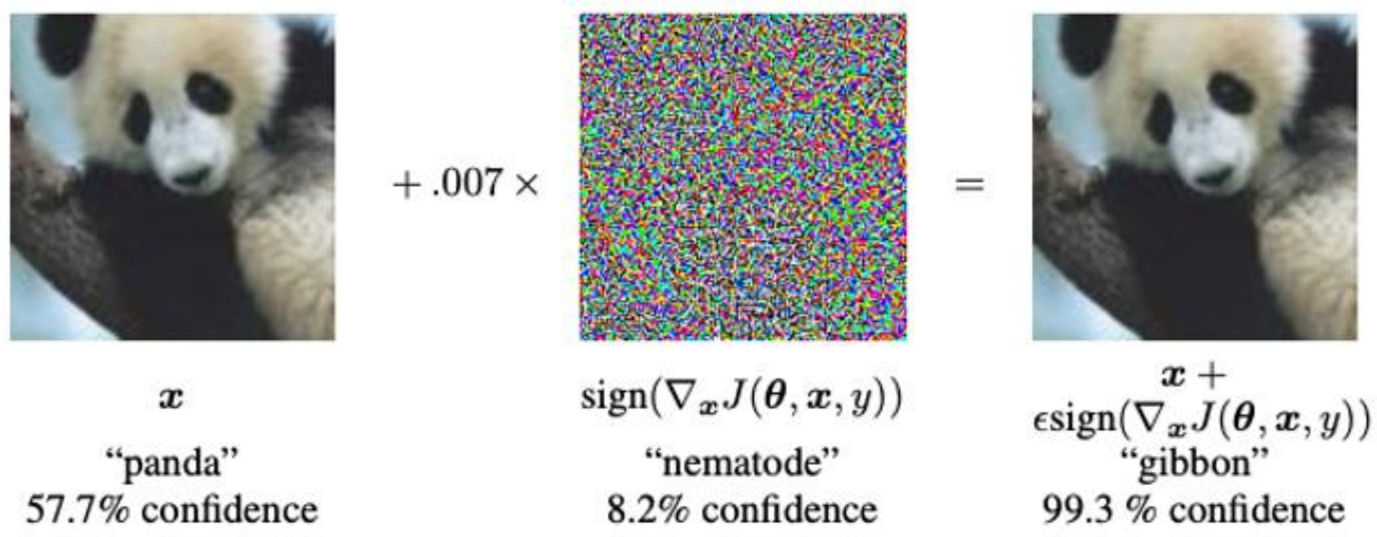
Adversarial example using FGSM

Outline

- Introduction
- Implementing
- Result

Introduction

- Adversarial examples
  - Special inputs which are confusing a neural network
  - Indistinguishable to the human eye
  - Cause the network to fail to identify
- Example



Introduction

- Fast gradient sign method
  - which is a *white box* attack whose goal is to ensure misclassification
  - Using the gradients of the loss to maximises the loss
  - Adversarial image can be summarised using the following

$$adv\_x = x + \epsilon * \text{sign}(\nabla_x J(\theta, x, y))$$

where

- adv_x : Adversarial image.
- x : Original input image.
- y : Original input label.
- ϵ : Multiplier to ensure the perturbations are small.
- θ : Model parameters.
- J : Loss.

Implementing

$$\text{sign}(\nabla_x J(\theta, x, y))$$

```python
# 使用Crossentropy當loss fuction
loss_object = tf.keras.losses.CategoricalCrossentropy()

def create_adversarial_pattern(input_image, input_label):
  with tf.GradientTape() as tape:
    tape.watch(input_image)
    prediction = pretrained_model(input_image)
    loss = loss_object(input_label, prediction)

  # Get the gradients of the loss w.r.t to the input image.
  gradient = tape.gradient(loss, input_image)
  # Get the sign of the gradients to create the perturbation
  signed_grad = tf.sign(gradient)
  return signed_grad
```

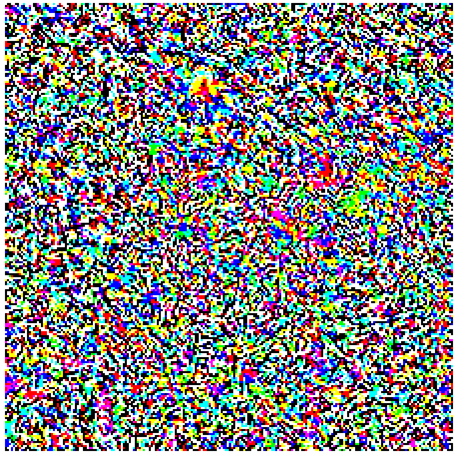
Implementing

$$adv\_x = x + \epsilon * \text{sign}(\nabla_x J(\theta, x, y))$$

```python
# Get the input label of the image.
# 這邊如果你的圖是dog則 tf.one_hot input 吃dog_index，這樣他才會產生變成貓的noise
# cat則使用cat_index
dog_index = 1
cat_index = 0
label = tf.one_hot(dog_index, image_probs.shape[-1])
label = tf.reshape(label, (1, image_probs.shape[-1]))
# label = image_probs

perturbations = create_adversarial_pattern(image, label)

# plt.imshow(perturbations[0]*0.5+0.5); # To change [-1, 1] to [0,1]

epsilons = [0, 0.01, 0.1, 0.15]
descriptions = [('Epsilon = {:0.3f}'.format(eps) if eps else 'Input')
                for eps in epsilons]

for i, eps in enumerate(epsilons):
  # 生產出adversaria的圖，使用epsilons來控制noise的影響
  adv_x = image + eps*perturbations
  adv_x = tf.cast(adv_x, tf.uint8)
  tf.keras.preprocessing.image.save_img('adversarial_dog1_'+str(i)+'.png',adv_x[0])
```

Result

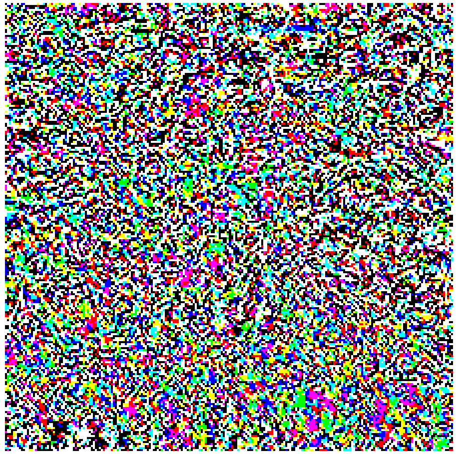
$+\ \varepsilon \times$



$=$

Result

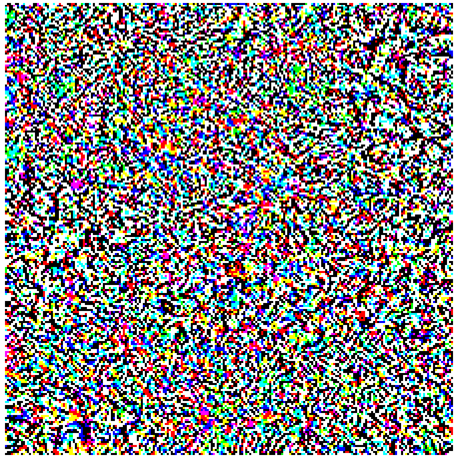
$+ \ \varepsilon \times$



$=$

Result

$+\ \varepsilon \times$



$=$

Result

```
adversaria_dog1_2.png  is  cat
    1.000  cat
    0.000  dog

adversaria_cat1_2.png  is  dog
    0.998  dog
    0.002  cat

adversaria_cat2_2.png  is  dog
    0.999  dog
    0.001  cat
```