Import software libraries and load the dataset

In [1]:
```python
# Import required libraries.
import sys                                    # Read system parameters.
import shutil
import numpy as np                            # Work with multi-dimensional arrays and matrices.
from numpy.random import seed
import matplotlib as mpl                      # Create 2D charts.
import matplotlib.pyplot as plt
import sklearn                                # Perform data mining and analysis.
import tensorflow                             # Train neural networks for deep learning.
import keras                                  # Provide a frontend for TensorFlow.
from keras import datasets
from keras.utils import to_categorical,plot_model
from keras.models import Sequential,Model
from keras.layers import AveragePooling2D, BatchNormalization, Conv2D, MaxPooling2D, Dense, Flatten
from keras.callbacks import EarlyStopping

from sklearn.model_selection import train_test_split

import pydot


# Summarize software libraries used.
print('Libraries used in this project:')
print('- Python {}'.format(sys.version))
print('- NumPy {}'.format(np.__version__))
print('- Matplotlib {}'.format(mpl.__version__))
print('- scikit-learn {}'.format(sklearn.__version__))
print('- TensorFlow {}'.format(tensorflow.__version__))
print('- Keras {}\n'.format(keras.__version__))

# Load the dataset.
#shutil.rmtree('/home/jovyan/.keras')
#shutil.copytree('/home/jovyan/work/.keras', '/home/jovyan/.keras')
(X_train, y_train), (X_test, y_test) = datasets.mnist.load_data()
print('Loaded {} training records.'.format(len(X_train.data)))
print('Loaded {} test records.'.format(len(X_test.data)))

# Uncomment the following two lines to make outcomes deterministic. Supply whatever seed values you wish.
seed(1)
tensorflow.random.set_seed(1)
```

```
Libraries used in this project:
- Python 3.8.5 (default, Sep  3 2020, 21:29:08) [MSC v.1916 64 bit (AMD64)]
- NumPy 1.19.2
- Matplotlib 3.3.2
- scikit-learn 0.23.2
- TensorFlow 2.4.0
- Keras 2.4.3

Loaded 60000 training records.
Loaded 10000 test records.
```

Get acquainted with the dataset

In [2]:
```python
# Show dimensions of the training and testing sets and their labels
X_train.shape, y_train.shape, X_test.shape, y_test.shape
```

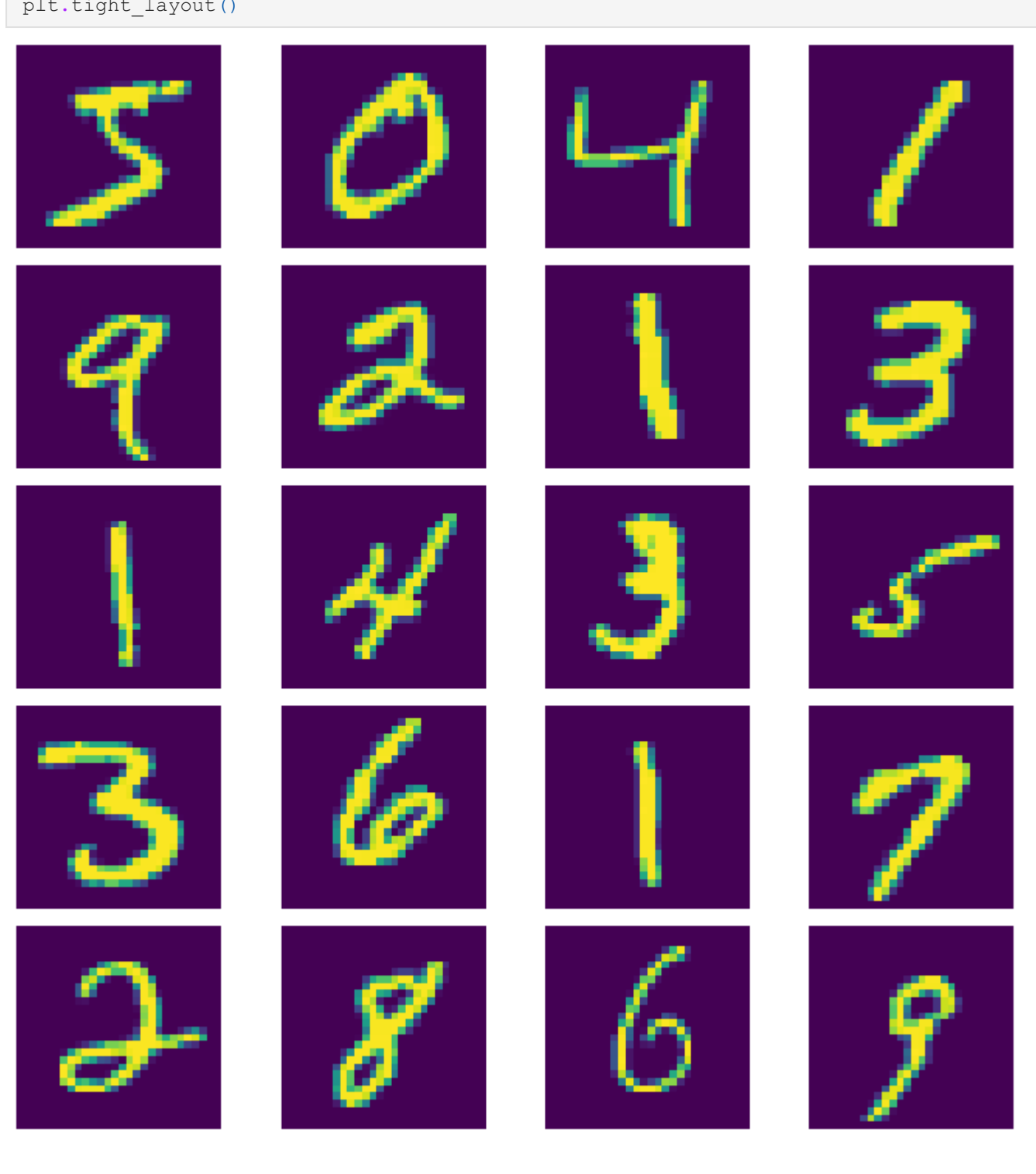
Out[2]:
```
((60000, 28, 28), (60000,), (10000, 28, 28), (10000,))
```

In [3]:
```python
X_train[0].shape
```

Out[3]:
```
(28, 28)
```

Visualize the data examples

In [4]:
```python
# Show a preview of the first 20 images

W = 4
L = 5

fig, axes = plt.subplots(nrows=L, ncols=W, figsize=(10,10))

axes = axes.ravel()

n_training = len(X_train)


for i in range(W*L):
    index = np.arange(0, n_training)
    axes[i].imshow(X_train[i])
    #axes[i].set_title(y_train[index],fontsize=15)
    axes[i].axis("off")

#plt.subplots_adjust(hspace=0.1)
plt.tight_layout()
```



Prepare the data for training with Keras

In [5]:
```python
# Reshape arrays to add greyscale flag.

# One-hot encode the data for each label.
```

In [6]:
```python
X_train = X_train.reshape(-1,28,28,1)
```

In [7]:
```python
X_test = X_test.reshape(-1,28,28,1)
```

In [8]:
```python
X_train.shape
```

Out[8]:
```
(60000, 28, 28, 1)
```

In [9]:
```python
X_train_scaled = X_train.astype('float')/255.
```

In [10]:
```python
X_test_scaled = X_test.astype('float')/255.
```

In [11]:
```python
y_train_encoded = to_categorical(y_train)
```

In [12]:
```python
y_test_encoded = to_categorical(y_test)
```

In [13]:
```python
X_train_scaled.shape, X_test_scaled.shape, y_train_encoded.shape, y_test_encoded.shape
```

Out[13]:
```
((60000, 28, 28, 1), (10000, 28, 28, 1), (60000, 10), (10000, 10))
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In [14]:
```python
X_train_scaled[0]
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Out[14]:
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