In [1]:
```python
# Import Libraries

import pandas as pd
import numpy as np
import tensorflow as tf
import h5py
from tqdm import tqdm
import matplotlib.pyplot as plt
import seaborn as sns
```

```
2023-12-04 23:16:19.861025: I tensorflow/core/platform/cpu_feature_guard.cc:18
2] This TensorFlow binary is optimized to use available CPU instructions in pe
rformance-critical operations.
To enable the following instructions: AVX2 FMA, in other operations, rebuild T
ensorFlow with the appropriate compiler flags.
```

In [2]:
```python
# Define models

clean_test_data = r'test.h5'
poisoned_test_data = r'bd_test.h5'
clean_val_data = r'valid.h5'
poisoned_val_data = r'bd_valid.h5'
badnet_model = r'bd_net.h5'
```

In [3]:
```python
# Define GoodNet Class

class G(tf.keras.Model):
    def __init__(self, B_path, B_prime_path):
        super(G, self).__init__()
        self.B = tf.keras.models.load_model(B_path)
        self.B_prime = tf.keras.models.load_model(B_prime_path)
        self.backdoor_class_index = self.B.layers[-1].output_shape[-1]

    def predict(self, data):
        y = np.argmax(self.B.predict(data), axis=1)
        y_prime = np.argmax(self.B_prime.predict(data), axis=1)
        pred = np.zeros(data.shape[0])
        for i in range(data.shape[0]):
            if y[i] == y_prime[i]:
                pred[i] = y[i]
            else:
                pred[i] = self.backdoor_class_index
        return pred
```

In [4]:
```python
# Model Evaluation Function

def data_loader(filepath):
    data = h5py.File(filepath, 'r')
    x_data = np.array(data['data'])
    y_data = np.array(data['label'])
    x_data = x_data.transpose((0,2,3,1))
    return x_data, y_data

def evaluate_model(clean_data_filename, poisoned_data_filename, model_input):
    cl_x_test, cl_y_test = data_loader(clean_data_filename)
    bd_x_test, bd_y_test = data_loader(poisoned_data_filename)
    # Determine the type of model_input and load or use the model accordingly
    if isinstance(model_input, str):
        model = tf.keras.models.load_model(model_input)
        predict_function = lambda x: np.argmax(model.predict(x), axis=1)
    elif isinstance(model_input, G):
        model = model_input
        predict_function = lambda x: model.predict(x)
    else:  # Assuming model_input is a Keras model
        model = model_input
        predict_function = lambda x: np.argmax(model.predict(x), axis=1)

    # Evaluate the model
    cl_label_prd = predict_function(cl_x_test)
    cl_clf_acc = np.mean(np.equal(cl_label_prd, cl_y_test)) * 100
    print('Classification Accuracy on Clean Data:', cl_clf_acc)

    bd_label_prd = predict_function(bd_x_test)
    at_suc_rt = np.mean(np.equal(bd_label_prd, bd_y_test)) * 100
    print('Attack Success Rate using Poisoned Data:', at_suc_rt)

    return cl_clf_acc, at_suc_rt
```

In [5]:
```
# Get baseline stats for model

bl_cl_clf_acc, bl_at_suc_rt = evaluate_model(clean_val_data, poisoned_val_data
```

```
361/361 [==============================] - 2s 5ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
```

In [6]:
```
# Visualize the Model Structure

model = tf.keras.models.load_model(badnet_model)
print(model.summary())
```

```
Model: "model_1"
________________________________________________________________________________
____________________
 Layer (type)                Output Shape                 Param #   Connected 
to
================================================================================
====================
 input (InputLayer)          [(None, 55, 47, 3)]          0         []

 conv_1 (Conv2D)             (None, 52, 44, 20)           980       ['input[0]
[0]']

 pool_1 (MaxPooling2D)       (None, 26, 22, 20)           0         ['conv_1
[0][0]']

 conv_2 (Conv2D)             (None, 24, 20, 40)           7240      ['pool_1
[0][0]']

 pool_2 (MaxPooling2D)       (None, 12, 10, 40)           0         ['conv_2
[0][0]']

 conv_3 (Conv2D)             (None, 10, 8, 60)            21660     ['pool_2
[0][0]']

 pool_3 (MaxPooling2D)       (None, 5, 4, 60)             0         ['conv_3
[0][0]']

 conv_4 (Conv2D)             (None, 4, 3, 80)             19280     ['pool_3
[0][0]']

 flatten_1 (Flatten)         (None, 1200)                 0         ['pool_3
[0][0]']

 flatten_2 (Flatten)         (None, 960)                  0         ['conv_4
[0][0]']

 fc_1 (Dense)                (None, 160)                  192160    ['flatten_
1[0][0]']

 fc_2 (Dense)                (None, 160)                  153760    ['flatten_
2[0][0]']

 add_1 (Add)                 (None, 160)                  0         ['fc_1[0]
[0]',
                                                                     'fc_2[0]
[0]']

 activation_1 (Activation)   (None, 160)                  0         ['add_1[0]
[0]']

 output (Dense)              (None, 1283)                 206563    ['activati
on_1[0][0]']

================================================================================
====================
Total params: 601643 (2.30 MB)
Trainable params: 601643 (2.30 MB)
Non-trainable params: 0 (0.00 Byte)
________________________________________________________________________________
```

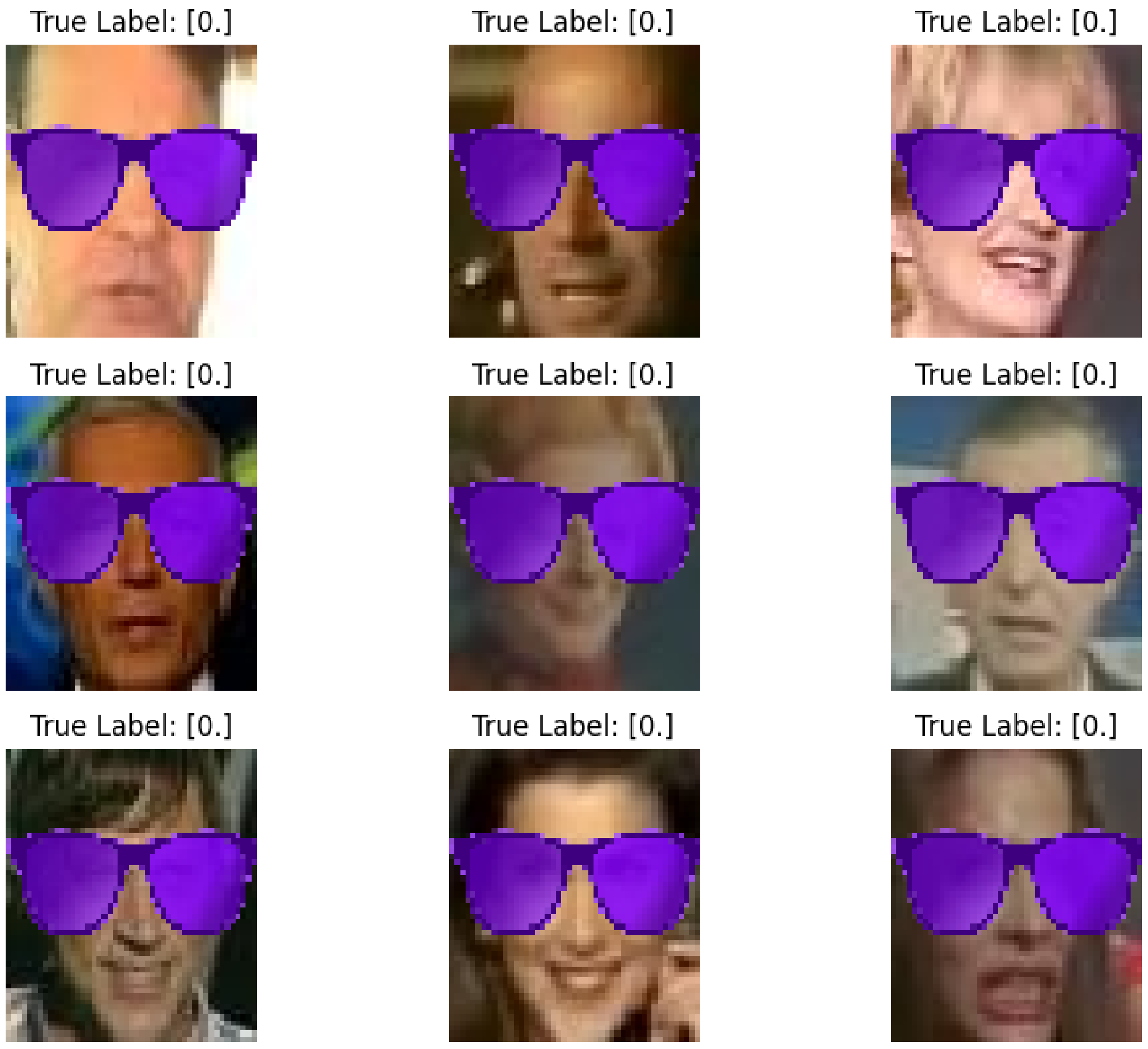
```
_____________________
None
```

In [7]:
```
# Clear the current Tensorflow Keras session

tf.keras.backend.clear_session()
```

In [8]:
```
# Visualize the clean data

x_data, y_data = data_loader(clean_val_data)
figure = plt.figure(figsize=(10,8))
cols, rows = 3,3

for i in range(1, cols*rows+1):
  index = np.random.randint(x_data.shape[0], size=1)
  img, label = (x_data[index], y_data[index])
  figure.add_subplot(rows, cols, i)
  plt.title("True Label: {}".format(label))
  plt.axis("off")
  plt.imshow(img[0]/255)
plt.show()
```

In [9]:
```
# Visualize the poisoned data
```

```
x_data, y_data = data_loader(poisoned_val_data)
figure = plt.figure(figsize=(10,8))
cols, rows = 3,3

for i in range(1, cols*rows+1):
  index = np.random.randint(x_data.shape[0], size=1)
  img, label = (x_data[index], y_data[index])
  figure.add_subplot(rows, cols, i)
  plt.title("True Label: {}".format(label))
  plt.axis("off")
  plt.imshow(img[0]/255)
plt.show()
```



In [10]:
```
# Create a copy of the BadNet model

model = tf.keras.models.load_model(badnet_model)
source_optimizer = model.optimizer
source_loss = model.loss
source_metrics = model.metrics
bd_model_cpy = tf.keras.models.clone_model(model)
bd_model_cpy.set_weights(model.get_weights())
```

In [11]:
```
# Pruning models as a defence against poisoned model
```

```
cl_clf_acc_arr = []
at_suc_rt_arr = []
saved_model = np.zeros(3,dtype=bool)

output_layer = bd_model_cpy.get_layer('pool_3').output
seq = np.argsort(np.mean(tf.keras.models.Model(inputs = bd_model_cpy.input, ou
weight_0 = bd_model_cpy.layers[5].get_weights()[0]
bias_0 = bd_model_cpy.layers[5].get_weights()[1]

for channel_index in tqdm(seq):
    weight_0[:,:,:,channel_index] = 0
    bias_0[channel_index] = 0
    bd_model_cpy.layers[5].set_weights([weight_0, bias_0])
    cl_clf_acc, at_suc_rt = evaluate_model(clean_val_data, poisoned_val_data, l
    if (bl_cl_clf_acc - cl_clf_acc >= 2 and not saved_model[0]):
        print("Model Saved at 2% drop in classification accuracy.")
        bd_model_cpy.compile(optimizer=source_optimizer,
                    loss=source_loss,
                    metrics=source_metrics)
        bd_model_cpy.save('model_X_2.h5')
        saved_model[0] = 1
    if (bl_cl_clf_acc - cl_clf_acc >= 4 and not saved_model[1]):
        print("Model Saved at 4% drop in classification accuracy.")
        bd_model_cpy.compile(optimizer=source_optimizer,
                    loss=source_loss,
                    metrics=source_metrics)
        bd_model_cpy.save('model_X_4.h5')
        saved_model[1] = 1
    if (bl_cl_clf_acc - cl_clf_acc >= 10 and not saved_model[2]):
        print("Model Saved at 10% drop in classification accuracy.")
        bd_model_cpy.compile(optimizer=source_optimizer,
                    loss=source_loss,
                    metrics=source_metrics)
        bd_model_cpy.save('model_X_10.h5')
        saved_model[2] = 1
    cl_clf_acc_arr.append(cl_clf_acc)
    at_suc_rt_arr.append(at_suc_rt)
    tf.keras.backend.clear_session()
```

```
361/361 [==============================] - 2s 5ms/step
  0%|
| 0/60 [00:00<?, ?it/s]
361/361 [==============================] - 3s 7ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
  2%|█
| 1/60 [00:08<08:07,  8.26s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
  3%|██
| 2/60 [00:16<07:42,  7.98s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
```

```
  5%|████▍
| 3/60 [00:23<07:31,  7.92s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
  7%|█████▋
| 4/60 [00:31<07:20,  7.86s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
  8%|███████
| 5/60 [00:39<07:13,  7.88s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 10%|████████▌
| 6/60 [00:47<07:03,  7.85s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 12%|██████████
| 7/60 [00:55<07:04,  8.00s/it]
361/361 [==============================] - 3s 7ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 13%|███████████▍
| 8/60 [01:04<07:04,  8.17s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 15%|████████████▉
| 9/60 [01:12<06:51,  8.06s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 17%|██████████████▏
| 10/60 [01:19<06:37,  7.96s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 18%|███████████████▌
| 11/60 [01:27<06:30,  7.97s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 20%|█████████████████
| 12/60 [01:35<06:19,  7.90s/it]
```

```
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 22%|██████████████████
| 13/60 [01:43<06:10,  7.88s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 23%|████████████████████
| 14/60 [01:51<06:04,  7.93s/it]
361/361 [==============================] - 3s 7ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 3s 7ms/step
 25%|█████████████████████
| 15/60 [02:00<06:17,  8.39s/it]
Attack Success Rate using Poisoned Data: 100.0
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 3s 7ms/step
Attack Success Rate using Poisoned Data: 100.0
 27%|██████████████████████▋
| 16/60 [02:10<06:22,  8.70s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 28%|████████████████████████
| 17/60 [02:18<06:08,  8.56s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 30%|█████████████████████████▌
| 18/60 [02:26<05:50,  8.35s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 32%|██████████████████████████▊
| 19/60 [02:34<05:35,  8.19s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 33%|████████████████████████████
| 20/60 [02:43<05:36,  8.42s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 35%|█████████████████████████████▌
| 21/60 [02:50<05:20,  8.22s/it]
```

```
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 37%|██████████████████████
| 22/60 [02:59<05:14,  8.27s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 38%|███████████████████████
| 23/60 [03:07<05:10,  8.40s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 40%|████████████████████████
| 24/60 [03:15<04:56,  8.24s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 42%|█████████████████████████
| 25/60 [03:23<04:43,  8.10s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 43%|██████████████████████████
| 26/60 [03:32<04:40,  8.25s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 45%|███████████████████████████
| 27/60 [03:40<04:29,  8.16s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 47%|████████████████████████████
| 28/60 [03:48<04:24,  8.26s/it]
361/361 [==============================] - 2s 7ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 48%|█████████████████████████████
| 29/60 [03:57<04:25,  8.57s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 50%|██████████████████████████████
| 30/60 [04:05<04:11,  8.40s/it]
```

```
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 52%|█████████████████████████████████████████████
| 31/60 [04:13<03:59,  8.27s/it]
361/361 [==============================] - 2s 7ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 53%|██████████████████████████████████████████████
| 32/60 [04:23<03:59,  8.57s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 55%|████████████████████████████████████████████████
| 33/60 [04:30<03:44,  8.31s/it]
361/361 [==============================] - 2s 7ms/step
Classification Accuracy on Clean Data: 98.64033948211657
361/361 [==============================] - 3s 7ms/step
Attack Success Rate using Poisoned Data: 100.0
 57%|█████████████████████████████████████████████████
| 34/60 [04:39<03:41,  8.52s/it]
361/361 [==============================] - 3s 7ms/step
Classification Accuracy on Clean Data: 98.64033948211657
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 58%|███████████████████████████████████████████████████
| 35/60 [04:49<03:37,  8.72s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.63167922404088
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 60%|████████████████████████████████████████████████████
| 36/60 [04:57<03:26,  8.61s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.65765999826795
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 62%|█████████████████████████████████████████████████████
| 37/60 [05:05<03:15,  8.50s/it]
361/361 [==============================] - 2s 7ms/step
Classification Accuracy on Clean Data: 98.64899974019225
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 63%|███████████████████████████████████████████████████████
| 38/60 [05:14<03:11,  8.69s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.6056984498138
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 65%|████████████████████████████████████████████████████████
| 39/60 [05:22<02:57,  8.45s/it]
```

```
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 98.57105741751104
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 67%|██████████████████████████████████████████
| 40/60 [05:31<02:49,  8.48s/it]
361/361 [==============================] - 3s 7ms/step
Classification Accuracy on Clean Data: 98.53641638520828
361/361 [==============================] - 2s 7ms/step
Attack Success Rate using Poisoned Data: 100.0
 68%|███████████████████████████████████████████
| 41/60 [05:40<02:45,  8.70s/it]
361/361 [==============================] - 2s 7ms/step
Classification Accuracy on Clean Data: 98.19000606218066
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 70%|████████████████████████████████████████████
| 42/60 [05:48<02:34,  8.59s/it]
361/361 [==============================] - 3s 7ms/step
Classification Accuracy on Clean Data: 97.65307006148784
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 72%|█████████████████████████████████████████████
| 43/60 [05:58<02:31,  8.91s/it]
361/361 [==============================] - 2s 7ms/step
Classification Accuracy on Clean Data: 97.50584567420108
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
 73%|██████████████████████████████████████████████
| 44/60 [06:08<02:26,  9.14s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 95.75647354291158
361/361 [==============================] - 2s 7ms/step
Attack Success Rate using Poisoned Data: 100.0
/Users/nicholasbennet/anaconda3/envs/jupyterlabml/lib/python3.11/site-package
s/keras/src/engine/training.py:3103: UserWarning: You are saving your model as
an HDF5 file via `model.save()`. This file format is considered legacy. We rec
ommend using instead the native Keras format, e.g. `model.save('my_model.kera
s')`.
  saving_api.save_model(
 75%|███████████████████████████████████████████████
| 45/60 [06:16<02:13,  8.93s/it]
Model Saved at 2% drop in classification accuracy.
361/361 [==============================] - 2s 5ms/step
Classification Accuracy on Clean Data: 95.20221702606739
361/361 [==============================] - 2s 6ms/step
 77%|████████████████████████████████████████████████
| 46/60 [06:24<02:02,  8.76s/it]
Attack Success Rate using Poisoned Data: 99.9913397419243
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 94.7172425738287
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 99.9913397419243
 78%|█████████████████████████████████████████████████
| 47/60 [06:33<01:51,  8.60s/it]
```

```
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 92.09318437689443
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 99.9913397419243
Model Saved at 4% drop in classification accuracy.
 80%|█████████████████████████████████████████████████████████████████████
| 48/60 [06:41<01:42,  8.57s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 91.49562656967177
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 99.9913397419243
 82%|███████████████████████████████████████████████████████████████████████
| 49/60 [06:51<01:38,  8.96s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 91.01931237550879
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 99.98267948384861
 83%|████████████████████████████████████████████████████████████████████████
| 50/60 [06:59<01:26,  8.65s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 89.17467740538669
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 80.73958603966398
 85%|█████████████████████████████████████████████████████████████████████████
| 51/60 [07:07<01:15,  8.44s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 84.43751623798389
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 77.015675067117
 87%|██████████████████████████████████████████████████████████████████████████
█            | 52/60 [07:16<01:09,  8.72s/it]
Model Saved at 10% drop in classification accuracy.
361/361 [==============================] - 2s 5ms/step
Classification Accuracy on Clean Data: 76.48739932449988
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 35.71490430414826
 88%|██████████████████████████████████████████████████████████████████████████
██           | 53/60 [07:24<00:59,  8.47s/it]
361/361 [==============================] - 3s 7ms/step
Classification Accuracy on Clean Data: 54.8627349095003
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 6.954187234779596
 90%|██████████████████████████████████████████████████████████████████████████
████         | 54/60 [07:33<00:51,  8.56s/it]
361/361 [==============================] - 2s 7ms/step
Classification Accuracy on Clean Data: 27.08928726076037
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 0.4243526457088421
 92%|██████████████████████████████████████████████████████████████████████████
█████        | 55/60 [07:43<00:44,  8.89s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 13.87373343725643
361/361 [==============================] - 3s 7ms/step
Attack Success Rate using Poisoned Data: 0.0
 93%|██████████████████████████████████████████████████████████████████████████
██████      | 56/60 [07:51<00:35,  8.80s/it]
```

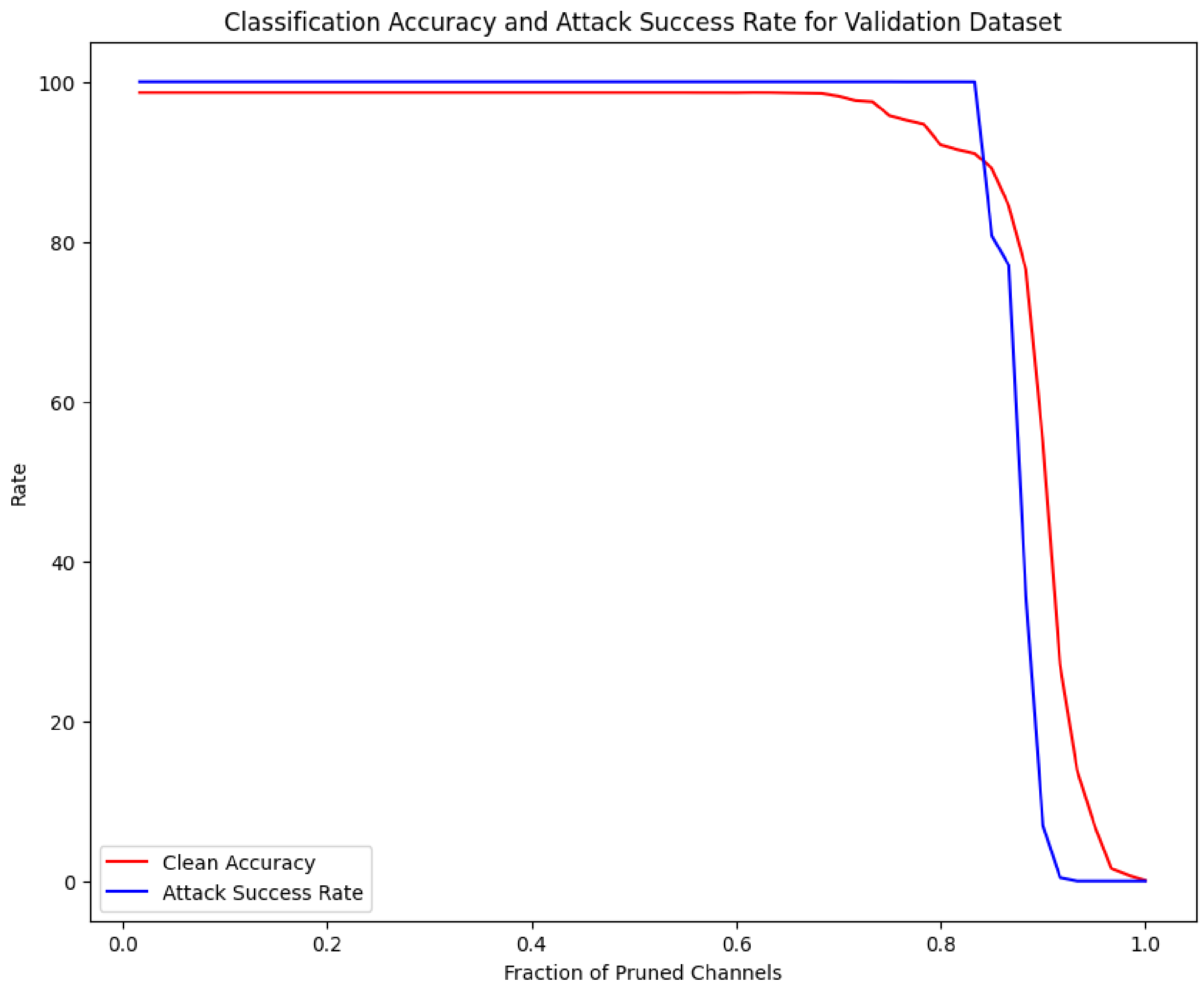
```
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 7.101411622066338
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 0.0
 95%|█████████████████████████████████████████████████████████████
███████     | 57/60 [08:01<00:27,  9.02s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 1.5501861955486274
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 0.0
 97%|█████████████████████████████████████████████████████████████
█████████   | 58/60 [08:09<00:17,  8.86s/it]
361/361 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 0.7188014202823244
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 0.0
 98%|█████████████████████████████████████████████████████████████
███████████ | 59/60 [08:18<00:08,  8.72s/it]
361/361 [==============================] - 2s 7ms/step
Classification Accuracy on Clean Data: 0.0779423226812159
361/361 [==============================] - 2s 6ms/step
Attack Success Rate using Poisoned Data: 0.0
100%|█████████████████████████████████████████████████████████████
████████████| 60/60 [08:27<00:00,  8.46s/it]
```

In [12]:

```python
# Plot Pruning graph on validation data

figure = plt.figure(figsize=(10,8))
x_axis = np.arange(1,61)/60
plt.plot(x_axis, cl_clf_acc_arr, color='red')
plt.plot(x_axis, at_suc_rt_arr, color='blue')
plt.legend(['Clean Accuracy', 'Attack Success Rate'])
plt.xlabel("Fraction of Pruned Channels")
plt.ylabel("Rate")
plt.title("Classification Accuracy and Attack Success Rate for Validation Datas
```

Out[12]:

```
Text(0.5, 1.0, 'Classification Accuracy and Attack Success Rate for Validation
Dataset')
```



In [13]:
```
# Clear the current Tensorflow Keras session

tf.keras.backend.clear_session()
```

In [14]:
```
# Define Pruned models

prune_model_X_2 = 'model_X_2.h5'
prune_model_X_4 = 'model_X_4.h5'
prune_model_X_10 = 'model_X_10.h5'
```

In [15]:
```
# Define GoodNet(Repaired) Models

G_model_X_2 = G(badnet_model, prune_model_X_2)
G_model_X_4 = G(badnet_model, prune_model_X_4)
G_model_X_10 = G(badnet_model, prune_model_X_10)
```

In [16]:
```
# Evaluate GoodNet(Repaired) Models
cl_clf_acc_X_2, at_suc_rt_X_2 = evaluate_model(clean_test_data, poisoned_test_
cl_clf_acc_X_4, at_suc_rt_X_4 = evaluate_model(clean_test_data, poisoned_test_
cl_clf_acc_X_10, at_suc_rt_X_10 = evaluate_model(clean_test_data, poisoned_tes
401/401 [==============================] - 2s 5ms/step
401/401 [==============================] - 3s 6ms/step
Classification Accuracy on Clean Data: 95.74434918160561
401/401 [==============================] - 3s 6ms/step
401/401 [==============================] - 3s 6ms/step
Attack Success Rate using Poisoned Data: 100.0
401/401 [==============================] - 3s 7ms/step
401/401 [==============================] - 2s 6ms/step
Classification Accuracy on Clean Data: 92.1278254091972
401/401 [==============================] - 3s 7ms/step
401/401 [==============================] - 3s 7ms/step
Attack Success Rate using Poisoned Data: 99.98441153546376
401/401 [==============================] - 3s 6ms/step
401/401 [==============================] - 3s 7ms/step
Classification Accuracy on Clean Data: 84.3335931410756
401/401 [==============================] - 3s 6ms/step
401/401 [==============================] - 3s 7ms/step
Attack Success Rate using Poisoned Data: 77.20966484801247
```

In [17]:

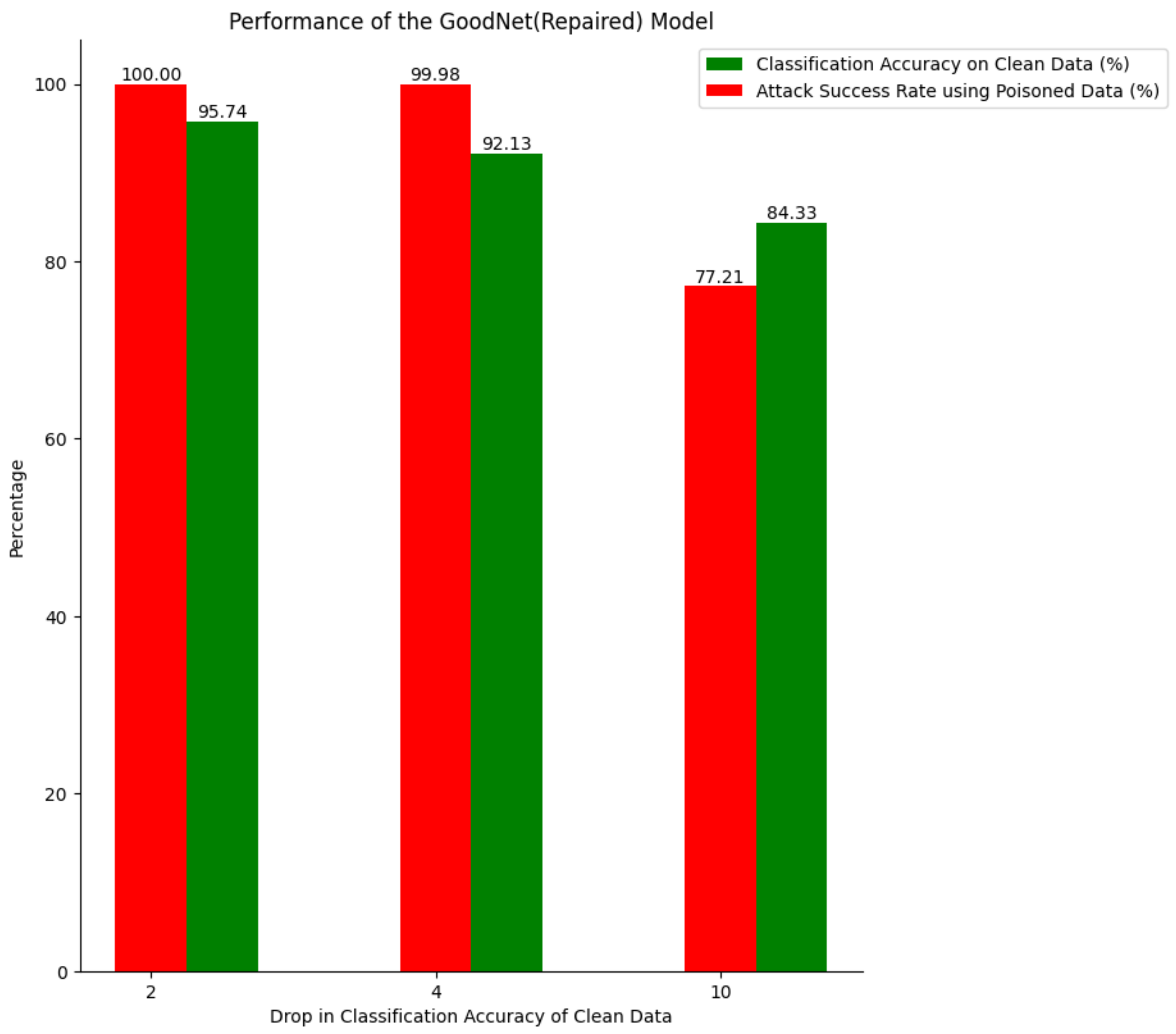
```
# Table of GoodNet(Repaired) model evaluation

cl_clf_acc_tb = [cl_clf_acc_X_2, cl_clf_acc_X_4, cl_clf_acc_X_10]
at_suc_rt_tb = [at_suc_rt_X_2, at_suc_rt_X_4, at_suc_rt_X_10]
data = {
    "Classification Accuracy on Clean Data": cl_clf_acc_tb,
    "Attack Success Rate using Poisoned Data": at_suc_rt_tb,
    "Model": ["GoodNet_2%", "GoodNet_4%", "GoodNet_10%"]
}
df = pd.DataFrame(data)
df.set_index('Model')
```

Out[17]:

Model	Classification Accuracy on Clean Data	Attack Success Rate using Poisoned Data
GoodNet_2%	95.744349	100.000000
GoodNet_4%	92.127825	99.984412
GoodNet_10%	84.333593	77.209665

In [18]:

```
# Graph of GoodNet(Repaired) model evaluation

opacity = 1
bar_width = 0.25

figure = plt.figure(figsize=(10,8))
plt.xlabel('Drop in Classification Accuracy of Clean Data')
plt.ylabel('Percentage')

plt.xticks(range(len(cl_clf_acc_tb)),('2', '4', '10'))
bar1 = plt.bar(np.arange(len(cl_clf_acc_tb)) + bar_width, cl_clf_acc_tb, bar_w
bar2 = plt.bar(range(len(at_suc_rt_tb)),at_suc_rt_tb, bar_width, align='center

for rect in bar1 + bar2:
    height = rect.get_height()
    plt.text(rect.get_x() + rect.get_width() / 2.0, height, f'{height:.02f}', 

plt.legend(bbox_to_anchor=(1.4, 1))
plt.tight_layout()
plt.title('Performance of the GoodNet(Repaired) Model')
sns.despine()
plt.show()
```


Performance of the GoodNet(Repaired) Model
Classification Accuracy on Clean Data (%)
Attack Success Rate using Poisoned Data (%)
Percentage
Drop in Classification Accuracy of Clean Data