

01-概述

1.1 基于数据的算法

你有没有考虑过，我们为什么需要机器学习？

如果没有的话，你可以先花费几分钟时间思考一下。

然后，一起看一下几个场景：

①我们有两张 $32 * 32$ 图片，其中有一张纯黑的，一张纯白的。现在需要编写一个程序，随机输入其中一张，程序要判断出这张图片是黑的还是白的。

In [1]:

```
!pip install numpy
!pip install matplotlib
!pip install tensorflow
```

Looking in indexes: https://super-spider-1605756846230:****@aaronjny-pypi.pkg.coding.net/super-spider/super-spider/simple
Requirement already satisfied: numpy in /Users/aaron/anaconda3/lib/python3.7/site-packages (1.18.1)
Looking in indexes: https://super-spider-1605756846230:****@aaronjny-pypi.pkg.coding.net/super-spider/super-spider/simple
Requirement already satisfied: matplotlib in /Users/aaron/anaconda3/lib/python3.7/site-packages (3.1.3)
Requirement already satisfied: cyclor>=0.10 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from matplotlib) (0.10.0)
Requirement already satisfied: kiwisolver>=1.0.1 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from matplotlib) (1.1.0)
Requirement already satisfied: numpy>=1.11 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from matplotlib) (1.18.1)
Requirement already satisfied: pyparsing!=2.0.4,!=2.1.2,!=2.1.6,>=2.0.1 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from matplotlib) (2.4.6)
Requirement already satisfied: python-dateutil>=2.1 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from matplotlib) (2.8.1)
Requirement already satisfied: six in /Users/aaron/anaconda3/lib/python3.7/site-packages (from cyclor>=0.10->matplotlib) (1.14.0)
Requirement already satisfied: setuptools in /Users/aaron/anaconda3/lib/python3.7/site-packages (from kiwisolver>=1.0.1->matplotlib) (50.3.2)
Looking in indexes: https://super-spider-1605756846230:****@aaronjny-pypi.pkg.coding.net/super-spider/super-spider/simple
Requirement already satisfied: tensorflow in /Users/aaron/anaconda3/lib/python3.7/site-packages (2.2.0)
Requirement already satisfied: tensorboard<2.3.0,>=2.2.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (2.2.2)
Requirement already satisfied: grpcio>=1.8.6 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (1.29.0)
Requirement already satisfied: absl-py>=0.7.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (0.9.0)
Requirement already satisfied: opt-einsum>=2.3.2 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (3.2.1)
Requirement already satisfied: wrapt>=1.11.1 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (1.11.2)
Requirement already satisfied: h5py<2.11.0,>=2.10.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (2.10.0)
Requirement already satisfied: tensorflow-estimator<2.3.0,>=2.2.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (2.2.0)
Requirement already satisfied: six>=1.12.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (1.14.0)
Requirement already satisfied: numpy<2.0,>=1.16.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (1.18.1)
Requirement already satisfied: termcolor>=1.1.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (1.1.0)
Requirement already satisfied: protobuf>=3.8.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (3.12.2)
Requirement already satisfied: wheel>=0.26; python_version >= "3" in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (0.35.1)
Requirement already satisfied: google-pasta>=0.1.8 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (0.2.0)
Requirement already satisfied: astunparse==1.6.3 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (1.6.3)
Requirement already satisfied: keras-preprocessing>=1.1.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (1.1.2)

Requirement already satisfied: gast==0.3.3 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (0.3.3)

Requirement already satisfied: scipy==1.4.1; python_version >= "3" in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorflow) (1.4.1)

Requirement already satisfied: google-auth<2,>=1.6.3 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorboard<2.3.0,>=2.2.0->tensorflow) (1.18.0)

Requirement already satisfied: google-auth-oauthlib<0.5,>=0.4.1 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorboard<2.3.0,>=2.2.0->tensorflow) (0.4.1)

Requirement already satisfied: setuptools>=41.0.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorboard<2.3.0,>=2.2.0->tensorflow) (50.3.2)

Requirement already satisfied: tensorboard-plugin-wit>=1.6.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorboard<2.3.0,>=2.2.0->tensorflow) (1.6.0.post3)

Requirement already satisfied: werkzeug>=0.11.15 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorboard<2.3.0,>=2.2.0->tensorflow) (1.0.0)

Requirement already satisfied: markdown>=2.6.8 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorboard<2.3.0,>=2.2.0->tensorflow) (3.2.2)

Requirement already satisfied: requests<3,>=2.21.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from tensorboard<2.3.0,>=2.2.0->tensorflow) (2.22.0)

Requirement already satisfied: rsa<5,>=3.1.4; python_version >= "3" in /Users/aaron/anaconda3/lib/python3.7/site-packages (from google-auth<2,>=1.6.3->tensorboard<2.3.0,>=2.2.0->tensorflow) (4.6)

Requirement already satisfied: pyasn1-modules>=0.2.1 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from google-auth<2,>=1.6.3->tensorboard<2.3.0,>=2.2.0->tensorflow) (0.2.8)

Requirement already satisfied: cachetools<5.0,>=2.0.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from google-auth<2,>=1.6.3->tensorboard<2.3.0,>=2.2.0->tensorflow) (4.1.0)

Requirement already satisfied: requests-oauthlib>=0.7.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.3.0,>=2.2.0->tensorflow) (1.3.0)

Requirement already satisfied: importlib-metadata; python_version < "3.8" in /Users/aaron/anaconda3/lib/python3.7/site-packages (from markdown>=2.6.8->tensorboard<2.3.0,>=2.2.0->tensorflow) (1.5.0)

Requirement already satisfied: urllib3!=1.25.0,!1.25.1,<1.26,>=1.21.1 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard<2.3.0,>=2.2.0->tensorflow) (1.25.8)

Requirement already satisfied: chardet<3.1.0,>=3.0.2 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard<2.3.0,>=2.2.0->tensorflow) (3.0.4)

Requirement already satisfied: certifi>=2017.4.17 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard<2.3.0,>=2.2.0->tensorflow) (2019.11.28)

Requirement already satisfied: idna<2.9,>=2.5 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from requests<3,>=2.21.0->tensorboard<2.3.0,>=2.2.0->tensorflow) (2.8)

Requirement already satisfied: pyasn1>=0.1.3 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from rsa<5,>=3.1.4; python_version >= "3"->google-auth<2,>=1.6.3->tensorboard<2.3.0,>=2.2.0->tensorflow) (0.4.8)

Requirement already satisfied: oauthlib>=3.0.0 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from requests-oauthlib>=0.7.0->google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.3.0,>=2.2.0->tensorflow) (3.1.0)

Requirement already satisfied: zipp>=0.5 in /Users/aaron/anaconda3/lib/python3.7/site-packages (from importlib-metadata; python_version < "3.8"->markdown>=2.6.8->tensorboard<2.3.0,>=2.2.0->tensorflow) (2.0)

In [2]:

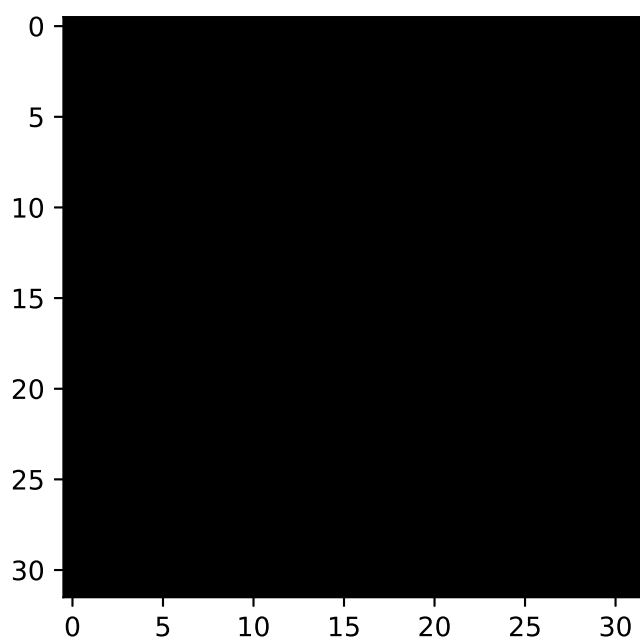
```
import numpy as np
import matplotlib.pyplot as plt
```

In [3]:

```
black_img=np.zeros((32,32,3),dtype=np.uint8)
plt.imshow(black_img)
```

Out[3]:

<matplotlib.image.AxesImage at 0x7fd8fff80350>

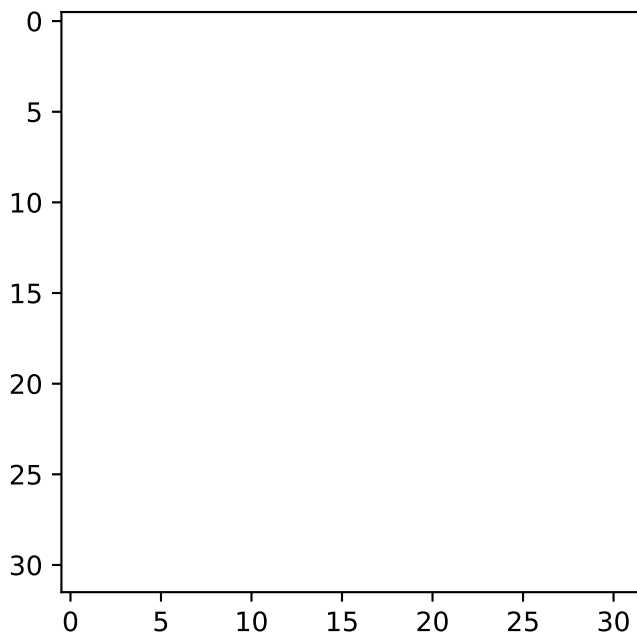


In [4]:

```
white_img=np.zeros((32,32,3))
white_img.fill(255)
white_img=np.asarray(white_img,dtype=np.uint8)
plt.imshow(white_img)
```

Out[4]:

<matplotlib.image.AxesImage at 0x7fd900638c90>



解决方案：很简单，灰度图片中，纯黑色像素值为0，纯白色像素值为255，只需要对输入的图片中的任意像素做判断，是0就是纯黑图片，是255就是纯白图片。

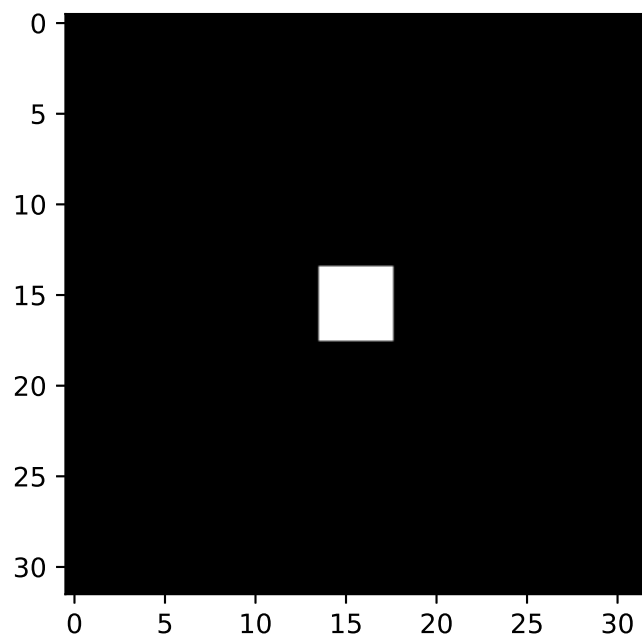
②我们两张32 * 32的图片，其中有一张中心有一个4 * 4的白色矩形，另一张中心有一个8 * 8的白色矩形，其余部位均为黑色。现在需要编写一个程序，随机输入其中一张，程序要判断出这张图片中心的矩形的形状。

In [5]:

```
img1=np.zeros((32,32,3),dtype=np.uint8)  
img1[14:18,14:18]+=255  
plt.imshow(img1)
```

Out[5]:

<matplotlib.image.AxesImage at 0x7fd9007337d0>

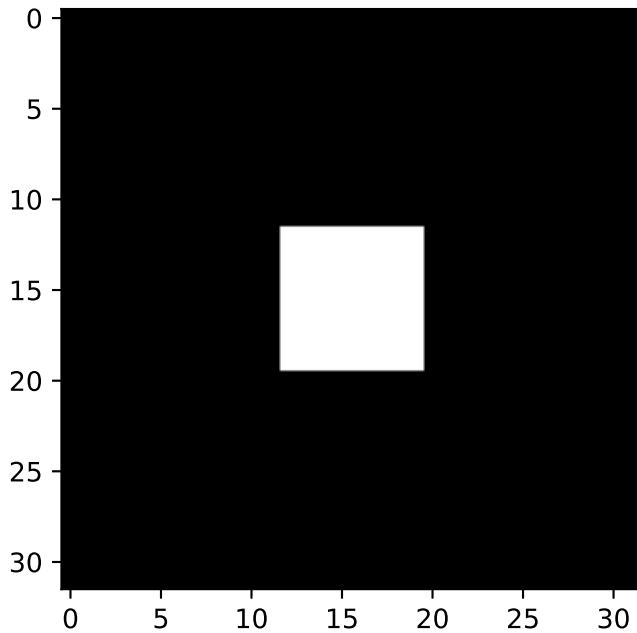


In [6]:

```
img2=np.zeros((32,32,3),dtype=np.uint8)
img2[12:20,12:20]+=255
plt.imshow(img2)
```

Out[6]:

<matplotlib.image.AxesImage at 0x7fd9010307d0>



解决方案：也不复杂，因为确定中心是矩形，所以我们逐像素扫描图片，找到第一个黑色点，然后分别向右和向下延伸所有的黑色点，以计算出矩形的宽和高。即得出矩形的形状。

③我们有若干张 $32 * 32$ 的灰度图片，其中每一张上都有一个手写阿拉伯数字（0-9）。现在需要编写一个程序，随机输入其中一张，程序要判断出这张图片上的数字是0~9中的哪一个。

In [7]:

```
# 这里只是展示MNIST手写数字数据集说明问题，看不懂代码也没关系，后面会说
import tensorflow as tf
(train_img,train_label),(test_img,test_label)=tf.keras.datasets.mnist.load_data
()
train_img.shape,train_label.shape,test_img.shape,test_label.shape
```

Out[7]:

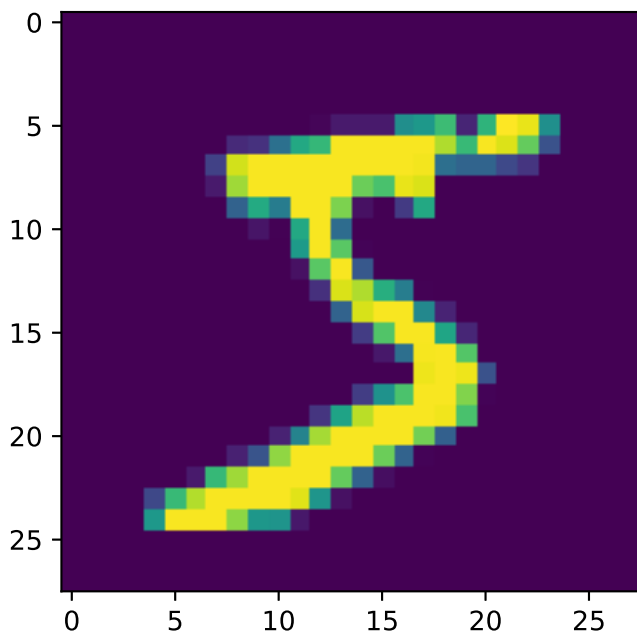
```
((60000, 28, 28), (60000,), (10000, 28, 28), (10000,))
```

In [8]:

```
plt.imshow(train_img[0])
```

Out[8]:

<matplotlib.image.AxesImage at 0x7fd9010ed950>

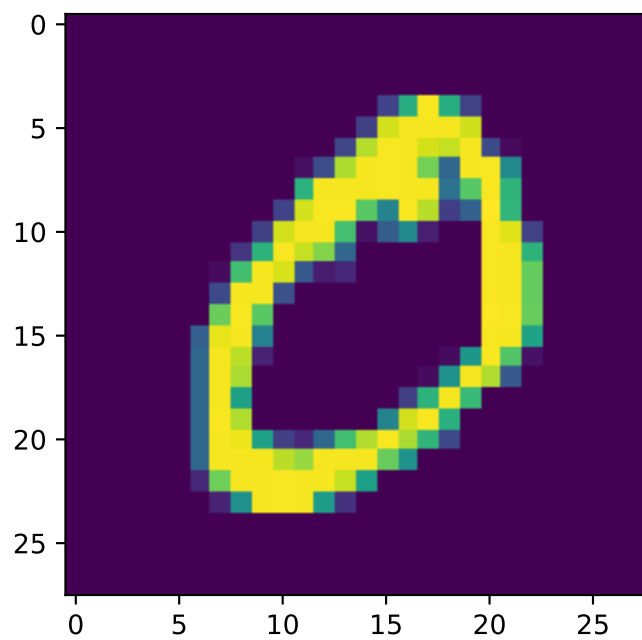


In [9]:

```
plt.imshow(train_img[1])
```

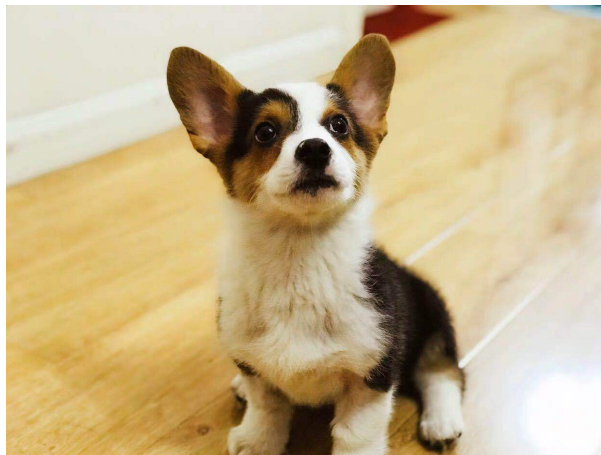
Out[9]:

<matplotlib.image.AxesImage at 0x7fd8ea161e50>



解决方案：黑人问号.jpg

④我们有100张分辨率不统一的照片，每张照片上包含且只包含猫或狗的其中一种。现在需要编写一个程序，随机输入其中一张，程序需要判断出这张照片是猫的照片，还是狗的照片。



解决方案：黑人问号.jpg

对于前两种场景，我们很容易想出解决方案，并通过一系列的规则来描述它，比如判断颜色是黑色还是白色，又比如延伸黑色点统计宽和高，都是一系列规则的组合，我们把这种算法称为基于规则的算法。

基于规则的算法很普遍，且能够快速有效地解决现实生活中的部分问题。但对于某些很复杂、难以表述的任务，基于规则的算法就显得很无力了。

比如第三个场景，我们怎么判断图片上的数字呢？看横竖？进而需要考虑到怎么判断横竖。对了，手写的时候可能会有弯曲和倾斜。哦对，还要考虑连笔的问题。emmm，还得考虑不同人的手写风格不一样.....

比如第四个场景，我们怎么描述猫呢？进而需要考虑到怎么描述猫的各个部位——耳朵、尾巴、眼睛、躯干等等。就单拿耳朵举例，猫的耳朵是什么样的？毛毛的？看起来像个三角形？哦对，还有折耳猫.....耳朵也有很多种颜色.....狗也有耳朵鸭，而且我们说的很多特征在狗身上也是成立的，那么怎么区分是猫的耳朵还是狗的耳朵呢？等等等等。

是不是快崩溃了？天哪，好麻烦啊！

基于规则的算法没有办法解决这样的问题吗？不，理论上是完全可以的。但实际上呢？我们很难人为地总结出如此详细、复杂的规则，几十万条规则都未必能解决简单的猫狗分类问题。对于稍微复杂一点的问题，整理、总结其规则的工作量更是人力难以企及的。

那么怎么办？就需要机器学习了~其精髓就在于“学习”二字上。

机器学习（包括后面会讲到的深度学习）就是一种基于数据的算法。

以猫狗分类问题为例，我们准备大量的已经标明类别的猫和狗的图片（告诉计算机哪些图片是猫的，哪些是狗的，即机器学习中的数据集），然后通过一个相对通用的算法（梯度下降、反向传播），让计算机自动地去从给定的大量图片中总结分类规则（即训练，也就是机器学习算法的“学习”过程）。

当训练完成后，我们输入一张新的图片，程序就会根据之前总结出的规则，判断这张图片是猫的图片还是狗的图片。程序总结出的规则，即为机器学习中的参数。这些参数多以矩阵的形式存在，其表达的规则的含义对人类未必可读。

1.2 关于机器学习和深度学习

机器学习实际上是对基于数据的算法的统称，它包括了如支持向量机、朴素贝叶斯、决策树、神经网络等算法。也就是说，我们常说的深度学习，是广义上的机器学习的一个子集。

而随着深度神经网络近些年来在诸多任务中都取得了远超其他机器学习算法的表现，针对于深度神经网络的研究和应用变得愈发火热，深度神经网络慢慢取得了特殊的地位，它以及由它衍生的各项技术被从广义的机器学习里面拎了出来，单独称之为“深度学习”，剩下的算法则是狭义的“机器学习”，我习惯称之为传统的统计学习算法。