Deep Learning Toolkit *(Numpy)*

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Numpy

https://numpy.org/

List vs Tuple or `a=[1, 2.2, ”the”]` vs `a=(1, 2.2, ”the”)`

	`List`	`Tuple`
Mutable	Yes	No
Supported	`index, count`	`index, count`
Supported	`insert, append, pop, clear, remove, reverse`	
Use	Elements might change	Fixed elements

Numpy - Basics

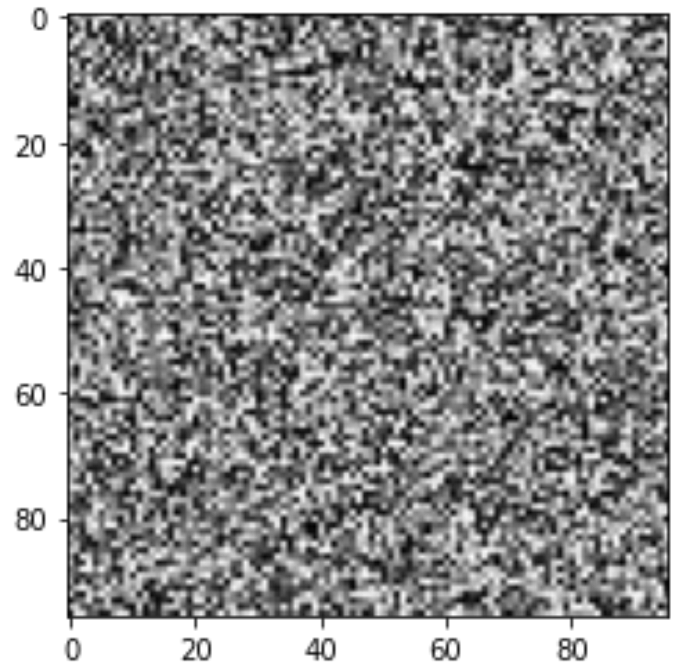
```
# Create an array
import numpy as np
a = np.array([[1,2,3], [4,5,6]])
# Data type: dtype('int64')
a.dtype
# Shape: (2, 3)
a.shape
# Number of dimensions: 2
a.ndim
```

Numpy - Basics

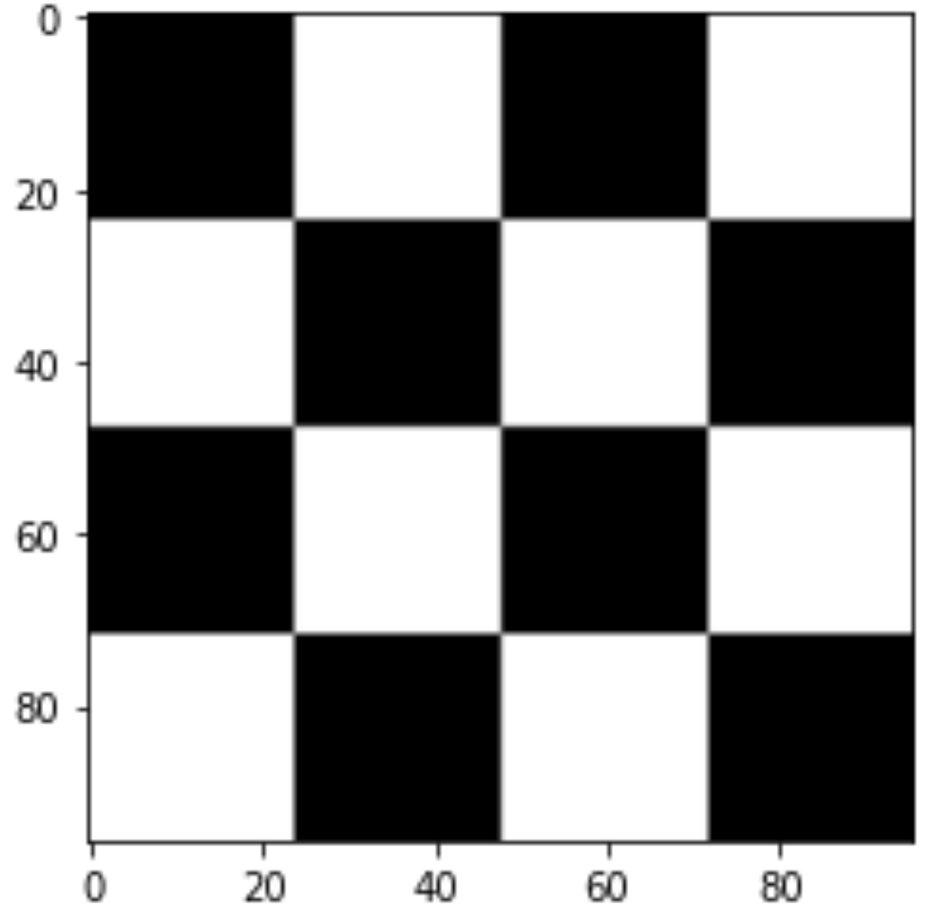
```
# Add a constant
2 + a
# Add 2 arrays
b = np.ones(a.shape)
a+b
# Multiply 2 arrays
a*b
# Matrix multiply 2 arrays
np.matmul(a,np.transpose(b))
a@np.transpose(b)
```

Numpy for Data

```
img = np.random.randint(0,255,size=(96,96),dtype=np.uint8)
plt.imshow(img, cmap='gray', vmin=0, vmax=255)
plt.show()
```



Chessboard Pattern



Chessboard Pattern

```
img = np.one[illegible]96), dtyp[illegible]int8)*255
for i in range[illegible]
  img[i*24:(i+1)[illegible]1)*24] = 0

for i in range(2,4[illegible]
  img[i*24:(i+1)[illegible](i[illegible]:(i-1)*24] = 0

for i in ra[illegible]):
  img[i*24:(i[illegible])*24, (i+2)*24:[illegible]+3)*24] = 0
```

Chessboard Pattern

```
def chessboard(shape):
  return np.indices(shape).sum(axis=0) % 2

img = chessboard((4,4))*255

img = np.repeat(img, (24), axis=0)
img = np.repeat(img, (24), axis=1)
```

`np.indices((4,4)) is 2x4x4`

```
[[[0 0 0 0]
  [1 1 1 1]
  [2 2 2 2]
  [3 3 3 3]]

 [[0 1 2 3]
  [0 1 2 3]
  [0 1 2 3]
  [0 1 2 3]]]
```

`np.indices((4,4)).sum(axis=0)`

```
[[0 1 2 3]
 [1 2 3 4]
 [2 3 4 5]
 [3 4 5 6]]
```

`np.indices((4,4)).sum(axis=0)%2`

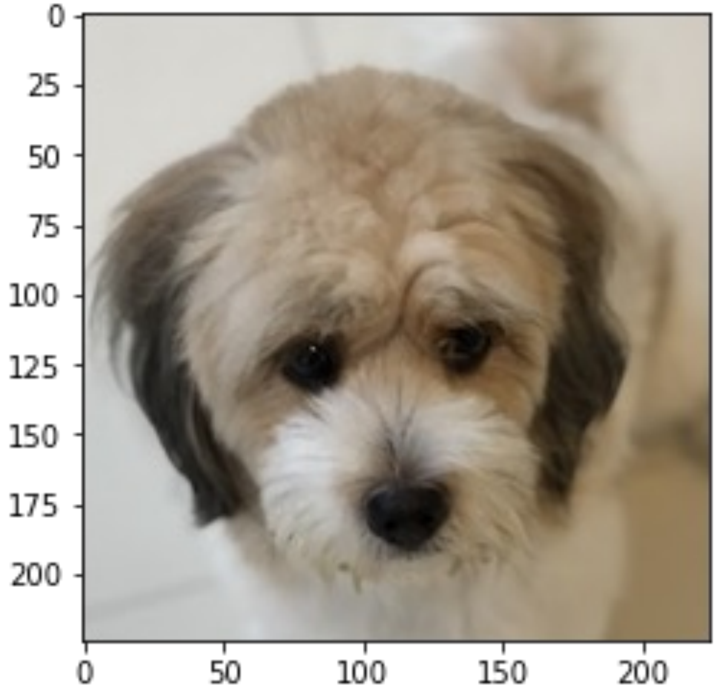
```
[[0 1 0 1]
 [1 0 1 0]
 [0 1 0 1]
 [1 0 1 0]]
```

Exercise:

Without using loops, find another algorithm that can generate this pattern.

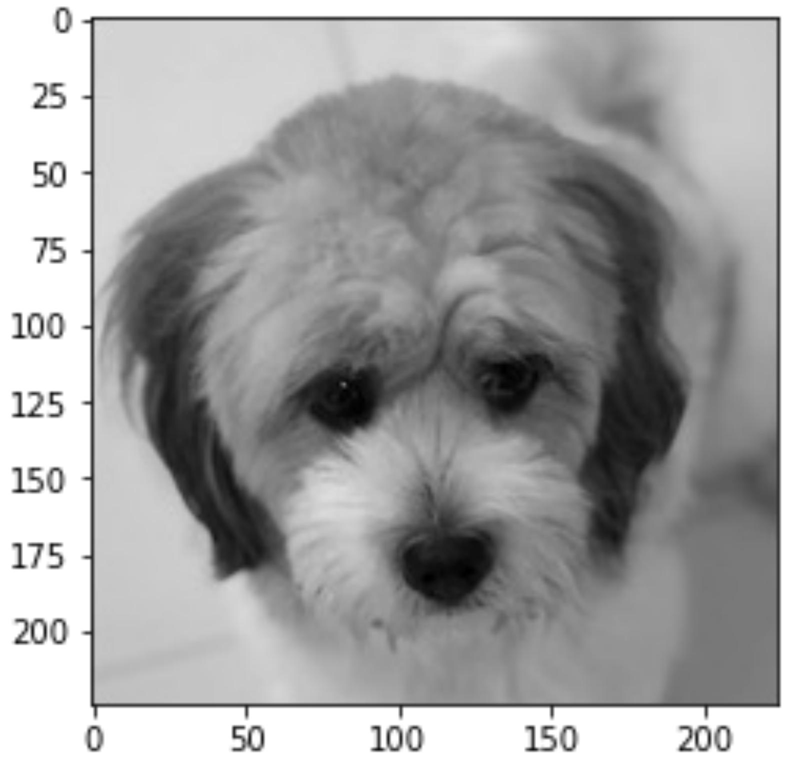
Loading an image

```
from matplotlib import image
img = image.imread("aki_dog.jpg")
```



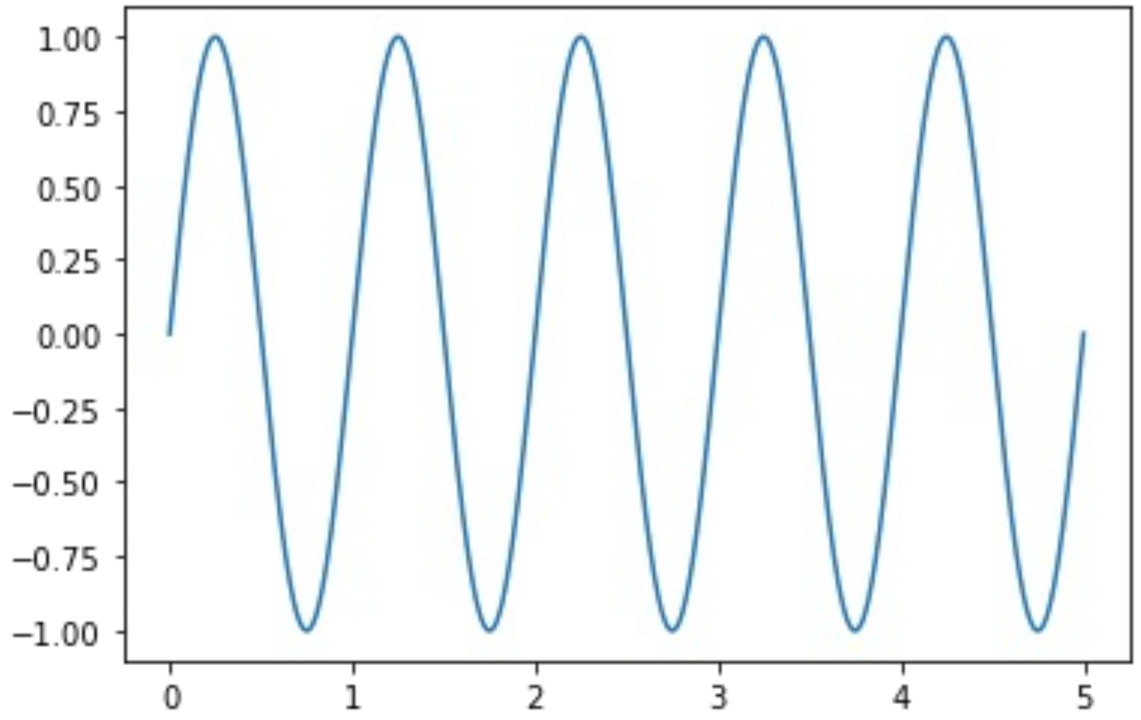
RGB to Grayscale

```
img = np.mean(img, axis=-1)
```



Synthetic Audio Waveform

```
samples_per_sec = 22050
freq = 1
n_points = samples_per_sec*5
t = np.linspace(0,5,n_points)
data = np.sin(2*np.pi*freq*t)
```



Limitations of Numpy

Not designed for GPU execution

- Alternative: `cupy`

Different methods/APIs for different tensor operations

Many steps for complex linear algebra operations

- Alternative: `einsum` and `einops`

End