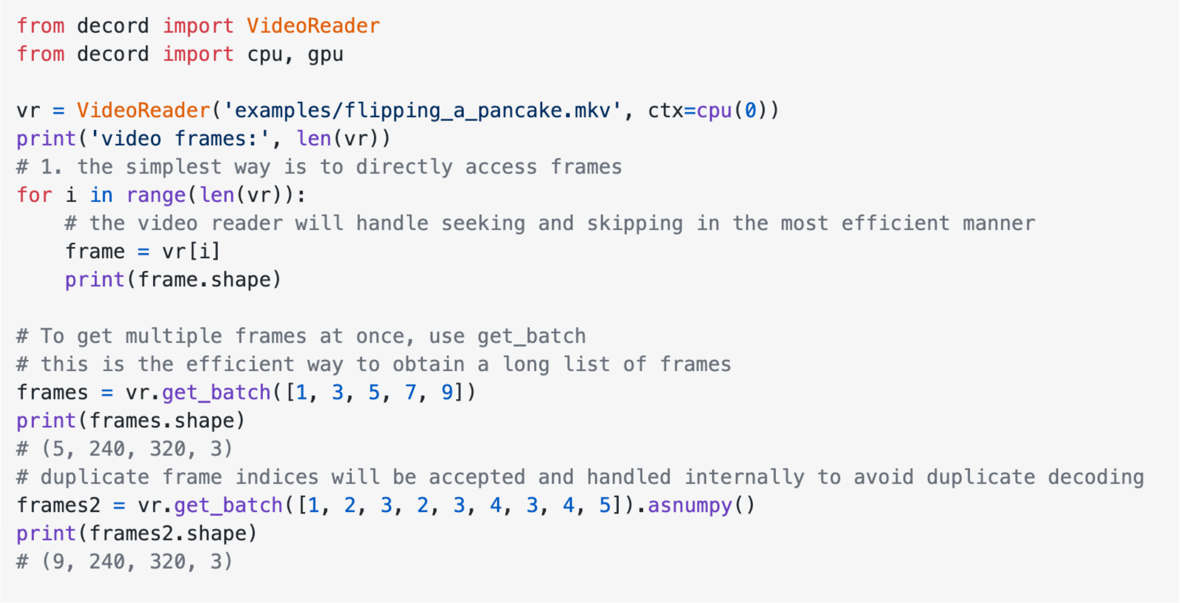
Usage



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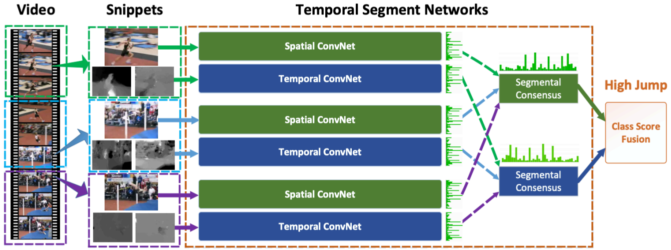


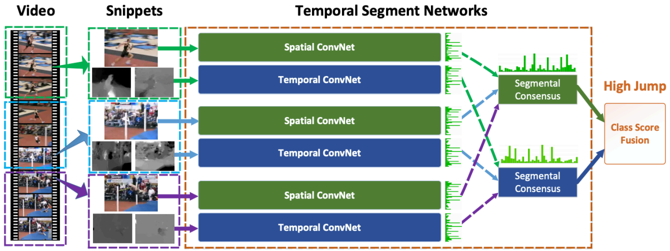
Segment1: index 9

Segment2: index 51

Segment3: index 102

vrames = vr.get_batch([9, 51, 102])

Usage



3D CNNs, loading clips instead of frames

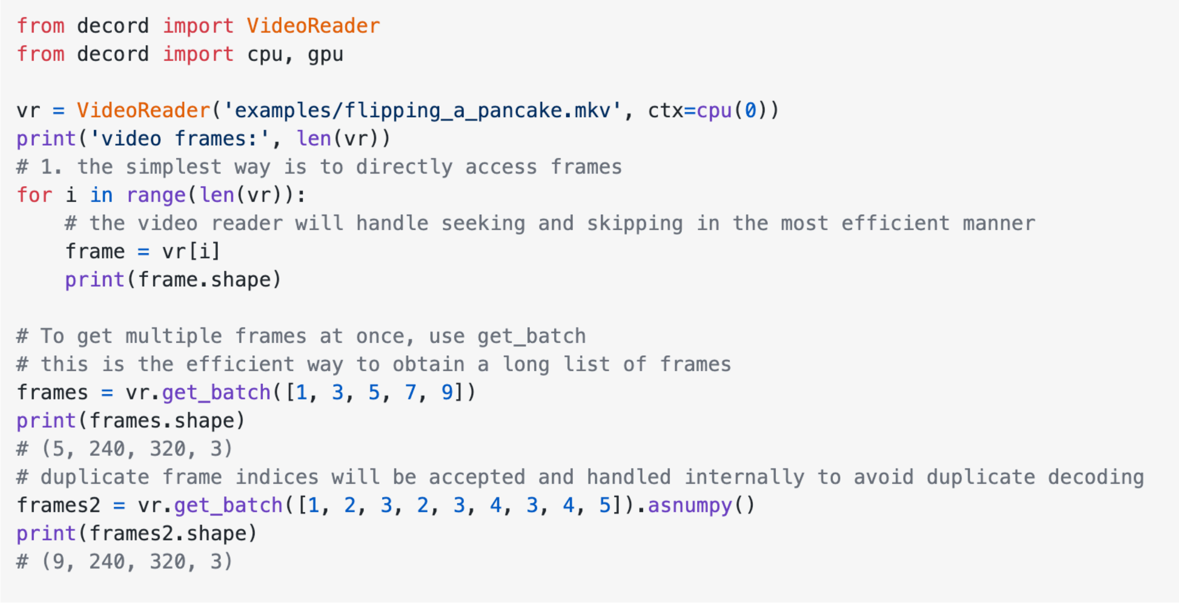
Segment1: index [1,2,3,4,5,6,7,8,9,10,11,12]
Segment2: index [5,6,7,8,9,10,11,12,13,14,15,16,17]
Segment3: index [9,10,11,12,13,14,15,16,17,18,19,20,21]

Duplication! (OpenCV -> slow, Lintel -> X)

Usage

Batch read frames

Efficient handling of duplication



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    print(frame.shape)

# To get multiple frames at once, use get_batch
# this is the efficient way to obtain a long list of frames
frames = vr.get_batch([1, 3, 5, 7, 9])
print(frames.shape)
# (5, 240, 320, 3)
# duplicate frame indices will be accepted and handled internally to avoid duplicate decoding
frames2 = vr.get_batch([1, 2, 3, 2, 3, 4, 3, 4, 5]).asnumpy()
print(frames2.shape)
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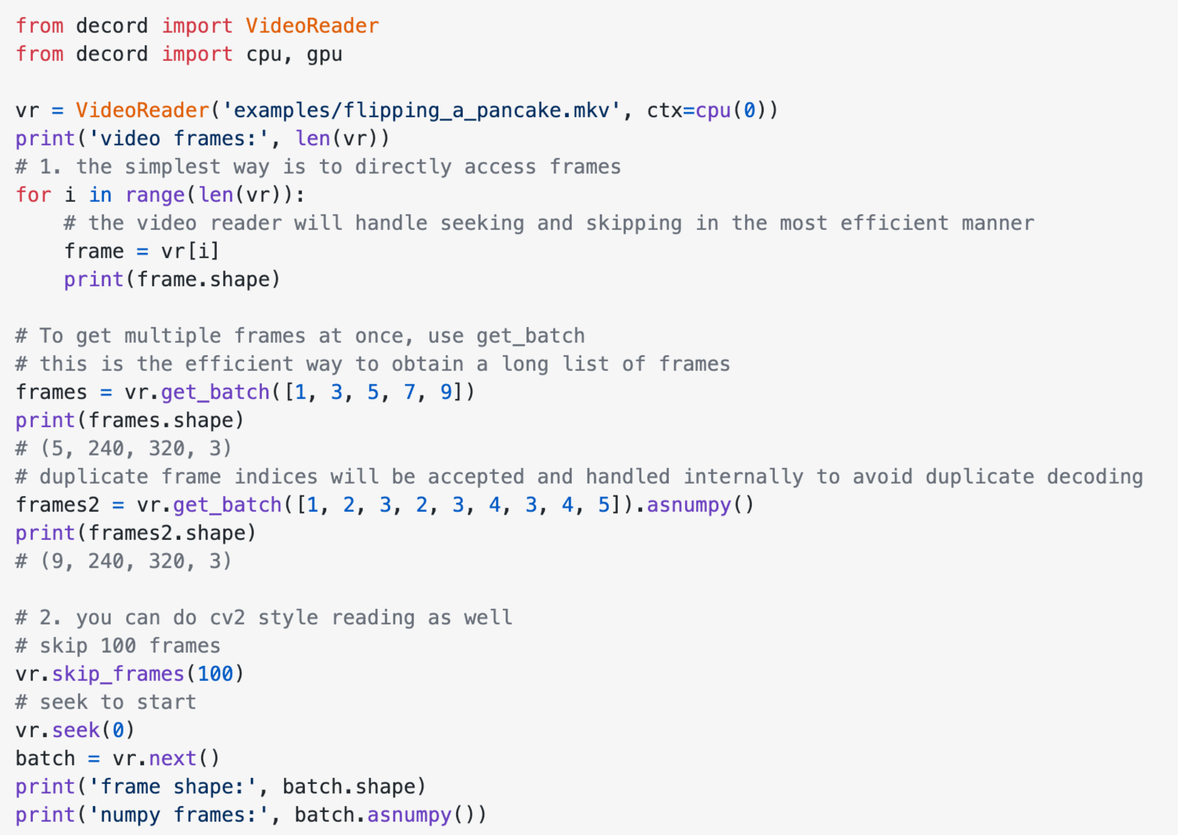
Usage



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# (5, 240, 320, 3)
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frames2 = vr.get_batch([1, 2, 3, 2, 3, 4, 3, 4, 5]).asnumpy()
print(frames2.shape)
# (9, 240, 320, 3)

# 2. you can do cv2 style reading as well
# skip 100 frames
vr.skip_frames(100)
# seek to start
vr.seek(0)
batch = vr.next()
print('frame shape:', batch.shape)
print('numpy frames:', batch.asnumpy())
```
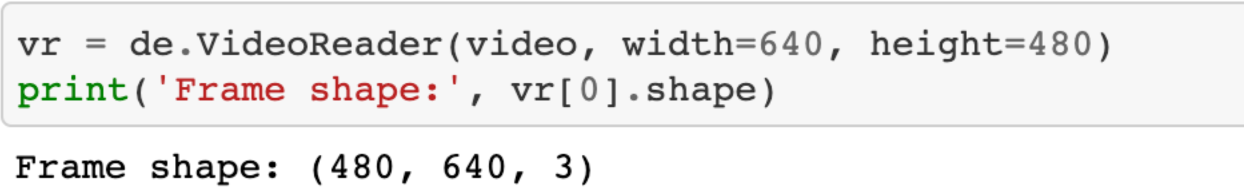

Drop-in replacement of OpenCV

Usage

Resize videos while video reading

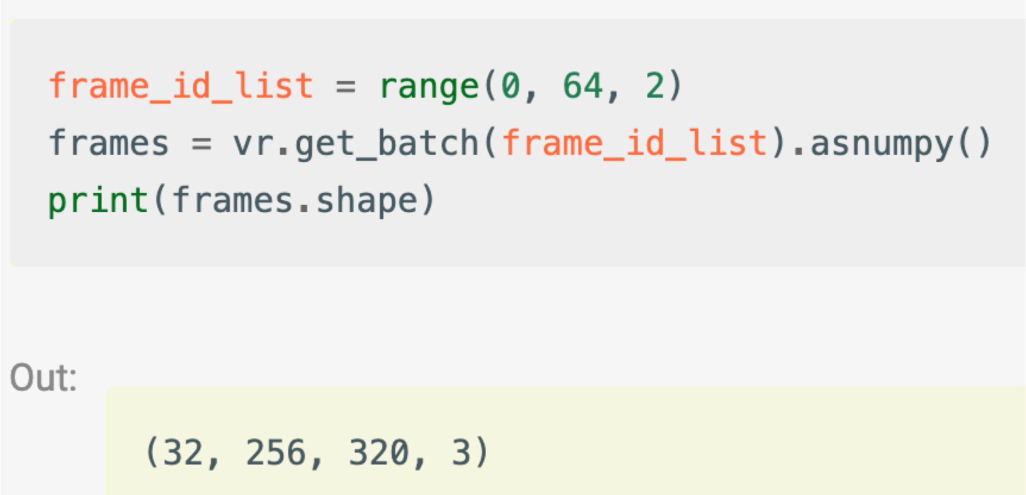


```
vr = de.VideoReader(video, width=640, height=480)
print('Frame shape:', vr[0].shape)
```

```
Frame shape: (480, 640, 3)
```

Usage

Batch reading using *range*, reduce python overhead



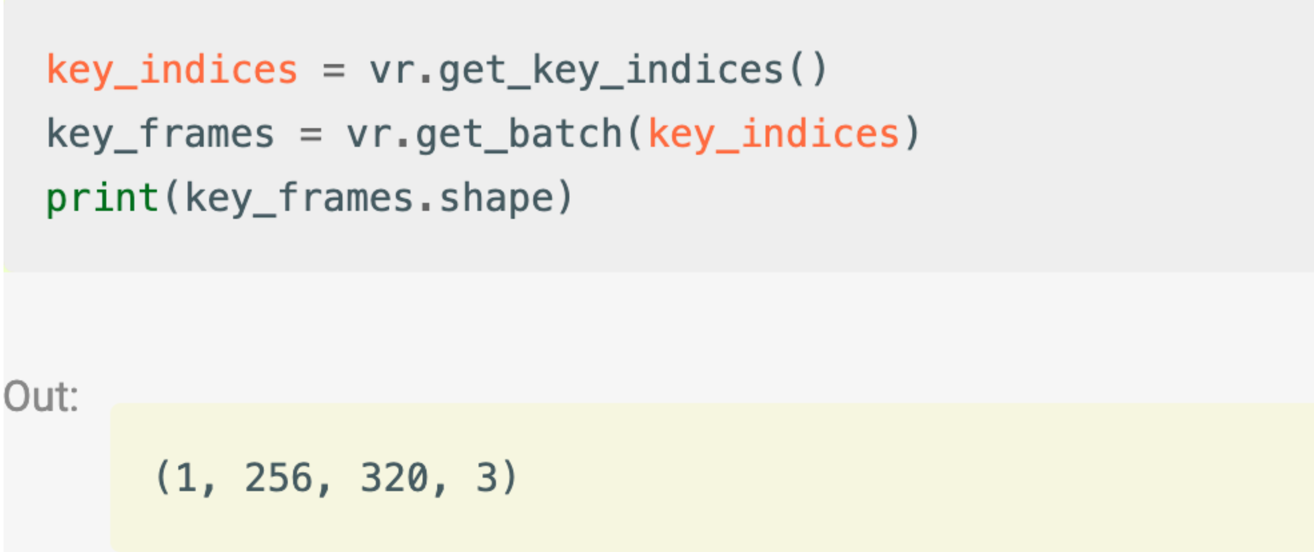
```
frame_id_list = range(0, 64, 2)
frames = vr.get_batch(frame_id_list).asnumpy()
print(frames.shape)
```

Out:

```
(32, 256, 320, 3)
```

Usage

Get all the key frames

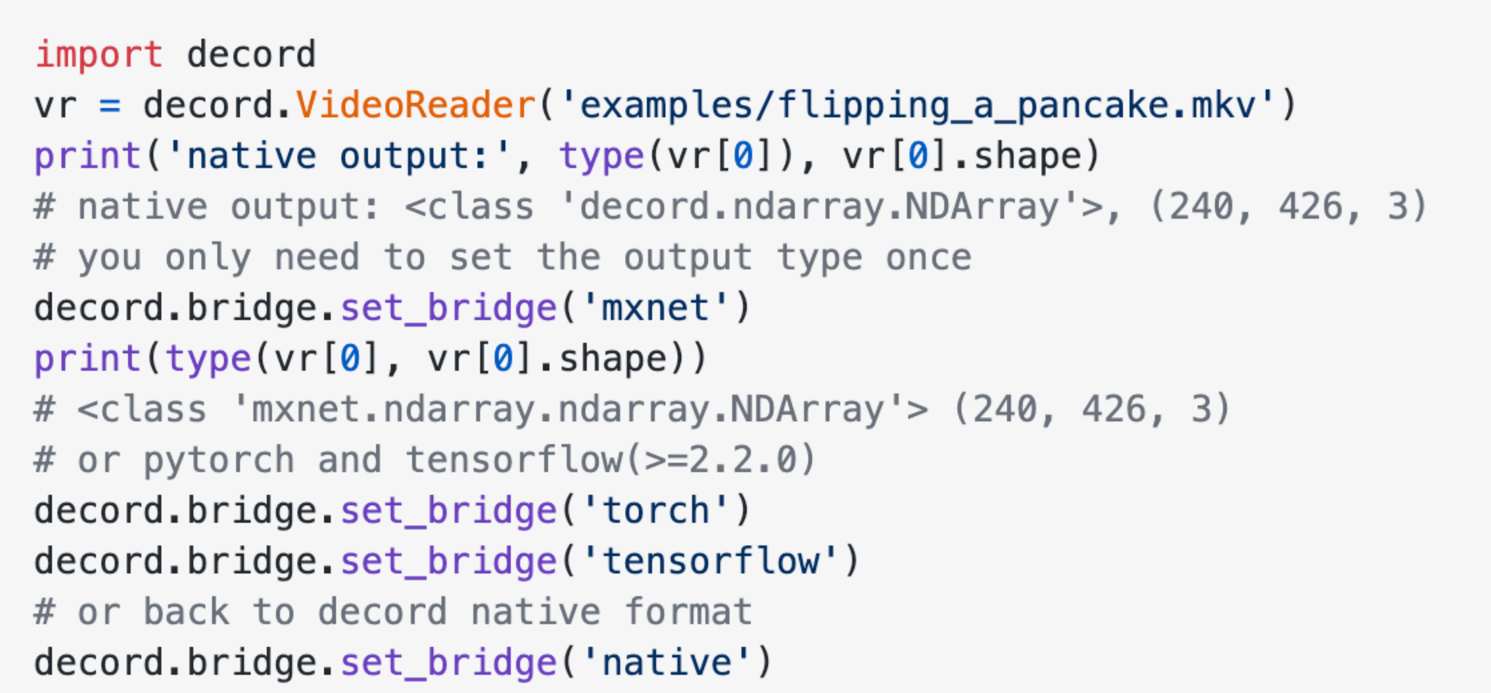


```
key_indices = vr.get_key_indices()
key_frames = vr.get_batch(key_indices)
print(key_frames.shape)
```

Out:

```
(1, 256, 320, 3)
```

Deep learning framework



```
import decord
vr = decord.VideoReader('examples/flipping_a_pancake.mkv')
print('native output:', type(vr[0]), vr[0].shape)
# native output: <class 'decord.ndarray.NDArray'>, (240, 426, 3)
# you only need to set the output type once
decord.bridge.set_bridge('mxnet')
print(type(vr[0], vr[0].shape))
# <class 'mxnet.ndarray.ndarray.NDArray'> (240, 426, 3)
# or pytorch and tensorflow(>=2.2.0)
decord.bridge.set_bridge('torch')
decord.bridge.set_bridge('tensorflow')
# or back to decord native format
decord.bridge.set_bridge('native')
```

Efficiency Comparison

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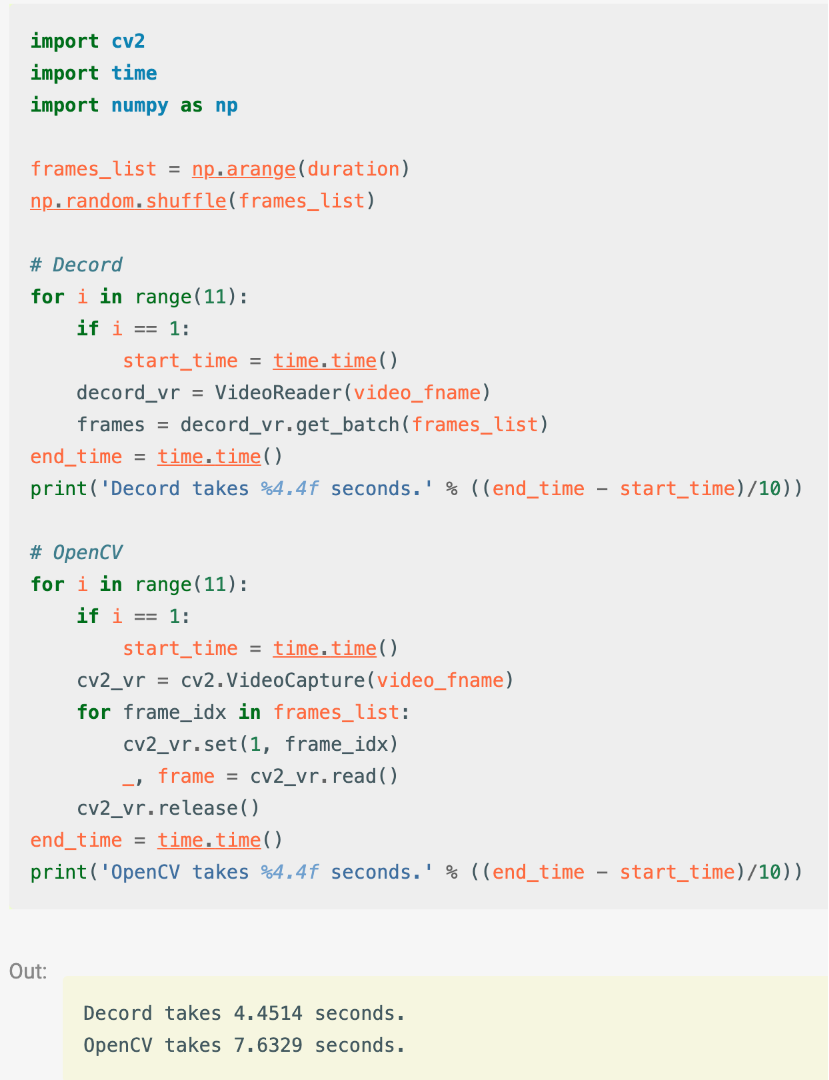
2x faster than OpenCV



```python
import cv2
import time
import numpy as np

frames_list = np.arange(duration)
np.random.shuffle(frames_list)

# Decord
for i in range(11):
    if i == 1:
        start_time = time.time()
    decord_vr = VideoReader(video_fname)
    frames = decord_vr.get_batch(frames_list)
end_time = time.time()
print('Decord takes %4.4f seconds.' % ((end_time - start_time)/10))

# OpenCV
for i in range(11):
    if i == 1:
        start_time = time.time()
    cv2_vr = cv2.VideoCapture(video_fname)
    for frame_idx in frames_list:
        cv2_vr.set(1, frame_idx)
        _, frame = cv2_vr.read()
    cv2_vr.release()
end_time = time.time()
print('OpenCV takes %4.4f seconds.' % ((end_time - start_time)/10))
```

Out:

```
Decord takes 4.4514 seconds.
OpenCV takes 7.6329 seconds.
```

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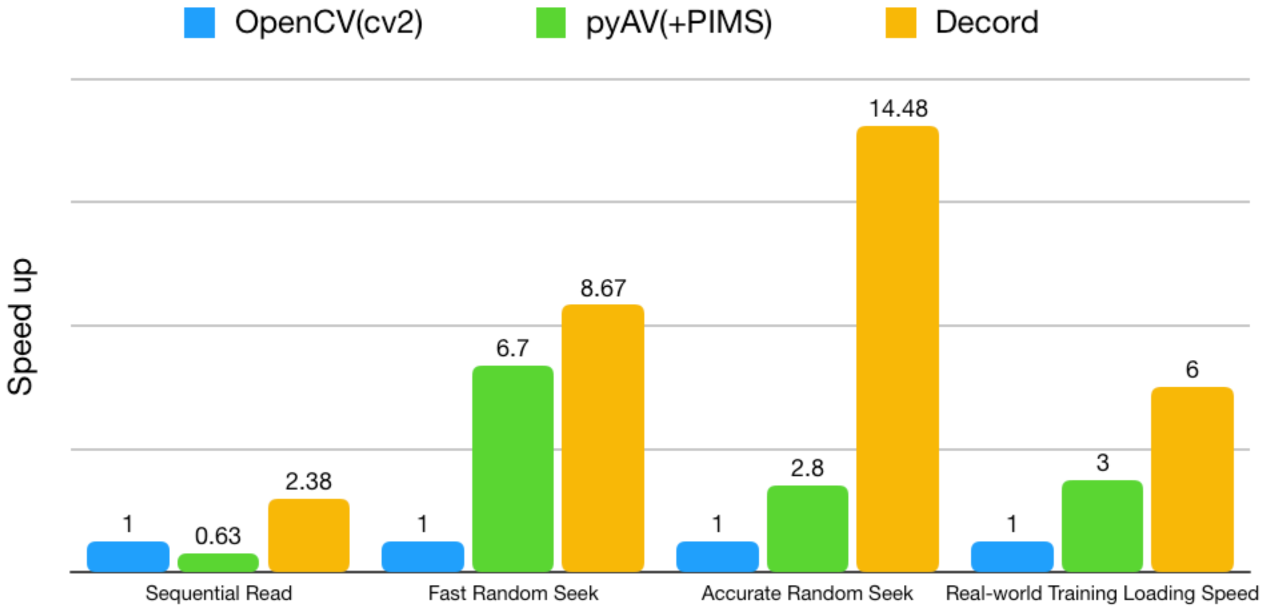
Speed Comparison



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Comparison to other video readers

- OpenCV and PyAV
  Slow in random access pattern

- Lintel (https://github.com/dukebw/lintel)
  can’t handle duplication, no key_frame handling

- DALI (https://github.com/NVIDIA/DALI)
  complicated pipeline and usage, has to use Nvidia GPU

We will provide interface to other video readers!

Previewed Features

- ➢ GPU decoding and data augmentation complete, but needs further optimization
- ➢ Video Loader
  an all-in-one solution
  https://github.com/dmlc/decord

Conclusion

- Easy to use and flexible
  pythonic

- Efficient

- Notebook
  (https://github.com/dmlc/decord/blob/master/examples/video_reader.ipynb)

- Please try Decord at https://github.com/dmlc/decord