In [1]:

```
import os
img_dir = '/tmp/nst'
if not os.path.exists(img_dir):
    os.makedirs(img_dir)
!wget --quiet -P /tmp/nst/ https://upload.wikimedia.org/wikipedia
/commons/d/d7/Green_Sea_Turtle_grazing_seagrass.jpg
!wget --quiet -P /tmp/nst/ https://upload.wikimedia.org/wikipedia
/commons/0/0a/The_Great_Wave_off_Kanagawa.jpg
!wget --quiet -P /tmp/nst/ https://upload.wikimedia.org/wikipedia
/commons/b/b4/Vassily_Kandinsky%2C_1913_-_Composition_7.jpg
!wget --quiet -P /tmp/nst/ https://upload.wikimedia.org/wikipedia
/commons/0/00/Tuebingen_Neckarfront.jpg
!wget --quiet -P /tmp/nst/ https://upload.wikimedia.org/wikipedia
/commons/6/68/Pillars_of_creation_2014_HST_WFC3-UVIS_full-res_den
oised.jpg
!wget --quiet -P /tmp/nst/ https://upload.wikimedia.org/wikipedia
/commons/thumb/e/ea/Van_Gogh_-_Starry_Night_-_Google_Art_Project.
jpg/1024px-Van_Gogh_-_Starry_Night_-_Google_Art_Project.jpg
```

In [2]:

```
import matplotlib.pyplot as plt
import matplotlib as mpl
mpl.rcParams['figure.figsize'] = (10,10)
mpl.rcParams['axes.grid'] = False

import numpy as np
from PIL import Image
import time
import functools
```

In [3]:

```
%tensorflow_version 1.x
import tensorflow as tf

from tensorflow.python.keras.preprocessing import image as kp_ima
ge
from tensorflow.python.keras import models
from tensorflow.python.keras import losses
from tensorflow.python.keras import layers
from tensorflow.python.keras import backend as K
```

```
TensorFlow 1.x selected.
```

In [4]:

```
tf.enable_eager_execution()
print("Eager execution: {}".format(tf.executing_eagerly()))
```

```
Eager execution: True
```

In [5]:

```
content_path = '/tmp/nst/Green_Sea_Turtle_grazing_seagrass.jpg'
style_path = '/tmp/nst/The_Great_Wave_off_Kanagawa.jpg'
```

In [6]:

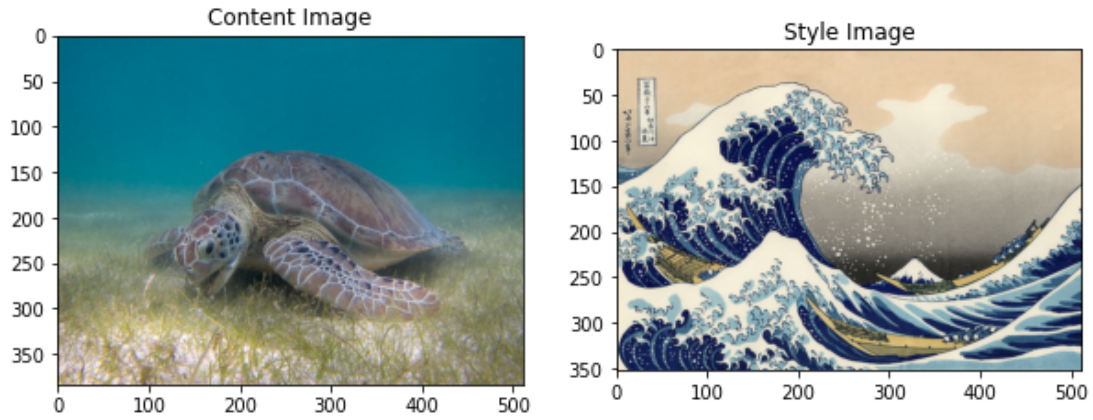
```
def load_img(path_to_img):
  max_dim = 512
  img = Image.open(path_to_img)
  long = max(img.size)
  scale = max_dim/long
  img = img.resize((round(img.size[0]*scale), round(img.size[1]*s
cale)), Image.ANTIALIAS)

  img = kp_image.img_to_array(img)

  img = np.expand_dims(img, axis=0)
  return img
```

In [7]:

```
def imshow(img, title=None):
  out = np.squeeze(img, axis=0)
  out = out.astype('uint8')
  plt.imshow(out)
  if title is not None:
    plt.title(title)
  plt.imshow(out)
```

In [8]:

```
plt.figure(figsize=(10,10))

content = load_img(content_path).astype('uint8')
style = load_img(style_path).astype('uint8')

plt.subplot(1, 2, 1)
imshow(content, 'Content Image')

plt.subplot(1, 2, 2)
imshow(style, 'Style Image')
plt.show()
```



In [9]:

```
def load_and_process_img(path_to_img):
  img = load_img(path_to_img)
  img = tf.keras.applications.vgg19.preprocess_input(img)
  return img
```

In [10]:

```
def deprocess_img(processed_img):
  x = processed_img.copy()
  if len(x.shape) == 4:
    x = np.squeeze(x, 0)
  assert len(x.shape) == 3,
  if len(x.shape) != 3:
    raise ValueError("Invalid input to deprocessing image")

  x[:, :, 0] += 103.939
  x[:, :, 1] += 116.779
  x[:, :, 2] += 123.68
  x = x[:, :, ::-1]

  x = np.clip(x, 0, 255).astype('uint8')
  return x
```

In [11]:

```
content_layers = ['block5_conv2']

style_layers = ['block1_conv1',
                'block2_conv1',
                'block3_conv1',
                'block4_conv1',
                'block5_conv1'
               ]

num_content_layers = len(content_layers)
num_style_layers = len(style_layers)
```

In [12]:

```
def get_model():
  vgg = tf.keras.applications.vgg19.VGG19(include_top=False, weights='imagenet')
  vgg.trainable = False

  style_outputs = [vgg.get_layer(name).output for name in style_layers]
  content_outputs = [vgg.get_layer(name).output for name in content_layers]
  model_outputs = style_outputs + content_outputs

  return models.Model(vgg.input, model_outputs)
```

In [13]:

```
def get_content_loss(base_content, target):
  return tf.reduce_mean(tf.square(base_content - target))
```

In [14]:

```
def gram_matrix(input_tensor):
  channels = int(input_tensor.shape[-1])
  a = tf.reshape(input_tensor, [-1, channels])
  n = tf.shape(a)[0]
  gram = tf.matmul(a, a, transpose_a=True)
  return gram / tf.cast(n, tf.float32)

def get_style_loss(base_style, gram_target):
  height, width, channels = base_style.get_shape().as_list()
  gram_style = gram_matrix(base_style)

  return tf.reduce_mean(tf.square(gram_style - gram_target))# / (4. * (channels ** 2) * (width * height) ** 2)
```

In [16]:

```
def get_feature_representations(model, content_path, style_path):
  content_image = load_and_process_img(content_path)
  style_image = load_and_process_img(style_path)
  style_outputs = model(style_image)
  content_outputs = model(content_image)


  style_features = [style_layer[0] for style_layer in style_outputs[:num_style_layers]]
  content_features = [content_layer[0] for content_layer in content_outputs[num_style_layers:]]
  return style_features, content_features
```

In [17]:

```
def compute_loss(model, loss_weights, init_image, gram_style_features, content_features):
  style_weight, content_weight = loss_weights
  model_outputs = model(init_image)

  style_output_features = model_outputs[:num_style_layers]
  content_output_features = model_outputs[num_style_layers:]

  style_score = 0
  content_score = 0

  weight_per_style_layer = 1.0 / float(num_style_layers)
  for target_style, comb_style in zip(gram_style_features, style_output_features):
    style_score += weight_per_style_layer * get_style_loss(comb_style[0], target_style)

  weight_per_content_layer = 1.0 / float(num_content_layers)
  for target_content, comb_content in zip(content_features, content_output_features):
    content_score += weight_per_content_layer* get_content_loss(comb_content[0], target_content)

  style_score *= style_weight
  content_score *= content_weight

  loss = style_score + content_score
  return loss, style_score, content_score
```

In [18]:

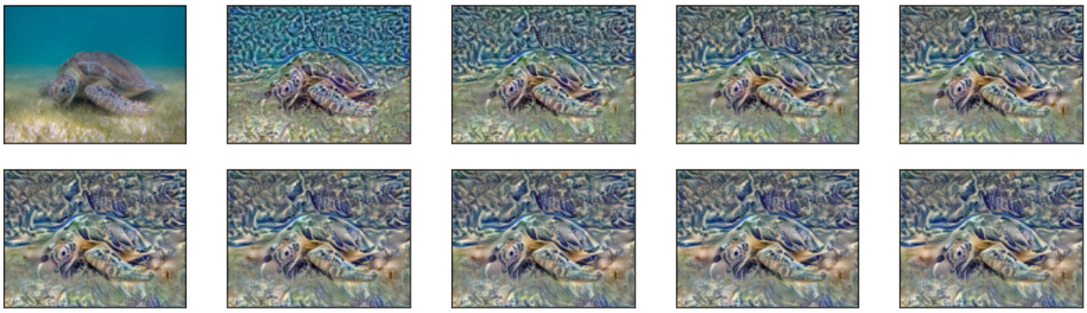
```
def compute_grads(cfg):
  with tf.GradientTape() as tape:
    all_loss = compute_loss(**cfg)
  total_loss = all_loss[0]
  return tape.gradient(total_loss, cfg['init_image']), all_loss
```

In [19]:

```
import IPython.display

def run_style_transfer(content_path,
                       style_path,
                       num_iterations=1000,
                       content_weight=1e3,
                       style_weight=1e-2):

  model = get_model()
  for layer in model.layers:
    layer.trainable = False

  style_features, content_features = get_feature_representations
(model, content_path, style_path)
  gram_style_features = [gram_matrix(style_feature) for style_fea
ture in style_features]

  init_image = load_and_process_img(content_path)
  init_image = tf.Variable(init_image, dtype=tf.float32)
  opt = tf.train.AdamOptimizer(learning_rate=5, beta1=0.99, epsil
on=1e-1)

  iter_count = 1

  best_loss, best_img = float('inf'), None

  loss_weights = (style_weight, content_weight)
  cfg = {
      'model': model,
      'loss_weights': loss_weights,
      'init_image': init_image,
      'gram_style_features': gram_style_features,
      'content_features': content_features
  }

  num_rows = 2
  num_cols = 5
  display_interval = num_iterations/(num_rows*num_cols)
  start_time = time.time()
  global_start = time.time()

  norm_means = np.array([103.939, 116.779, 123.68])
  min_vals = -norm_means
  max_vals = 255 - norm_means

  imgs = []
  for i in range(num_iterations):
    grads, all_loss = compute_grads(cfg)
    loss, style_score, content_score = all_loss
    opt.apply_gradients([(grads, init_image)])
    clipped = tf.clip_by_value(init_image, min_vals, max_vals)
    init_image.assign(clipped)
    end_time = time.time()

    if loss < best_loss:
      best_loss = loss
      best_img = deprocess_img(init_image.numpy())

    if i % display_interval== 0:
      start_time = time.time()
      plot_img = init_image.numpy()
      plot_img = deprocess_img(plot_img)
      imgs.append(plot_img)
      IPython.display.clear_output(wait=True)
      IPython.display.display_png(Image.fromarray(plot_img))
      print('Iteration: {}'.format(i))
      print('Total loss: {:.4e}, '
            'style loss: {:.4e}, '
            'content loss: {:.4e}, '
            'time: {:.4f}s'.format(loss, style_score, content_sco
re, time.time() - start_time))
  print('Total time: {:.4f}s'.format(time.time() - global_start))
  IPython.display.clear_output(wait=True)
  plt.figure(figsize=(14,4))
  for i,img in enumerate(imgs):
      plt.subplot(num_rows,num_cols,i+1)
      plt.imshow(img)
      plt.xticks([])
      plt.yticks([])

  return best_img, best_loss
```

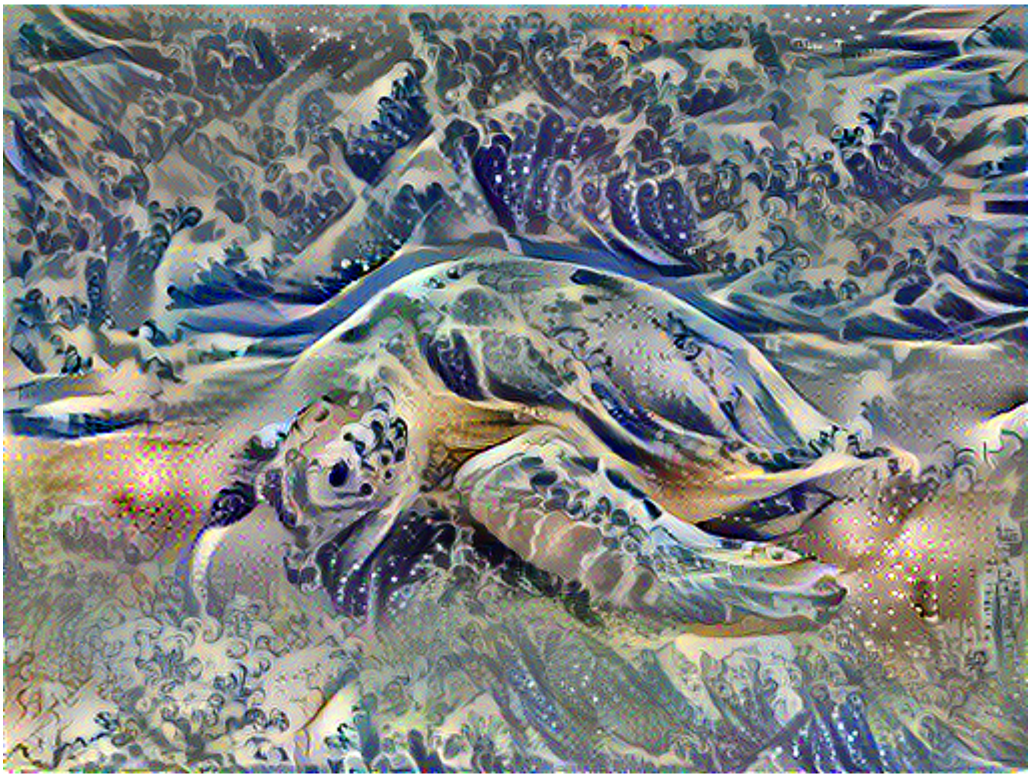
In [20]:

```
best, best_loss = run_style_transfer(content_path,
                                     style_path, num_iterations=1
000)
```



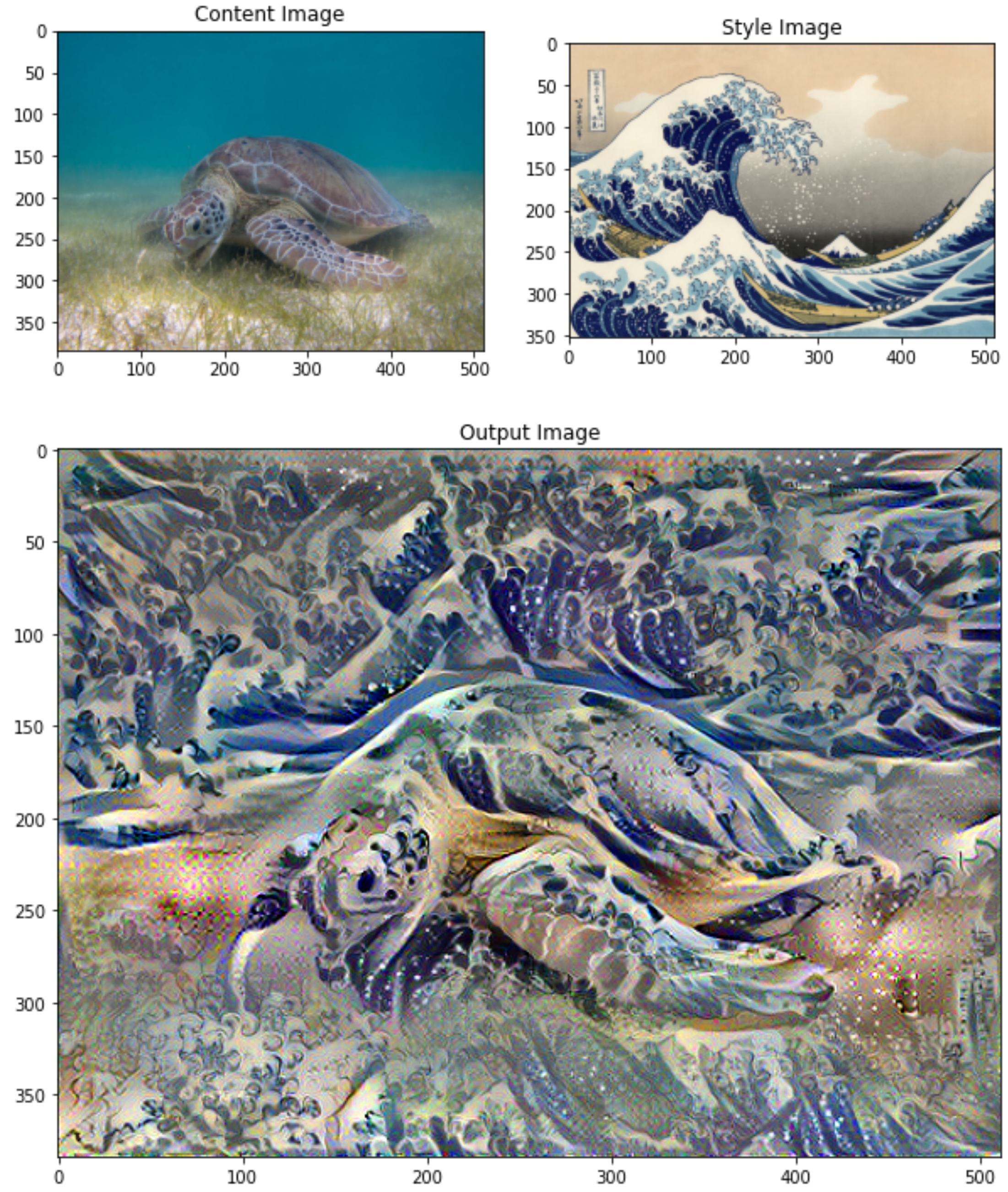
In [23]:
```
Image.fromarray(best)
```

Out[23]:

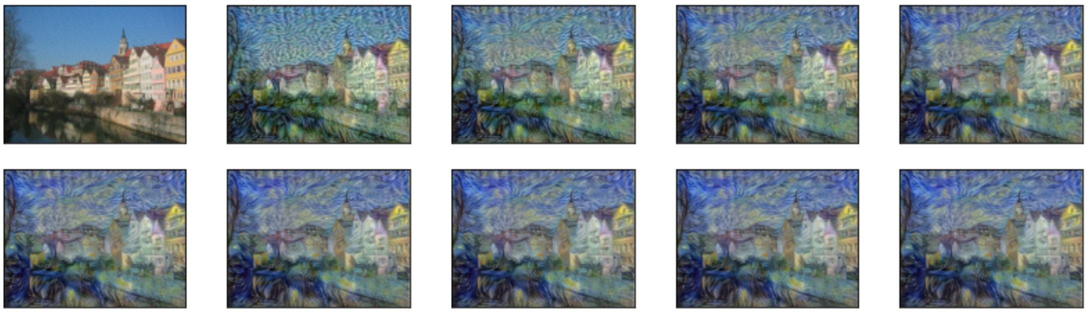


In [24]:
```
def show_results(best_img, content_path, style_path, show_large_f
inal=True):
  plt.figure(figsize=(10, 5))
  content = load_img(content_path)
  style = load_img(style_path)

  plt.subplot(1, 2, 1)
  imshow(content, 'Content Image')

  plt.subplot(1, 2, 2)
  imshow(style, 'Style Image')

  if show_large_final:
    plt.figure(figsize=(10, 10))

    plt.imshow(best_img)
    plt.title('Output Image')
    plt.show()
```

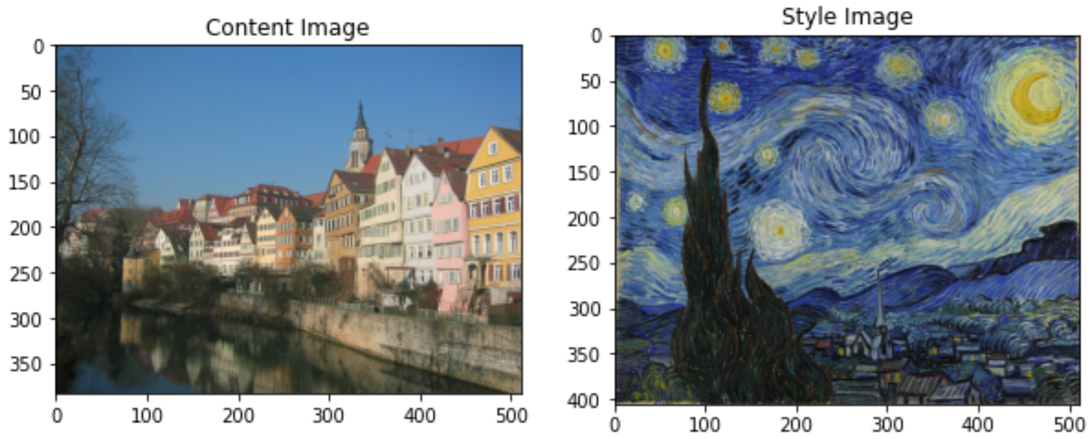
In [25]:
```
show_results(best, content_path, style_path)
```



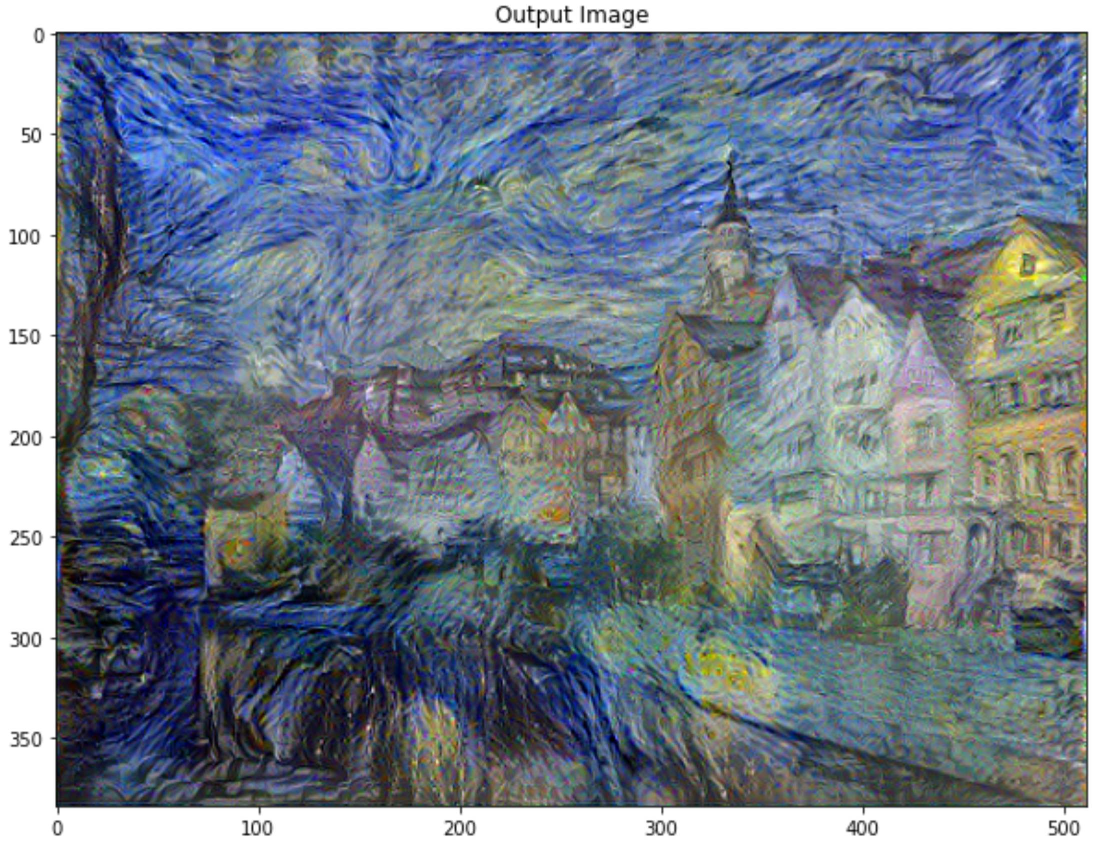
In [21]:
```
best_starry_night, best_loss = run_style_transfer('/tmp/nst/Tuebingen_Neckarfront.jpg',
                                                  '/tmp/nst/1024px-Van_Gogh_-_Starry_Night_-_Google_Art_Project.jpg')
```



In [26]:
```
show_results(best_starry_night, '/tmp/nst/Tuebingen_Neckarfront.jpg',
             '/tmp/nst/1024px-Van_Gogh_-_Starry_Night_-_Google_Art_Project.jpg')
```


Content Image

Style Image


Output Image

In [ ]:
```
```