Importing Libraries

In [1]:
```
!pip install matplotlib
!pip install tensorflow
!pip install pandas
!pip install seaborn
```

```
Requirement already satisfied: matplotlib in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (3.8.3)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib)
(1.2.0)
Requirement already satisfied: cycler>=0.10 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib) (0.
12.1)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotli
b) (4.50.0)
Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotli
b) (1.4.5)
Requirement already satisfied: numpy<2,>=1.21 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib)
(1.26.4)
Requirement already satisfied: packaging>=20.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib)
(24.0)
Requirement already satisfied: pillow>=8 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib) (10.2.
0)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib)
(3.1.2)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplot
lib) (2.9.0.post0)
Requirement already satisfied: six>=1.5 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from python-dateutil>=2.
7->matplotlib) (1.16.0)
Requirement already satisfied: tensorflow in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (2.16.1)
Requirement already satisfied: tensorflow-intel==2.16.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from ten
sorflow) (2.16.1)
Requirement already satisfied: absl-py>=1.0.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-in
tel==2.16.1->tensorflow) (2.1.0)
Requirement already satisfied: astunparse>=1.6.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow
-intel==2.16.1->tensorflow) (1.6.3)
Requirement already satisfied: flatbuffers>=23.5.26 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorf
low-intel==2.16.1->tensorflow) (24.3.25)
Requirement already satisfied: gast!=0.5.0,!=0.5.1,!=0.5.2,>=0.2.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-package
s (from tensorflow-intel==2.16.1->tensorflow) (0.5.4)
Requirement already satisfied: google-pasta>=0.1.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorfl
ow-intel==2.16.1->tensorflow) (0.2.0)
Requirement already satisfied: h5py>=3.10.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-inte
l==2.16.1->tensorflow) (3.10.0)
Requirement already satisfied: libclang>=13.0.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (18.1.1)
Requirement already satisfied: ml-dtypes~=0.3.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (0.3.2)
Requirement already satisfied: opt-einsum>=2.3.2 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow
-intel==2.16.1->tensorflow) (3.3.0)
Requirement already satisfied: packaging in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-intel==
2.16.1->tensorflow) (24.0)
Requirement already satisfied: protobuf!=4.21.0,!=4.21.1,!=4.21.2,!=4.21.3,!=4.21.4,!=4.21.5,<5.0.0dev,>=3.20.3 in c:\users\gupta\desktop\p
lant disease detection\tfenv\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (4.25.3)
Requirement already satisfied: requests<3,>=2.21.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorfl
ow-intel==2.16.1->tensorflow) (2.31.0)
Requirement already satisfied: setuptools in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-intel=
=2.16.1->tensorflow) (63.2.0)
Requirement already satisfied: six>=1.12.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-intel
==2.16.1->tensorflow) (1.16.0)
Requirement already satisfied: termcolor>=1.1.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-
intel==2.16.1->tensorflow) (2.4.0)
Requirement already satisfied: typing-extensions>=3.6.6 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from ten
sorflow-intel==2.16.1->tensorflow) (4.10.0)
Requirement already satisfied: wrapt>=1.11.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-int
el==2.16.1->tensorflow) (1.16.0)
Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorfl
ow-intel==2.16.1->tensorflow) (1.62.1)
Requirement already satisfied: tensorboard<2.17,>=2.16 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tens
orflow-intel==2.16.1->tensorflow) (2.16.2)
Requirement already satisfied: keras>=3.0.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorflow-inte
l==2.16.1->tensorflow) (3.1.1)
Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packag
es (from tensorflow-intel==2.16.1->tensorflow) (0.31.0)
Requirement already satisfied: numpy<2.0.0,>=1.23.5 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorf
low-intel==2.16.1->tensorflow) (1.26.4)
Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from astunpars
e>=1.6.0->tensorflow-intel==2.16.1->tensorflow) (0.43.0)
Requirement already satisfied: rich in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from keras>=3.0.0->tensorflo
w-intel==2.16.1->tensorflow) (13.7.1)
Requirement already satisfied: namex in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from keras>=3.0.0->tensorfl
ow-intel==2.16.1->tensorflow) (0.0.7)
Requirement already satisfied: optree in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from keras>=3.0.0->tensorf
low-intel==2.16.1->tensorflow) (0.11.0)
Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from req
uests<3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (3.3.2)
Requirement already satisfied: idna<4,>=2.5 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from requests<3,>=2.
21.0->tensorflow-intel==2.16.1->tensorflow) (3.6)
Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from requests<
3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (2.2.1)
Requirement already satisfied: certifi>=2017.4.17 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from requests<
3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (2024.2.2)
Requirement already satisfied: markdown>=2.6.8 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorboard<
2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (3.6)
Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packa
ges (from tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (0.7.2)
Requirement already satisfied: werkzeug>=1.0.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from tensorboard<
2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (3.0.1)
Requirement already satisfied: MarkupSafe>=2.1.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from werkzeug>=
1.0.1->tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (2.1.5)
Requirement already satisfied: markdown-it-py>=2.2.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from rich->
```

```
keras>=3.0.0->tensorflow-intel==2.16.1->tensorflow) (3.0.0)
Requirement already satisfied: pygments<3.0.0,>=2.13.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from rich
->keras>=3.0.0->tensorflow-intel==2.16.1->tensorflow) (2.17.2)
Requirement already satisfied: mdurl~=0.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from markdown-it-py>=
2.2.0->rich->keras>=3.0.0->tensorflow-intel==2.16.1->tensorflow) (0.1.2)
Requirement already satisfied: pandas in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (2.2.1)
Requirement already satisfied: numpy<2,>=1.22.4 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from pandas) (1.
26.4)
Requirement already satisfied: python-dateutil>=2.8.2 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from panda
s) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from pandas) (2024.
1)
Requirement already satisfied: tzdata>=2022.7 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from pandas) (202
4.1)
Requirement already satisfied: six>=1.5 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from python-dateutil>=2.
8.2->pandas) (1.16.0)
Requirement already satisfied: seaborn in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (0.13.2)
Requirement already satisfied: numpy!=1.24.0,>=1.20 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from seabor
n) (1.26.4)
Requirement already satisfied: pandas>=1.2 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from seaborn) (2.2.1)
Requirement already satisfied: matplotlib!=3.6.1,>=3.4 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from seab
orn) (3.8.3)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib!
=3.6.1,>=3.4->seaborn) (1.2.0)
Requirement already satisfied: cycler>=0.10 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib!=3.
6.1,>=3.4->seaborn) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotli
b!=3.6.1,>=3.4->seaborn) (4.50.0)
Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotli
b!=3.6.1,>=3.4->seaborn) (1.4.5)
Requirement already satisfied: packaging>=20.0 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib!=
3.6.1,>=3.4->seaborn) (24.0)
Requirement already satisfied: pillow>=8 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib!=3.6.1,
>=3.4->seaborn) (10.2.0)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplotlib!
=3.6.1,>=3.4->seaborn) (3.1.2)
Requirement already satisfied: python-dateutil>=2.7 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from matplot
lib!=3.6.1,>=3.4->seaborn) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from pandas>=1.2->se
aborn) (2024.1)
Requirement already satisfied: tzdata>=2022.7 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from pandas>=1.2->
seaborn) (2024.1)
Requirement already satisfied: six>=1.5 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from python-dateutil>=2.
7->matplotlib!=3.6.1,>=3.4->seaborn) (1.16.0)
```

In [2]:
```
import tensorflow as tf
import matplotlib.pyplot as plt
import pandas as pd
import seaborn as sns
```

Data Preprocessing

Training Image Preprocessing

In [3]:
```
training_set = tf.keras.utils.image_dataset_from_directory(
    'train',
    labels="inferred",
    label_mode="categorical",
    class_names=None,
    color_mode="rgb",
    batch_size=32,
    image_size=(128, 128),
    shuffle=True,
    seed=None,
    validation_split=None,
    subset=None,
    interpolation="bilinear",
    follow_links=False,
    crop_to_aspect_ratio=False,
#     pad_to_aspect_ratio=False,
#     data_format=None,
#     verbose=True,
)
```

```
Found 70295 files belonging to 38 classes.
```

Validation Image Preprocessing

In [4]:
```
validation_set = tf.keras.utils.image_dataset_from_directory(
    'valid',
    labels="inferred",
    label_mode="categorical",
    class_names=None,
    color_mode="rgb",
    batch_size=32,
    image_size=(128, 128),
    shuffle=True,
    seed=None,
    validation_split=None,
    subset=None,
```

```
    interpolation="bilinear",
    follow_links=False,
    crop_to_aspect_ratio=False,
#     pad_to_aspect_ratio=False,
#     data_format=None,
#     verbose=True,
)
```

```
Found 17572 files belonging to 38 classes.
```

In [5]:
```
training_set
```

Out[5]:
```
<_PrefetchDataset element_spec=(TensorSpec(shape=(None, 128, 128, 3), dtype=tf.float32, name=None), TensorSpec(shape=(None, 38), dtype=tf.float32, name=None))>
```

In [6]:
```
for x,y in training_set:
    print(x)
    print(y)
    break
```

```
tf.Tensor(
[[[[ 79.75  68.25  76.25]
   [146.25 131.   137.75]
   [147.   128.75 132.  ]
   ...
   [174.5  162.5  162.5 ]
   [172.   160.   160.  ]
   [176.   164.   164.  ]]

  [[ 72.25  60.75  66.25]
   [136.   121.25 124.  ]
   [150.75 134.5  134.  ]
   ...
   [174.5  162.5  162.5 ]
   [160.   148.   148.  ]
   [179.5  167.5  167.5 ]]

  [[ 76.25  67.    67.25]
   [152.75 140.75 139.  ]
   [138.   123.75 116.  ]
   ...
   [183.5  171.5  171.5 ]
   [175.   163.   163.  ]
   [167.   155.   155.  ]]

  ...

  [[ 70.5   60.5   63.5 ]
   [140.75 129.75 133.75]
   [152.   141.   145.  ]
   ...
   [163.75 152.75 156.75]
   [170.5  159.5  163.5 ]
   [166.   155.   159.  ]]

  [[ 81.75  71.75  74.75]
   [140.25 129.25 133.25]
   [147.   136.   140.  ]
   ...
   [158.25 147.25 151.25]
   [174.   163.   167.  ]
   [172.75 161.75 165.75]]

  [[ 74.    64.    67.  ]
   [140.   129.   133.  ]
   [142.25 131.25 135.25]
   ...
   [170.75 159.75 163.75]
   [163.   152.   156.  ]
   [163.5  152.5  156.5 ]]]


 [[[156.   151.5  162.  ]
   [153.5  151.   165.  ]
   [146.   146.   164.  ]
   ...
   [ 90.25  83.25  99.25]
   [ 92.75  85.75 101.75]
   [ 94.25  87.25 103.25]]

  [[158.75 154.25 165.75]
   [152.   149.25 163.5 ]
   [150.5  150.5  168.5 ]
   ...
   [ 86.75  79.75  95.75]
   [ 87.25  80.25  96.25]
   [ 87.75  80.75  96.75]]

  [[162.   157.5  169.  ]
   [155.5  153.   167.25]
   [154.75 153.75 171.25]
   ...
   [ 88.5   81.5   97.5 ]
   [ 89.5   82.5   98.5 ]
   [ 89.75  82.75  98.75]]

  ...

  [[168.75 161.75 168.75]
   [169.   162.   169.  ]
   [170.   163.   170.  ]
   ...
   [153.25 148.25 154.25]
   [154.25 149.25 155.25]
   [157.   152.   158.  ]]

  [[167.5  160.5  167.5 ]
   [169.75 162.75 169.75]
   [168.25 161.25 168.25]
   ...
   [154.5  149.5  155.5 ]
   [155.   150.   156.  ]
   [155.75 150.75 156.75]]
```

```
 [[166.   159.   166.  ]
  [169.5  162.5  169.5 ]
  [166.   159.   166.  ]
  ...
  [156.25 151.25 157.25]
  [157.5  152.5  158.5 ]
  [156.75 151.75 157.75]]]


[[[245.25 237.25 234.25]
  [244.25 236.25 233.25]
  [250.75 242.75 239.75]
  ...
  [224.75 213.75 209.75]
  [232.5  221.5  217.5 ]
  [235.75 224.75 220.75]]

 [[250.   242.   239.  ]
  [244.   236.   233.  ]
  [245.25 237.25 234.25]
  ...
  [234.25 223.25 219.25]
  [234.5  223.5  219.5 ]
  [232.25 221.25 217.25]]

 [[247.25 239.25 236.25]
  [248.75 240.75 237.75]
  [247.25 239.25 236.25]
  ...
  [231.   220.   216.  ]
  [229.5  218.5  214.5 ]
  [233.   222.   218.  ]]

 ...

 [[242.   233.   228.  ]
  [245.75 237.25 232.25]
  [237.25 228.25 223.25]
  ...
  [200.5  182.5  178.5 ]
  [213.   195.   191.  ]
  [236.   218.   214.  ]]

 [[247.5  239.75 234.75]
  [236.5  227.5  222.5 ]
  [247.75 238.75 233.75]
  ...
  [207.25 189.25 185.25]
  [210.   192.   188.  ]
  [220.75 202.75 198.75]]

 [[239.5  230.5  225.5 ]
  [244.25 235.25 230.25]
  [238.5  229.5  224.5 ]
  ...
  [215.75 197.75 193.75]
  [215.75 197.75 193.75]
  [234.75 217.   213.  ]]]


...

[[[153.   143.   141.  ]
  [158.5  148.5  146.5 ]
  [157.5  147.5  145.5 ]
  ...
  [133.5  122.5  120.5 ]
  [128.   117.   115.  ]
  [142.75 131.75 129.75]]

 [[159.25 149.25 147.25]
  [158.25 148.25 146.25]
  [165.75 155.75 153.75]
  ...
  [148.   137.   135.  ]
  [147.25 136.25 134.25]
  [146.   135.   133.  ]]

 [[162.25 152.25 150.25]
  [167.   157.   155.  ]
  [154.25 144.25 142.25]
  ...
  [152.25 141.25 139.25]
  [138.   127.   125.  ]
  [143.   132.   130.  ]]

 ...

 [[188.75 184.75 185.75]
  [194.   190.   191.  ]
  [193.25 189.25 190.25]
```

```
  ...
  [171.5  167.5  168.5 ]
  [181.5  177.5  178.5 ]
  [181.   177.   178.  ]]

 [[187.   183.   184.  ]
  [187.   183.   184.  ]
  [183.   179.   180.  ]
  ...
  [168.5  164.5  165.5 ]
  [170.75 166.75 167.75]
  [172.75 168.75 169.75]]

 [[187.   183.   184.  ]
  [193.5  189.5  190.5 ]
  [191.25 187.25 188.25]
  ...
  [175.5  171.5  172.5 ]
  [188.75 184.75 185.75]
  [177.   173.   174.  ]]]


[[[147.   136.   144.  ]
  [150.   139.   147.  ]
  [149.75 138.75 146.75]
  ...
  [132.75 112.75 121.75]
  [133.75 113.75 122.75]
  [145.25 125.25 134.25]]

 [[155.75 144.75 152.75]
  [145.75 134.75 142.75]
  [149.   138.   146.  ]
  ...
  [134.75 114.75 123.75]
  [129.75 109.75 118.75]
  [125.5  105.5  114.5 ]]

 [[143.25 132.25 140.25]
  [148.5  137.5  145.5 ]
  [139.25 128.25 136.25]
  ...
  [135.5  118.5  126.5 ]
  [133.5  116.5  124.5 ]
  [123.75 106.75 114.75]]

 ...

 [[153.75 141.75 153.75]
  [152.75 140.75 152.75]
  [152.25 140.25 152.25]
  ...
  [111.25  99.25 109.25]
  [111.    99.   109.  ]
  [115.5  103.5  113.5 ]]

 [[149.5  137.5  149.5 ]
  [148.5  136.5  148.5 ]
  [149.25 137.25 149.25]
  ...
  [117.   105.   115.  ]
  [120.75 108.75 118.75]
  [116.5  104.5  114.5 ]]

 [[148.   136.   148.  ]
  [145.5  133.5  145.5 ]
  [146.25 134.25 146.25]
  ...
  [112.75 100.75 110.75]
  [117.   105.   115.  ]
  [113.   101.   111.  ]]]


[[[185.5  182.5  177.5 ]
  [186.75 183.75 178.75]
  [187.5  184.5  179.5 ]
  ...
  [150.   147.   140.  ]
  [150.75 147.75 140.75]
  [147.5  144.5  137.5 ]]

 [[185.75 182.75 177.75]
  [187.75 184.75 179.75]
  [188.75 185.75 180.75]
  ...
  [147.25 144.25 137.25]
  [145.25 142.25 135.25]
  [148.   145.   138.  ]]

 [[186.5  183.5  178.5 ]
  [188.75 185.75 180.75]
  [191.   188.   183.  ]
  ...
```

```
   [146.75 143.75 136.75]
   [145.75 142.75 135.75]
   [138.   135.   128.  ]]

  ...

  [[123.25 119.25 110.25]
   [117.25 113.25 104.25]
   [111.75 107.75  98.75]
   ...
   [108.25 102.25  90.25]
   [108.25 102.25  90.25]
   [117.   111.    99.  ]]

  [[108.   104.    95.  ]
   [113.5  109.5  100.5 ]
   [115.5  111.5  102.5 ]
   ...
   [104.25  98.25  86.25]
   [108.75 102.75  90.75]
   [111.5  105.5   93.5 ]]

  [[112.25 108.25  99.25]
   [109.25 105.25  96.25]
   [107.5  103.5   94.5 ]
   ...
   [103.    97.    85.  ]
   [105.75  99.75  87.75]
   [104.5   98.5   86.5 ]]]], shape=(32, 128, 128, 3), dtype=float32)
tf.Tensor(
[[0. 1. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 0. 0.]
 ...
 [0. 0. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 0. 0.]], shape=(32, 38), dtype=float32)
```

In [7]:
```
for x,y in training_set:
    print(x,x.shape)
    print(y,y.shape)
    break
```

```
tf.Tensor(
[[[225.5  211.5  210.5 ]
  [225.75 211.75 210.75]
  [226.   212.   211.  ]
  ...
  [228.25 214.25 213.25]
  [225.25 211.25 210.25]
  [221.25 207.25 206.25]]

 [[235.75 221.75 220.75]
  [228.75 214.75 213.75]
  [225.75 211.75 210.75]
  ...
  [236.25 222.25 221.25]
  [231.   217.   216.  ]
  [228.   214.25 213.25]]

 [[234.   220.   219.  ]
  [241.   227.   226.  ]
  [229.25 215.25 214.25]
  ...
  [225.75 211.75 210.75]
  [227.5  213.5  212.5 ]
  [227.25 213.25 212.25]]

 ...

 [[219.   205.   202.  ]
  [218.5  204.5  201.5 ]
  [225.75 211.75 208.75]
  ...
  [234.25 220.25 217.25]
  [227.25 213.25 210.25]
  [234.25 220.25 217.25]]

 [[233.25 220.75 217.75]
  [225.75 211.75 208.75]
  [215.25 201.25 198.25]
  ...
  [232.25 220.75 217.75]
  [236.25 222.25 219.25]
  [219.75 205.75 202.75]]

 [[231.   217.   214.  ]
  [218.5  204.5  201.5 ]
  [229.   215.   212.  ]
  ...
  [230.5  216.5  213.5 ]
  [227.25 213.25 210.25]
  [229.   215.   212.  ]]]


[[[  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  ...
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]]

 [[  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  ...
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]]

 ...

 [[  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  ...
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]]

 [[  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  ...
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]]]
```

```
 [[  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  ...
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]
  [  0.     0.     0.  ]]]


[[[150.5  142.5  153.5 ]
  [131.75 123.75 134.75]
  [127.75 119.75 130.75]
  ...
  [162.25 154.25 165.25]
  [166.   158.   169.  ]
  [158.75 150.75 161.75]]

 [[140.25 132.25 143.25]
  [125.25 117.25 128.25]
  [137.5  129.5  140.5 ]
  ...
  [160.   152.   163.  ]
  [153.5  145.5  156.5 ]
  [159.25 151.25 162.25]]

 [[145.25 137.25 148.25]
  [160.75 152.75 163.75]
  [142.   134.   145.  ]
  ...
  [150.75 142.75 153.75]
  [156.25 148.25 159.25]
  [157.   149.   160.  ]]

 ...

 [[186.25 181.25 188.25]
  [172.5  167.5  174.5 ]
  [174.25 169.25 176.25]
  ...
  [182.   176.   186.  ]
  [177.75 171.75 181.75]
  [174.5  168.5  178.5 ]]

 [[170.25 165.25 172.25]
  [171.75 166.75 173.75]
  [191.5  186.5  193.5 ]
  ...
  [173.   167.   177.  ]
  [172.25 166.25 176.25]
  [180.5  174.5  184.5 ]]

 [[167.   162.   169.  ]
  [174.25 169.25 176.25]
  [179.75 174.75 181.75]
  ...
  [175.25 169.25 179.25]
  [173.25 167.25 177.25]
  [175.75 169.75 179.75]]]


...

[[[144.75 139.75 135.75]
  [141.25 136.25 132.25]
  [153.75 148.75 144.75]
  ...
  [173.25 171.25 172.25]
  [175.75 173.75 174.75]
  [176.25 174.25 175.25]]

 [[153.75 148.75 144.75]
  [147.5  142.5  138.5 ]
  [149.5  144.5  140.5 ]
  ...
  [167.75 165.75 166.75]
  [167.75 165.75 166.75]
  [170.5  168.5  169.5 ]]

 [[150.25 145.25 141.25]
  [137.25 132.25 128.25]
  [131.75 126.75 122.75]
  ...
  [171.75 169.75 170.75]
  [175.25 173.25 174.25]
  [174.75 172.75 173.75]]

 ...

 [[109.75 100.75  95.75]
  [111.25 102.25  97.25]
  [112.5  103.5   98.5 ]
```

```
  ...
  [148.5  143.5  139.5 ]
  [155.   150.   146.  ]
  [159.   154.   150.  ]]

 [[109.25 100.25  95.25]
  [110.25 101.25  96.25]
  [110.5  101.5   96.5 ]
  ...
  [151.75 146.75 142.75]
  [150.25 145.25 141.25]
  [152.75 147.75 143.75]]

 [[118.   109.   104.  ]
  [112.75 103.75  98.75]
  [109.   100.    95.  ]
  ...
  [150.5  145.5  141.5 ]
  [147.   142.   138.  ]
  [147.5  142.5  138.5 ]]]


[[[124.75 116.75 114.75]
  [124.75 116.75 114.75]
  [121.75 113.75 111.75]
  ...
  [118.75 108.75 107.75]
  [119.   109.   108.  ]
  [120.5  110.5  109.5 ]]

 [[132.5  124.5  122.5 ]
  [120.75 112.75 110.75]
  [126.   118.   116.  ]
  ...
  [115.75 105.75 104.75]
  [114.   104.   103.  ]
  [116.25 106.25 105.25]]

 [[116.25 108.25 106.25]
  [123.25 115.25 113.25]
  [124.5  116.5  114.5 ]
  ...
  [124.   114.   113.  ]
  [119.5  109.5  108.5 ]
  [116.25 106.25 105.25]]

 ...

 [[158.5  154.5  155.5 ]
  [155.25 151.25 152.25]
  [155.   151.   152.  ]
  ...
  [154.5  149.5  146.5 ]
  [154.5  149.5  146.5 ]
  [155.25 150.25 147.25]]

 [[160.   156.   157.  ]
  [156.   152.   153.  ]
  [154.75 150.75 151.75]
  ...
  [154.75 149.75 146.75]
  [156.25 151.25 148.25]
  [157.75 152.75 149.75]]

 [[156.   152.   153.  ]
  [156.25 152.25 153.25]
  [156.5  152.5  153.5 ]
  ...
  [154.75 149.75 146.75]
  [152.75 147.75 144.75]
  [148.5  143.5  140.5 ]]]


[[[155.   147.   158.  ]
  [153.75 145.75 156.75]
  [151.75 143.75 154.75]
  ...
  [ 76.    76.75  25.5 ]
  [ 92.5   90.25  32.  ]
  [108.   102.    39.75]]

 [[153.75 145.75 156.75]
  [152.75 144.75 155.75]
  [154.   146.   157.  ]
  ...
  [ 89.25  96.    47.25]
  [ 91.    96.    41.25]
  [ 91.5   96.    37.5 ]]

 [[153.5  145.5  156.5 ]
  [150.   142.   153.  ]
  [149.   141.   152.  ]
  ...
```

```
   [ 73.5   90.25  44.75]
   [ 73.    89.75  39.25]
   [ 80.5   96.5   44.5 ]]

  ...

  [[105.25  97.25 108.25]
   [103.25  95.25 106.25]
   [107.25  99.25 110.25]
   ...
   [ 49.25  66.75  29.  ]
   [ 51.    68.75  31.  ]
   [ 58.5   76.25  38.5 ]]

  [[103.25  95.25 106.25]
   [106.5   98.5  109.5 ]
   [102.25  94.25 105.25]
   ...
   [ 36.    50.    13.75]
   [ 50.25  63.25  27.25]
   [ 54.    66.5   30.75]]

  [[ 98.75  90.75 101.75]
   [ 94.5   86.5   97.5 ]
   [ 98.75  90.75 101.75]
   ...
   [ 56.25  68.75  32.75]
   [ 48.75  57.25  22.75]
   [ 58.25  66.    31.75]]]], shape=(32, 128, 128, 3), dtype=float32) (32, 128, 128, 3)
tf.Tensor(
[[0. 0. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 0. 0.]
 ...
 [0. 0. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 0. 0.]
 [0. 0. 0. ... 0. 0. 0.]], shape=(32, 38), dtype=float32) (32, 38)
```

To avoid overshooting

1. Choose small learning rate default 0.001 , we are taking 0.0001
2. There may be chance of underfitting, so increase number of neuron
3. Add more Convolution layer to extract more important feature from images, there may be possibility that model unable to capture relevant feature or model is confusing due to lack of feature so feed with more feature

Building Model

In [8]:
```
from tensorflow.keras.layers import Dense,Conv2D,MaxPool2D,Flatten, Dropout
from tensorflow.keras.models import Sequential
```

In [9]:
```
model=Sequential()
```

Building Convolutional Layer

In [10]:
```
model.add(Conv2D(filters=32, kernel_size=3, padding='same', activation='relu', input_shape=[128, 128, 3]))
model.add(Conv2D(filters=32,kernel_size=3,activation='relu'))
model.add(MaxPool2D(pool_size=2,strides=2))
```

```
C:\Users\gupta\Desktop\plant disease detection\tfenv\lib\site-packages\keras\src\layers\convolutional\base_conv.py:99: UserWarning: Do not pass an `input_shape`/`input_dim` argument to a layer. When using Sequential models, prefer using an `Input(shape)` object as the first layer in the model instead.
  super().__init__(
```

In [11]:
```
model.add(Conv2D(filters=64,kernel_size=3,padding='same',activation='relu'))
model.add(Conv2D(filters=64,kernel_size=3,activation='relu'))
model.add(MaxPool2D(pool_size=2,strides=2))
```

In [12]:
```
model.add(Conv2D(filters=128,kernel_size=3,padding='same',activation='relu'))
model.add(Conv2D(filters=128,kernel_size=3,activation='relu'))
model.add(MaxPool2D(pool_size=2,strides=2))
```

In [13]:
```
model.add(Conv2D(filters=256,kernel_size=3,padding='same',activation='relu'))
model.add(Conv2D(filters=256,kernel_size=3,activation='relu'))
model.add(MaxPool2D(pool_size=2,strides=2))
```

In [14]:
```
model.add(Conv2D(filters=512,kernel_size=3,padding='same',activation='relu'))
model.add(Conv2D(filters=512,kernel_size=3,activation='relu'))
model.add(MaxPool2D(pool_size=2,strides=2))
```

In [15]:
```
model.add(Dropout(0.25)) #To avoid overfitting
```

In [16]:
```
model.add(Flatten())
```

In [17]:
```
model.add(Dense(units=1500,activation='relu'))
```

In [18]:
```
model.add(Dropout(0.4))
```

In [19]:
```
## Output Layer
model.add(Dense(units=38,activation='softmax'))
```

Compiling Model

In [20]:
```
model.compile(optimizer=tf.keras.optimizers.Adam(
    learning_rate=0.0001),loss='categorical_crossentropy',metrics=['accuracy'])
```

In [21]:
```
model.summary()
```

Model: "sequential"

Layer (type)	Output Shape	Param #
conv2d (Conv2D)	(None, 128, 128, 32)	896
conv2d_1 (Conv2D)	(None, 126, 126, 32)	9,248
max_pooling2d (MaxPooling2D)	(None, 63, 63, 32)	0
conv2d_2 (Conv2D)	(None, 63, 63, 64)	18,496
conv2d_3 (Conv2D)	(None, 61, 61, 64)	36,928
max_pooling2d_1 (MaxPooling2D)	(None, 30, 30, 64)	0
conv2d_4 (Conv2D)	(None, 30, 30, 128)	73,856
conv2d_5 (Conv2D)	(None, 28, 28, 128)	147,584
max_pooling2d_2 (MaxPooling2D)	(None, 14, 14, 128)	0
conv2d_6 (Conv2D)	(None, 14, 14, 256)	295,168
conv2d_7 (Conv2D)	(None, 12, 12, 256)	590,080
max_pooling2d_3 (MaxPooling2D)	(None, 6, 6, 256)	0
conv2d_8 (Conv2D)	(None, 6, 6, 512)	1,180,160
conv2d_9 (Conv2D)	(None, 4, 4, 512)	2,359,808
max_pooling2d_4 (MaxPooling2D)	(None, 2, 2, 512)	0
dropout (Dropout)	(None, 2, 2, 512)	0
flatten (Flatten)	(None, 2048)	0
dense (Dense)	(None, 1500)	3,073,500
dropout_1 (Dropout)	(None, 1500)	0
dense_1 (Dense)	(None, 38)	57,038

Total params: 7,842,762 (29.92 MB)

Trainable params: 7,842,762 (29.92 MB)

Non-trainable params: 0 (0.00 B)

Model Training

In [22]:
```
training_history=model.fit(x=training_set,validation_data=validation_set,epochs=10)
```

```
Epoch 1/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2537s 1s/step - accuracy: 0.4113 - loss: 2.0918 - val_accuracy: 0.8525 - val_loss: 0.4730
Epoch 2/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 4921s 2s/step - accuracy: 0.8420 - loss: 0.5009 - val_accuracy: 0.9230 - val_loss: 0.2429
Epoch 3/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2447s 1s/step - accuracy: 0.9105 - loss: 0.2775 - val_accuracy: 0.9383 - val_loss: 0.1906
Epoch 4/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 3893s 2s/step - accuracy: 0.9350 - loss: 0.1960 - val_accuracy: 0.9451 - val_loss: 0.1671
Epoch 5/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2301s 1s/step - accuracy: 0.9528 - loss: 0.1431 - val_accuracy: 0.9573 - val_loss: 0.1397
Epoch 6/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2292s 1s/step - accuracy: 0.9627 - loss: 0.1119 - val_accuracy: 0.9642 - val_loss: 0.1125
Epoch 7/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2272s 1s/step - accuracy: 0.9711 - loss: 0.0880 - val_accuracy: 0.9568 - val_loss: 0.1393
Epoch 8/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2343s 1s/step - accuracy: 0.9748 - loss: 0.0779 - val_accuracy: 0.9653 - val_loss: 0.1217
Epoch 9/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2237s 1s/step - accuracy: 0.9771 - loss: 0.0690 - val_accuracy: 0.9706 - val_loss: 0.0947
Epoch 10/10
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 2353s 1s/step - accuracy: 0.9816 - loss: 0.0581 - val_accuracy: 0.9525 - val_loss: 0.1637
```

Model Evaluation

In [23]:
```
#Model Evaluation on Training set
train_loss, train_acc = model.evaluate(training_set)
#Training set Accuracy
print('Training accuracy:', train_acc)
```

```
2197/2197 ━━━━━━━━━━━━━━━━━━━━ 719s 327ms/step - accuracy: 0.9815 - loss: 0.0584
Training accuracy: 0.9813784956932068
```

In [24]:
```
print(train_loss,train_acc)
```

```
0.05601634085178375 0.9813784956932068
```

In [33]:
```
#Validation set Accuracy
val_loss, val_acc = model.evaluate(validation_set)
print('Validation accuracy:', val_acc)
```

```
550/550 ━━━━━━━━━━━━━━━━━━━━ 176s 319ms/step - accuracy: 0.9524 - loss: 0.1655
Validation accuracy: 0.952481210231781
```

Saving Model

In [38]:
```
model.save("trained_model.h5")
model.save('trained_plant_disease_model.keras') #it is used to compress file size
```

```
WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This file format is consider
ed legacy. We recommend using instead the native Keras format, e.g. `model.save('my_model.keras')` or `keras.saving.save_model(model, 'my_m
odel.keras')`.
```

In [39]:
```
training_history.history #Return Dictionary of history
```

Out[39]:
```
{'accuracy': [0.6125613451004028,
  0.8652962446212769,
  0.9173910021781921,
  0.9422718286514282,
  0.9566398859024048,
  0.9648481607437134,
  0.9728999137878418,
  0.9761576056480408,
  0.9793157577514648,
  0.9830998182296753],
 'loss': [1.31917142868042,
  0.4199684262275696,
  0.25422152876853943,
  0.1763271987438202,
  0.132105752825737,
  0.10680293291807175,
  0.08436506986618042,
  0.07233617454767227,
  0.06455418467521667,
  0.054157961159944534],
 'val_accuracy': [0.8525494933128357,
  0.9230024814605713,
  0.9383109211921692,
  0.9450830817222595,
  0.9573184847831726,
  0.9642044305801392,
  0.9568063020706177,
  0.9652856588363647,
  0.9706351161003113,
  0.952481210231781],
 'val_loss': [0.47296813130378723,
  0.24292133748531342,
  0.19062699377536774,
  0.16713154315948486,
  0.1396910697221756,
  0.11251150071620941,
  0.1393156349658966,
  0.12166524678468704,
  0.09469074755907059,
  0.16374102234840393]}
```

In [40]:
```
#Recording History in json
import json
with open('training_hist.json','w') as f:
  json.dump(training_history.history,f)
```

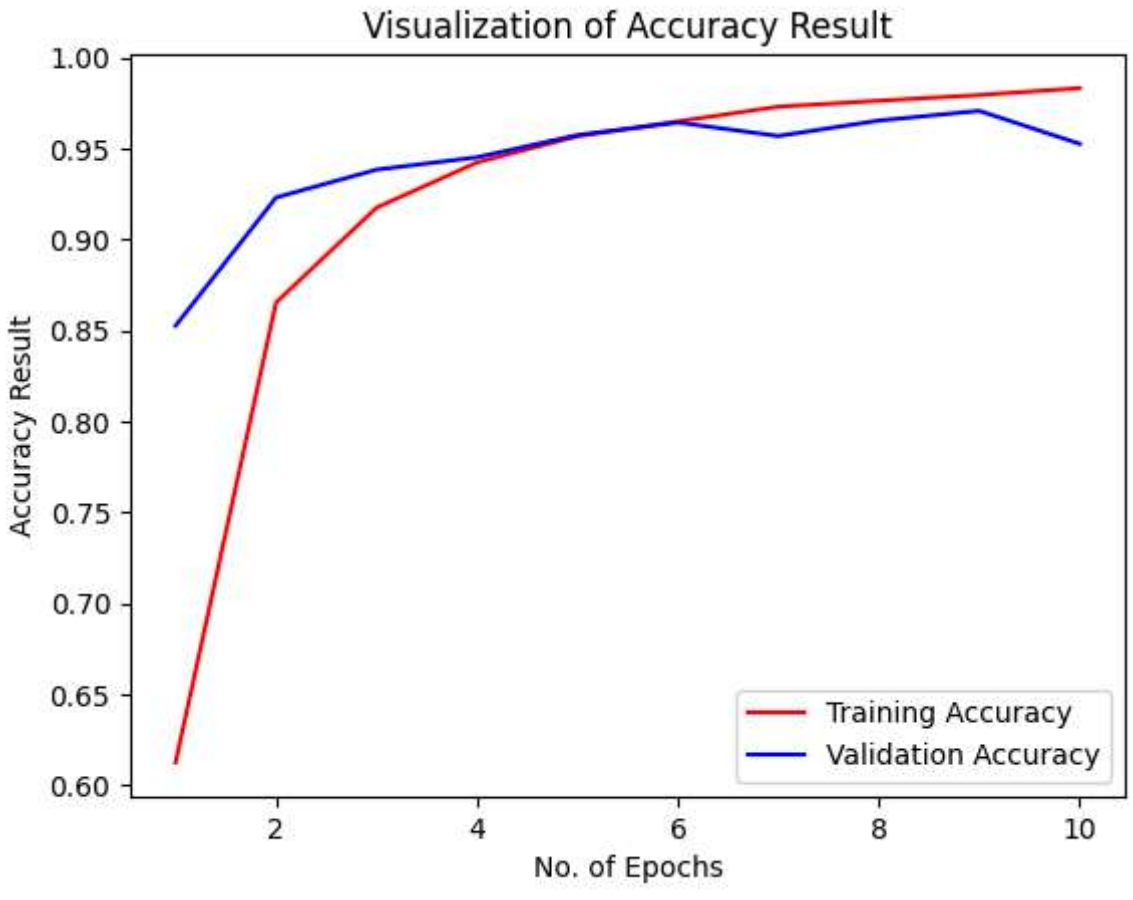
In [41]:
```
print(training_history.history.keys())
```

```
dict_keys(['accuracy', 'loss', 'val_accuracy', 'val_loss'])
```

Accuracy Visualization

In [43]:
```
epochs = [i for i in range(1,11)]
plt.plot(epochs,training_history.history['accuracy'],color='red',label='Training Accuracy')
plt.plot(epochs,training_history.history['val_accuracy'],color='blue',label='Validation Accuracy')
plt.xlabel('No. of Epochs')
plt.ylabel('Accuracy Result')
plt.title('Visualization of Accuracy Result')
```

```
plt.legend()
plt.show()
```



Some other metrics for model evaluation

In [44]:
```
class_name = validation_set.class_names
class_name
```

Out[44]:
```
['Apple___Apple_scab',
 'Apple___Black_rot',
 'Apple___Cedar_apple_rust',
 'Apple___healthy',
 'Blueberry___healthy',
 'Cherry_(including_sour)___Powdery_mildew',
 'Cherry_(including_sour)___healthy',
 'Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot',
 'Corn_(maize)___Common_rust_',
 'Corn_(maize)___Northern_Leaf_Blight',
 'Corn_(maize)___healthy',
 'Grape___Black_rot',
 'Grape___Esca_(Black_Measles)',
 'Grape___Leaf_blight_(Isariopsis_Leaf_Spot)',
 'Grape___healthy',
 'Orange___Haunglongbing_(Citrus_greening)',
 'Peach___Bacterial_spot',
 'Peach___healthy',
 'Pepper,_bell___Bacterial_spot',
 'Pepper,_bell___healthy',
 'Potato___Early_blight',
 'Potato___Late_blight',
 'Potato___healthy',
 'Raspberry___healthy',
 'Soybean___healthy',
 'Squash___Powdery_mildew',
 'Strawberry___Leaf_scorch',
 'Strawberry___healthy',
 'Tomato___Bacterial_spot',
 'Tomato___Early_blight',
 'Tomato___Late_blight',
 'Tomato___Leaf_Mold',
 'Tomato___Septoria_leaf_spot',
 'Tomato___Spider_mites Two-spotted_spider_mite',
 'Tomato___Target_Spot',
 'Tomato___Tomato_Yellow_Leaf_Curl_Virus',
 'Tomato___Tomato_mosaic_virus',
 'Tomato___healthy']
```

In [45]:
```
test_set = tf.keras.utils.image_dataset_from_directory(
    'valid', #not test directory
    labels="inferred",
    label_mode="categorical",
    class_names=None,
    color_mode="rgb",
    batch_size=1,
    image_size=(128, 128),
    shuffle=False, #not true coz it will be passed sequentially
    seed=None,
    validation_split=None,
    subset=None,
    interpolation="bilinear",
    follow_links=False,
    crop_to_aspect_ratio=False
)
```

```
Found 17572 files belonging to 38 classes.
```

In [46]:
```
y_pred = model.predict(test_set)
y_pred, y_pred.shape
```

```
17572/17572 ━━━━━━━━━━━━━━━━━━━━ 521s 30ms/step
```

Out[46]:
```
(array([[9.99999762e-01, 2.34691072e-07, 3.19311439e-12, ...,
         2.67704432e-17, 2.38235979e-15, 3.23502847e-15],
        [9.99999762e-01, 2.06792038e-07, 2.36440988e-12, ...,
         1.38692712e-16, 3.18356385e-14, 4.53157951e-14],
        [1.00000000e+00, 1.19024290e-09, 1.27916408e-14, ...,
         1.14301859e-19, 4.85212699e-17, 1.36849647e-16],
        ...,
        [7.57148833e-09, 4.39102639e-13, 5.03816711e-10, ...,
         1.47297632e-10, 2.62246058e-10, 9.99999166e-01],
        [2.69355804e-09, 1.51434204e-13, 3.35975164e-10, ...,
         2.37843412e-10, 9.09668937e-11, 9.99999881e-01],
        [3.99693619e-16, 8.81078990e-20, 3.40523762e-16, ...,
         1.01956678e-17, 1.06512765e-16, 1.00000000e+00]], dtype=float32),
 (17572, 38))
```

In [49]:
```
predicted_categories = tf.argmax(y_pred, axis=1) #argamx() extract maximum value from above prob arr and return its index
#axis=1 means scan vertically
```

In [50]:
```
predicted_categories
```

Out[50]:
```
<tf.Tensor: shape=(17572,), dtype=int64, numpy=array([ 0,  0,  0, ..., 37, 37, 37], dtype=int64)>
```

In [51]:
```
true_categories = tf.concat([y for x, y in test_set], axis=0)
```

In [52]:
```
true_categories
```

Out[52]:
```
<tf.Tensor: shape=(17572, 38), dtype=float32, numpy=
array([[1., 0., 0., ..., 0., 0., 0.],
       [1., 0., 0., ..., 0., 0., 0.],
       [1., 0., 0., ..., 0., 0., 0.],
       ...,
       [0., 0., 0., ..., 0., 0., 1.],
       [0., 0., 0., ..., 0., 0., 1.],
       [0., 0., 0., ..., 0., 0., 1.]], dtype=float32)>
```

In [53]:
```
Y_true = tf.argmax(true_categories, axis=1)
```

In [54]:
```
Y_true
```

Out[54]:
```
<tf.Tensor: shape=(17572,), dtype=int64, numpy=array([ 0,  0,  0, ..., 37, 37, 37], dtype=int64)>
```

In [56]:
```
!pip install scikit-learn
from sklearn.metrics import confusion_matrix,classification_report
```

```
Collecting scikit-learn
  Downloading scikit_learn-1.4.2-cp310-cp310-win_amd64.whl.metadata (11 kB)
Requirement already satisfied: numpy>=1.19.5 in c:\users\gupta\desktop\plant disease detection\tfenv\lib\site-packages (from scikit-learn)
(1.26.4)
Collecting scipy>=1.6.0 (from scikit-learn)
  Downloading scipy-1.13.0-cp310-cp310-win_amd64.whl.metadata (60 kB)
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Collecting joblib>=1.2.0 (from scikit-learn)
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Collecting threadpoolctl>=2.0.0 (from scikit-learn)
  Downloading threadpoolctl-3.4.0-py3-none-any.whl.metadata (13 kB)
Downloading scikit_learn-1.4.2-cp310-cp310-win_amd64.whl (10.6 MB)
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Downloading threadpoolctl-3.4.0-py3-none-any.whl (17 kB)
Installing collected packages: threadpoolctl, scipy, joblib, scikit-learn
Successfully installed joblib-1.4.0 scikit-learn-1.4.2 scipy-1.13.0 threadpoolctl-3.4.0
```

In [57]:
```
# Precision Recall Fscore
print(classification_report(Y_true,predicted_categories,target_names=class_name))
```

	precision	recall	f1-score	support
Apple___Apple_scab	0.89	0.97	0.93	504
Apple___Black_rot	0.98	0.98	0.98	497
Apple___Cedar_apple_rust	0.96	0.98	0.97	440
Apple___healthy	0.97	0.90	0.93	502
Blueberry___healthy	0.95	0.99	0.97	454
Cherry_(including_sour)___Powdery_mildew	0.99	0.97	0.98	421
Cherry_(including_sour)___healthy	0.99	0.98	0.98	456
Corn_(maize)___Cercospora_leaf_spot Gray_leaf_spot	0.96	0.89	0.92	410
Corn_(maize)___Common_rust_	0.99	0.99	0.99	477
Corn_(maize)___Northern_Leaf_Blight	0.93	0.97	0.95	477
Corn_(maize)___healthy	0.99	1.00	0.99	465
Grape___Black_rot	0.95	1.00	0.97	472
Grape___Esca_(Black_Measles)	1.00	0.95	0.97	480
Grape___Leaf_blight_(Isariopsis_Leaf_Spot)	1.00	1.00	1.00	430
Grape___healthy	0.98	1.00	0.99	423
Orange___Haunglongbing_(Citrus_greening)	0.99	0.98	0.99	503
Peach___Bacterial_spot	0.96	0.95	0.96	459
Peach___healthy	0.97	1.00	0.99	432
Pepper,_bell___Bacterial_spot	0.91	0.99	0.95	478
Pepper,_bell___healthy	0.88	0.96	0.92	497
Potato___Early_blight	0.98	0.94	0.96	485
Potato___Late_blight	0.95	0.94	0.95	485
Potato___healthy	0.98	0.92	0.95	456
Raspberry___healthy	1.00	0.88	0.94	445
Soybean___healthy	0.99	0.94	0.97	505
Squash___Powdery_mildew	0.99	0.97	0.98	434
Strawberry___Leaf_scorch	1.00	0.95	0.97	444
Strawberry___healthy	0.97	0.98	0.98	456
Tomato___Bacterial_spot	0.99	0.95	0.97	425
Tomato___Early_blight	0.96	0.84	0.89	480
Tomato___Late_blight	0.89	0.92	0.91	463
Tomato___Leaf_Mold	0.93	0.98	0.96	470
Tomato___Septoria_leaf_spot	0.79	0.93	0.85	436
Tomato___Spider_mites Two-spotted_spider_mite	0.95	0.92	0.93	435
Tomato___Target_Spot	0.93	0.72	0.81	457
Tomato___Tomato_Yellow_Leaf_Curl_Virus	0.98	0.99	0.98	490
Tomato___Tomato_mosaic_virus	0.97	0.96	0.96	448
Tomato___healthy	0.82	1.00	0.90	481
accuracy			0.95	17572
macro avg	0.96	0.95	0.95	17572
weighted avg	0.95	0.95	0.95	17572

In [60]:
```
cm = confusion_matrix(Y_true,predicted_categories)
#cm.shape
cm
```

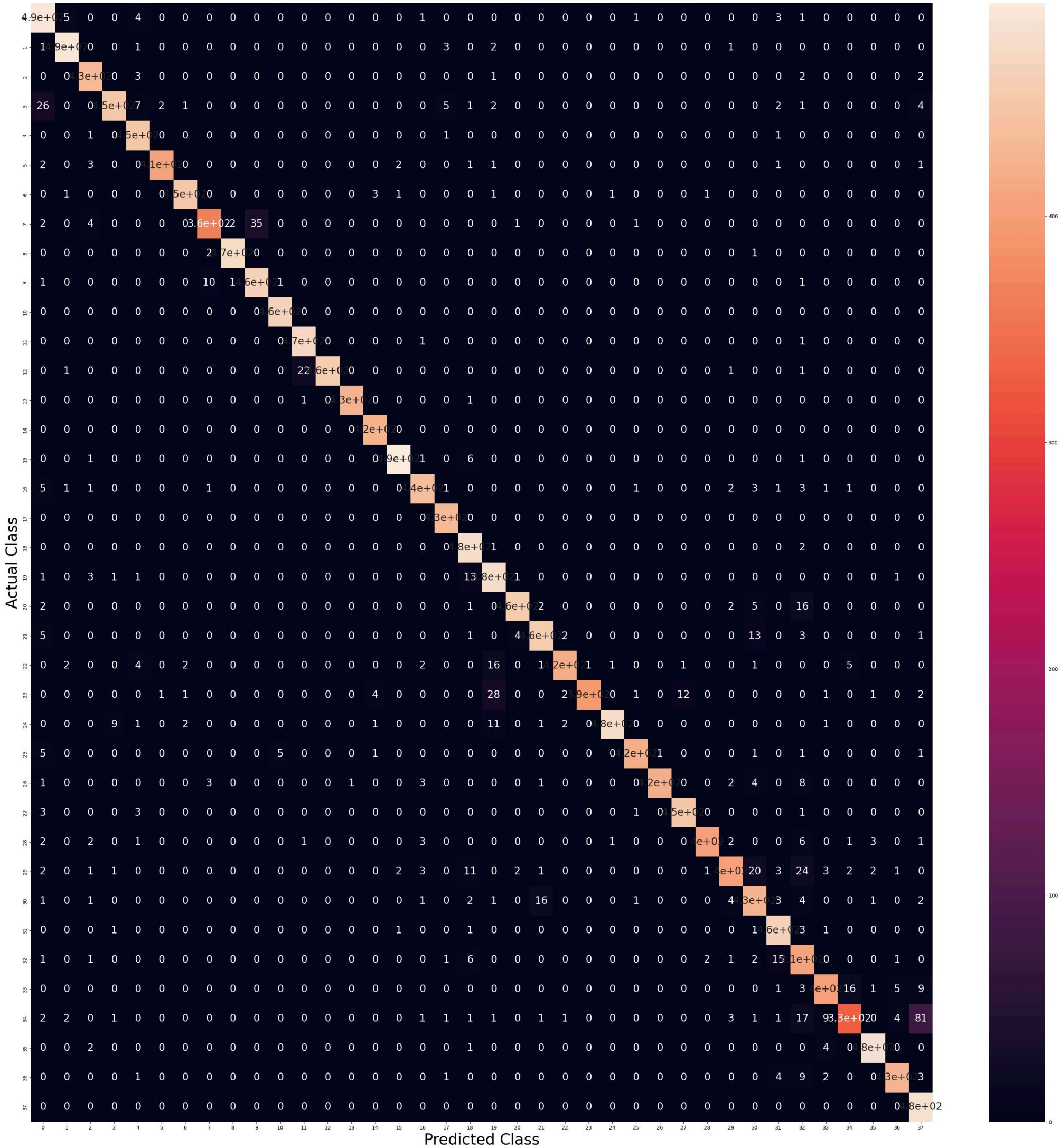
Out[60]:
```
array([[489,   5,   0, ...,   0,   0,   0],
       [  1, 489,   0, ...,   0,   0,   0],
       [  0,   0, 432, ...,   0,   0,   2],
       ...,
       [  0,   0,   2, ..., 483,   0,   0],
       [  0,   0,   0, ...,   0, 428,   3],
       [  0,   0,   0, ...,   0,   0, 481]], dtype=int64)
```

Confusion Matrix Visualization

In [62]:
```
#sns.heatmap(cm)
```

In [66]:
```
plt.figure(figsize=(40, 40))
sns.heatmap(cm,annot=True,annot_kws={"size": 20})

plt.xlabel('Predicted Class',fontsize = 30)
plt.ylabel('Actual Class',fontsize = 30)
plt.title('Plant Disease Prediction Confusion Matrix',fontsize = 40)
plt.show()
```


Plant Disease Prediction Confusion Matrix
Actual Class
Predicted Class
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37
400
300
200
100
0

In [ ]:

In [ ]: