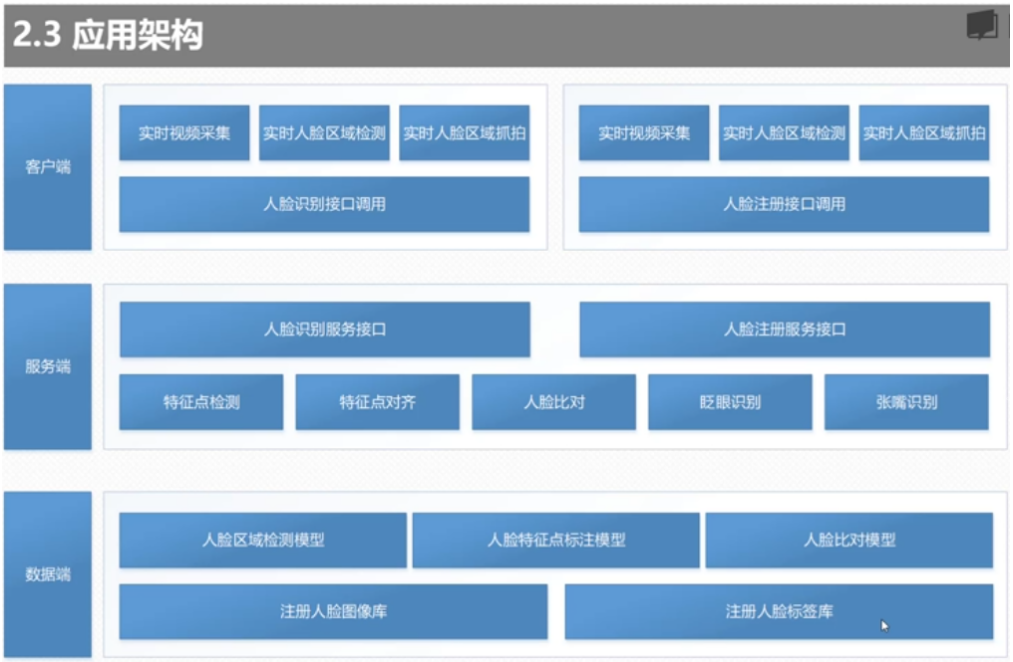
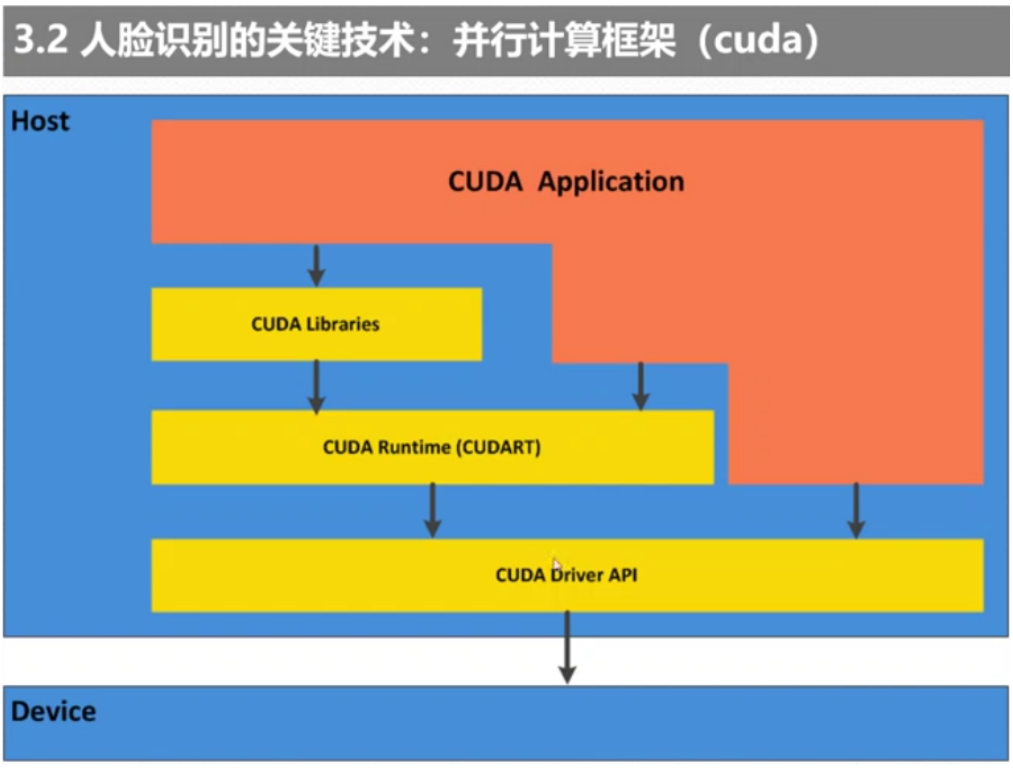
- 项目概述篇（案例演示）
  - 完整项目运行演示
    - 人脸特征点（68,72,84,194）
  - 项目系统架构设计
    - 

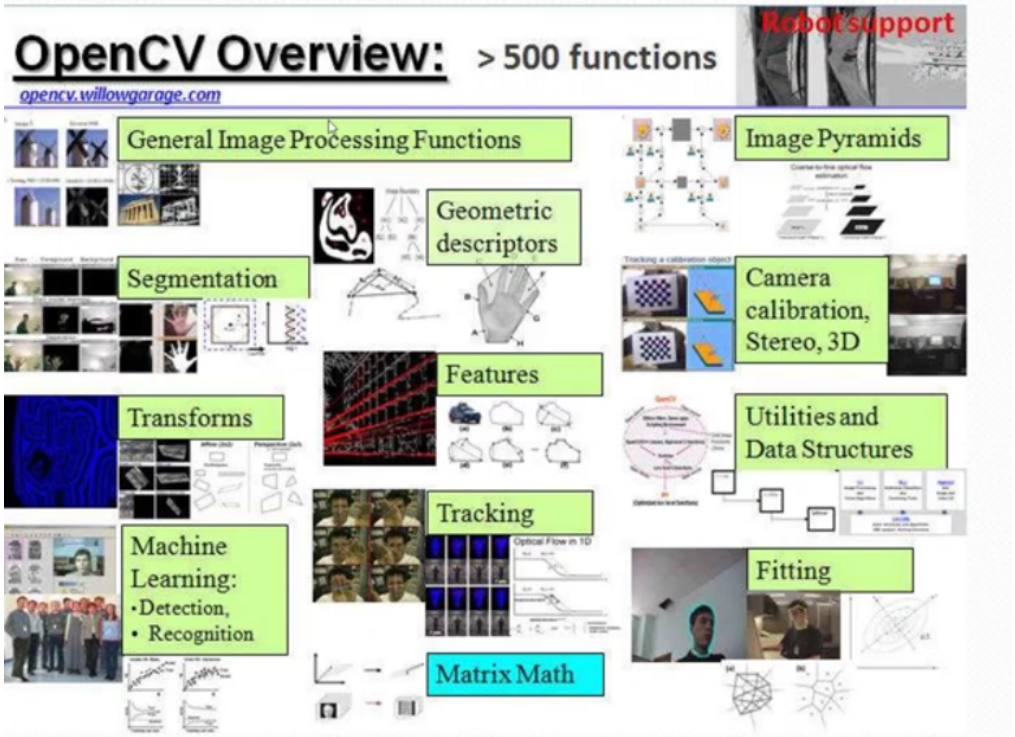

2.3 应用架构
客户端
实时视频采集
实时人脸区域检测
实时人脸区域抓拍
人脸识别接口调用
实时视频采集
实时人脸区域检测
实时人脸区域抓拍
人脸注册接口调用
服务端
人脸识别服务接口
人脸注册服务接口
特征点检测
特征点对齐
人脸比对
眨眼识别
张嘴识别
数据端
人脸区域检测模型
人脸特征点标注模型
人脸比对模型
注册人脸图像库
注册人脸标签库


2.4 数据架构
网易云
应用数据
注册人脸资源库
注册人脸标签库
训练模型
人脸特征点标注模型
人脸比对模型
人脸区域检测模型
训练样本
人脸区域检测标注样本
人脸特征点标注样本
人脸图像文件资源库

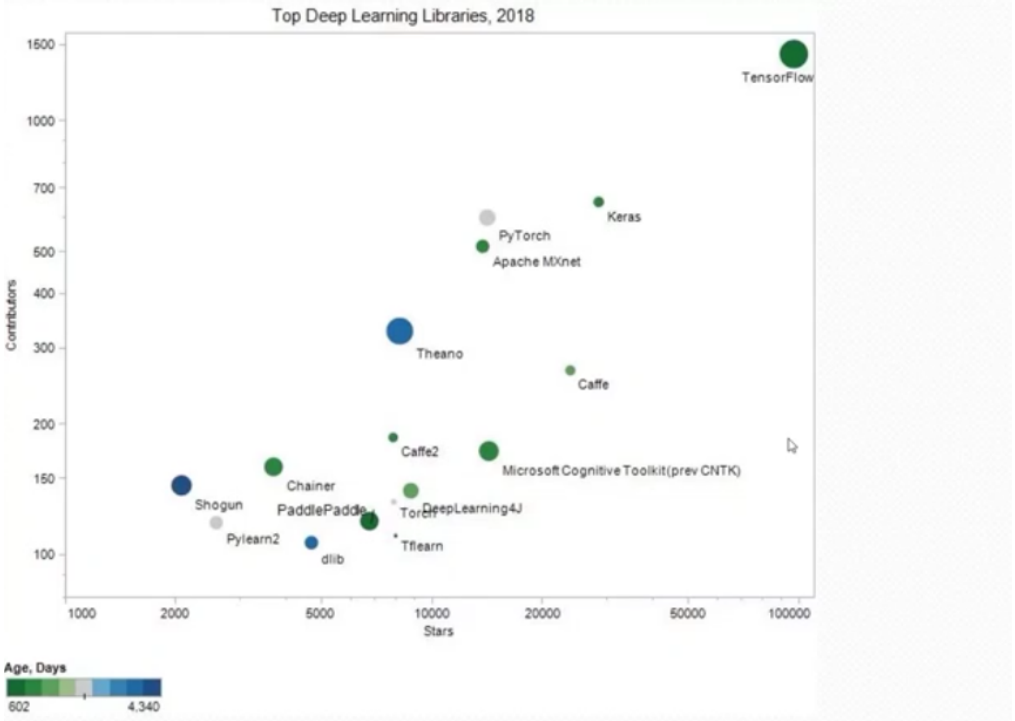
- 项目关键技术说明


3.2 人脸识别的关键技术：并行计算框架（cuda）
Host
CUDA Application
CUDA Libraries
CUDA Runtime (CUDART)
CUDA Driver API
Device

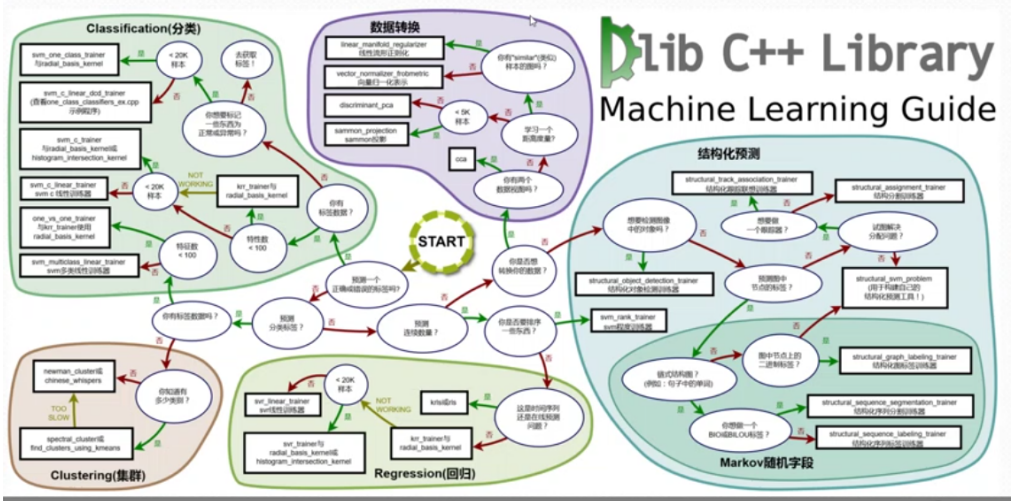
3.2 人脸识别的关键技术：专业图像处理框架



3.2 人脸识别的关键技术：深度学习框架



- 3.2 人脸识别的关键技术：深度学习框架

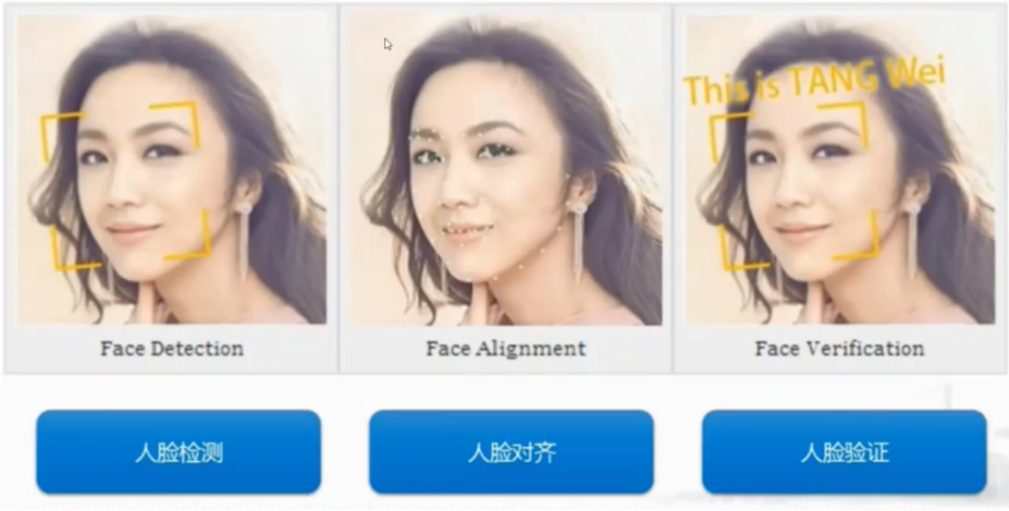


- 3.2 人脸识别的关键技术：算法模型

Simile classifiers[11]	0.8472 ± 0.0041
Attribute and Simile classifiers[11]	0.8554 ± 0.0035
Multiple LE + comp[12]	0.8445 ± 0.0046
Associate-Predict[13]	0.9057 ± 0.0056
Tom-vs-Pete[13]	0.9310 ± 0.0135
Tom-vs-Pete + Attribute[13]	0.9330 ± 0.0128
combined Joint Bayesian[13]	0.9242 ± 0.0108
high-dim LBP[C]	0.9517 ± 0.0113
DFD[13]	0.8402 ± 0.0044
TL Joint Bayesian[13]	0.9633 ± 0.0108
face.com r2011b[19]	0.9130 ± 0.0030
Face++[40]	0.9950 ± 0.0036
DeepFace-ensemble[3]	0.9735 ± 0.0025
ConvNet-RBM[5]	0.9252 ± 0.0038
POOF-gradhist[14]	0.9313 ± 0.0040
POOF-HOG[14]	0.9280 ± 0.0047
FR+FCN[18]	0.9645 ± 0.0025
DeepID[8]	0.9745 ± 0.0026
GaussianFace[47]	0.9852 ± 0.0066
DeepID2[48]	0.9915 ± 0.0013
TCIT[52]	0.9333 ± 0.0124
DeepID2+[55]	0.9947 ± 0.0012
betaface.com[56]	0.9953 ± 0.0009
DeepID3[57]	0.9953 ± 0.0010
intsky.so[59]	0.9551 ± 0.0013
Uni-Ubi[60]	0.9900 ± 0.0032
FaceNet[61]	0.9963 ± 0.0009
Baidu[64]	0.9977 ± 0.0006
AuthenMetric[65]	0.9977 ± 0.0009
MMDFR[67]	0.9902 ± 0.0019
CW-DNA-1[70]	0.9950 ± 0.0022
Faceall[71]	0.9967 ± 0.0007
JustMeTali[72]	0.9887 ± 0.0016

pose+shape+expression augmentation[73]	0.9807 ± 0.0060
ColorReco[76]	0.9940 ± 0.0022
Asaphus[77]	0.9815 ± 0.0039
Daream[78]	0.9968 ± 0.0009
Dahua-FaceImage[80]	0.9978 ± 0.0007
Skytop Gaia[82]	0.9630 ± 0.0023
CNN-3DMM estimation[83]	0.9235 ± 0.0129
Samtech Facequest[84]	0.9971 ± 0.0018
XYZ Robot[87]	0.9895 ± 0.0020
THU CV-AI Lab[88]	0.9973 ± 0.0008
dlib[91]	0.9938 ± 0.0027
Aureya[92]	0.9920 ± 0.0030
YouTu Lab, Tencent[93]	0.9980 ± 0.0023
Orion Star[92]	0.9965 ± 0.0032
Yuntu WiseSight[92]	0.9943 ± 0.0045
PingAn AI Lab[89]	0.9980 ± 0.0016
Turing123[94]	0.9940 ± 0.0040
Hisign[95]	0.9968 ± 0.0030
VisionLabs V2.0[96]	0.9978 ± 0.0007
Deepmark[98]	0.9923 ± 0.0016
Force Infosystems[97]	0.9973 ± 0.0028
ReadSense[98]	0.9982 ± 0.0007
CM-CV&AR[99]	0.9963 ± 0.0039
sensingtech[100]	0.9970 ± 0.0008
Glasssix[101]	0.9983 ± 0.0018
carevision[102]	0.9977 ± 0.0030
Tasen Electron[81]	0.9983 ± 0.0006
yunshitu[103]	0.9975 ± 0.0006
RemarkFace[104]	0.9963 ± 0.0030

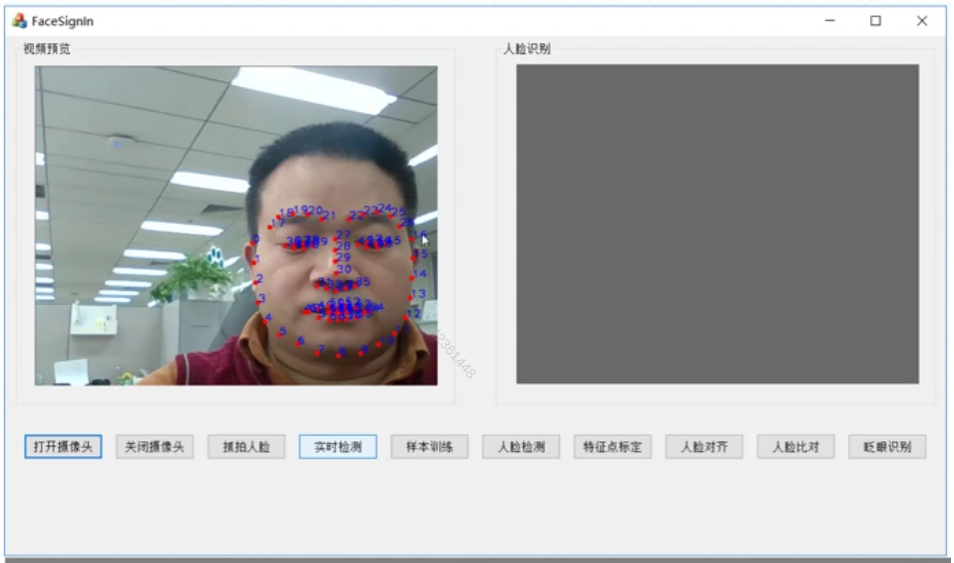
- 项目业务需求分析
  - 4.1 项目需求概述



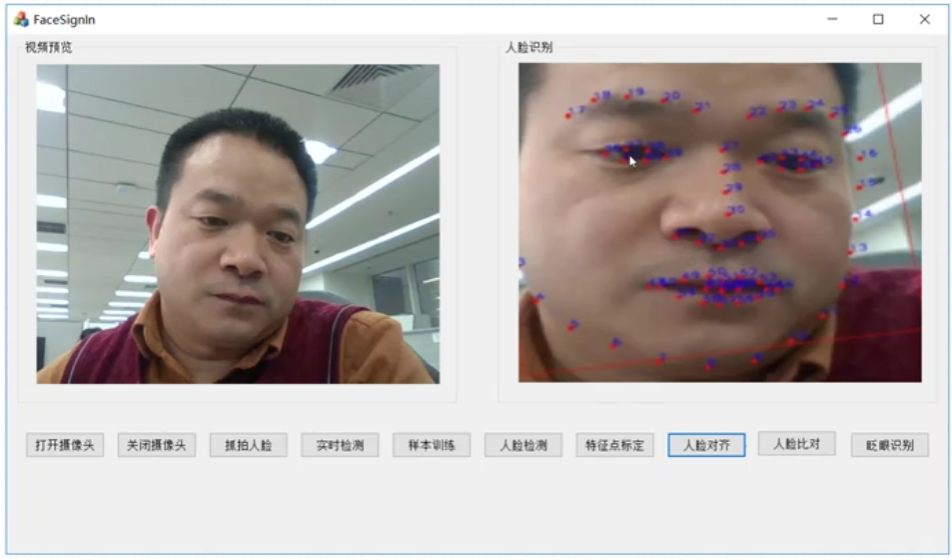
4.2 项目需求说明：人脸检测

- 人脸对齐：人脸特征点的标注（标注出特征点）->位置的矫正->特征向量的比对（特征点信息映射到128维向量，再判定欧式距离，如何在阈值之内就是同一个人）->活体检测（常见就是眨眼张嘴点头）

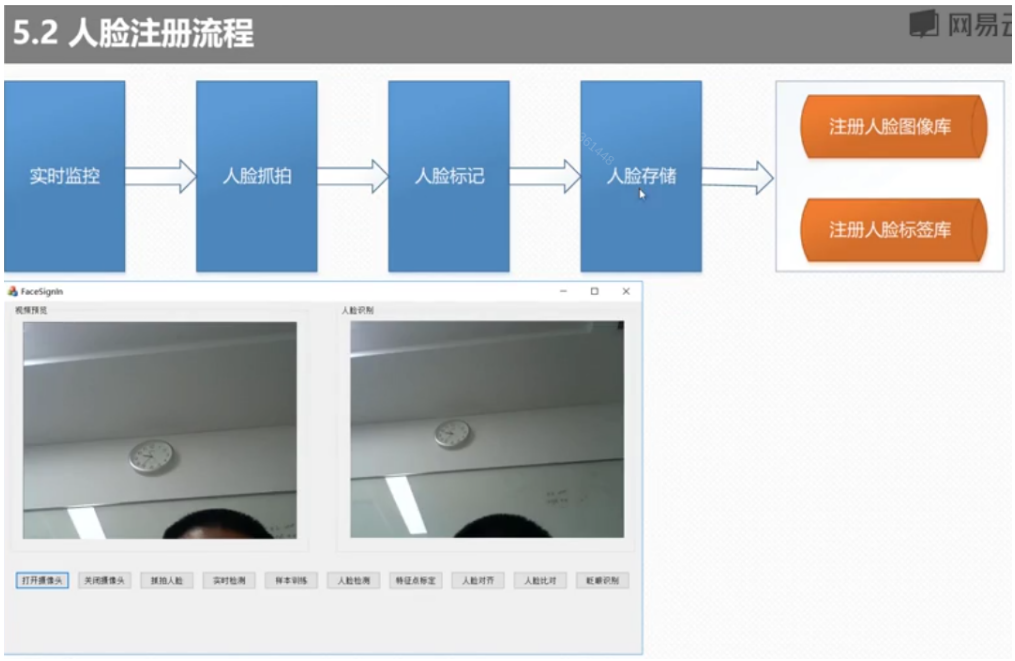
4.2 项目需求说明：人脸对齐



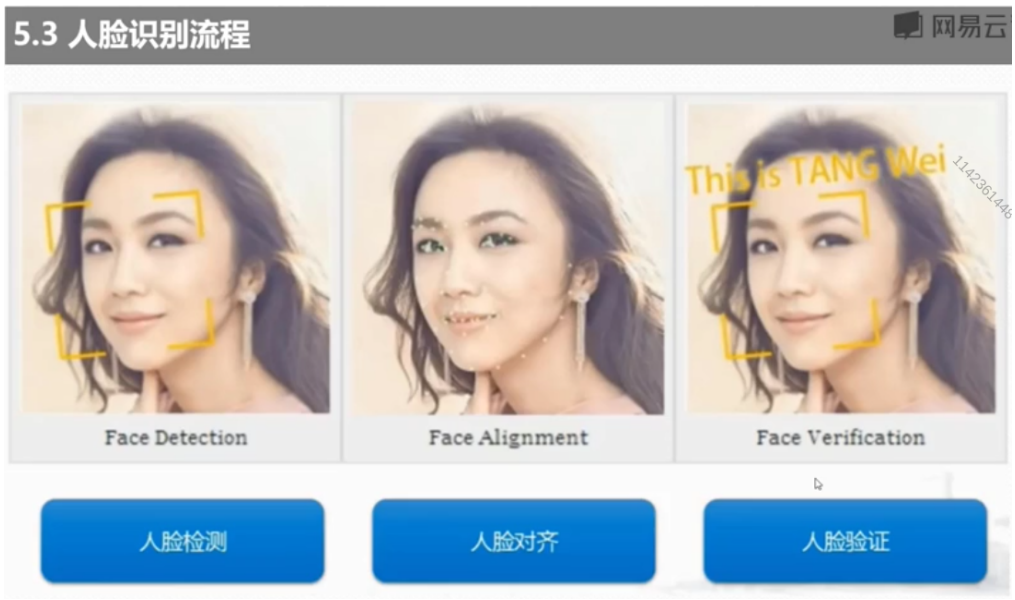
4.2 项目需求说明：人脸对齐



- 项目业务流程分析
  - 样本标注->模型训练->模型应用



  - 5.2对应如下5.3

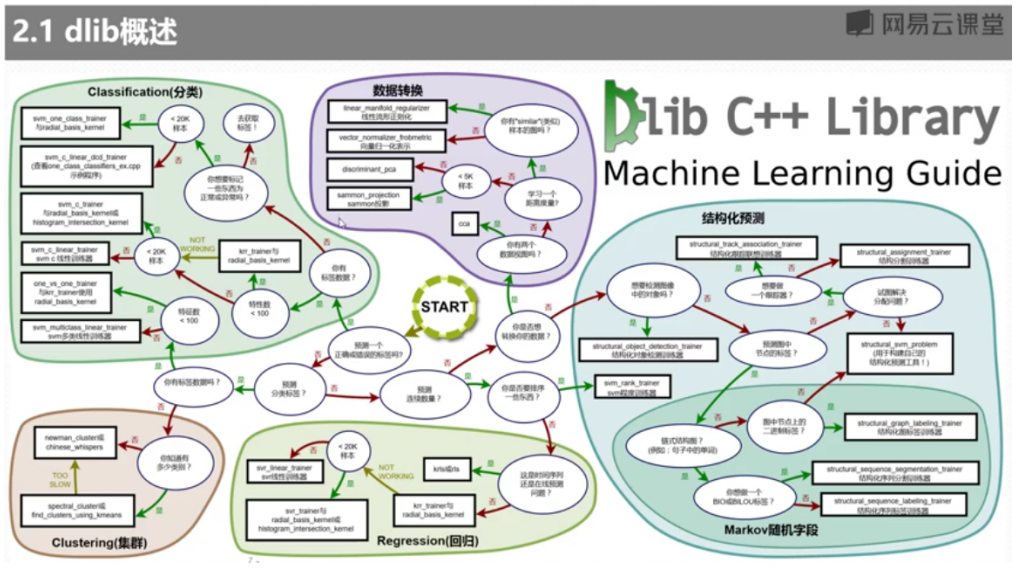


- 5.3对应的核心过程（看图对应其中内容）

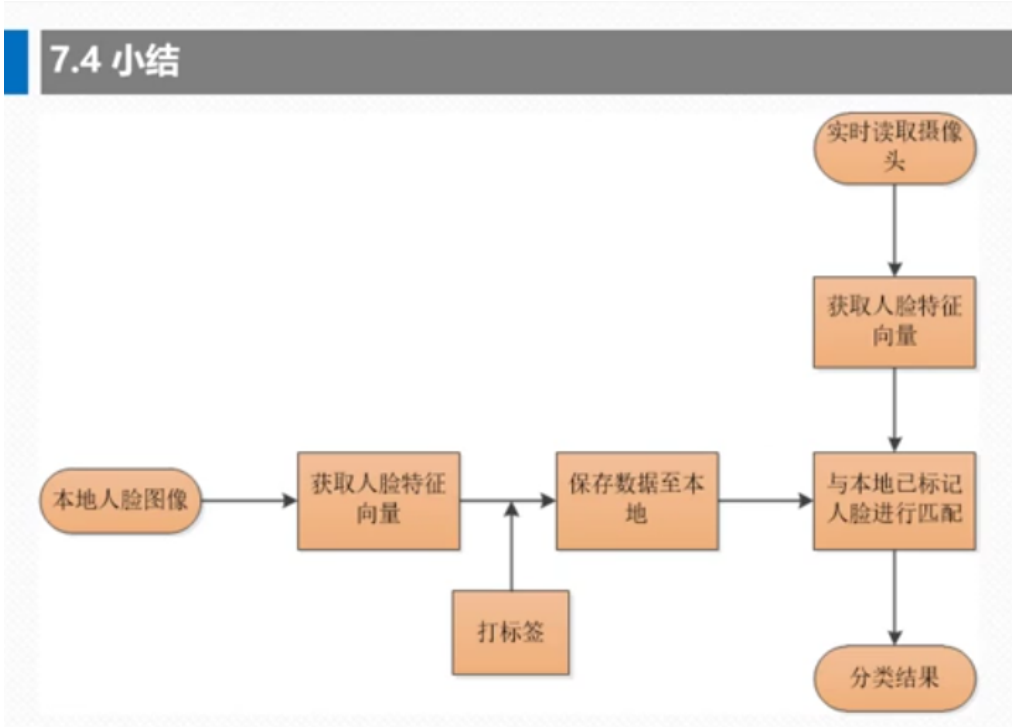
- 环境部署篇（技术框架）
  - 项目开发环境概述

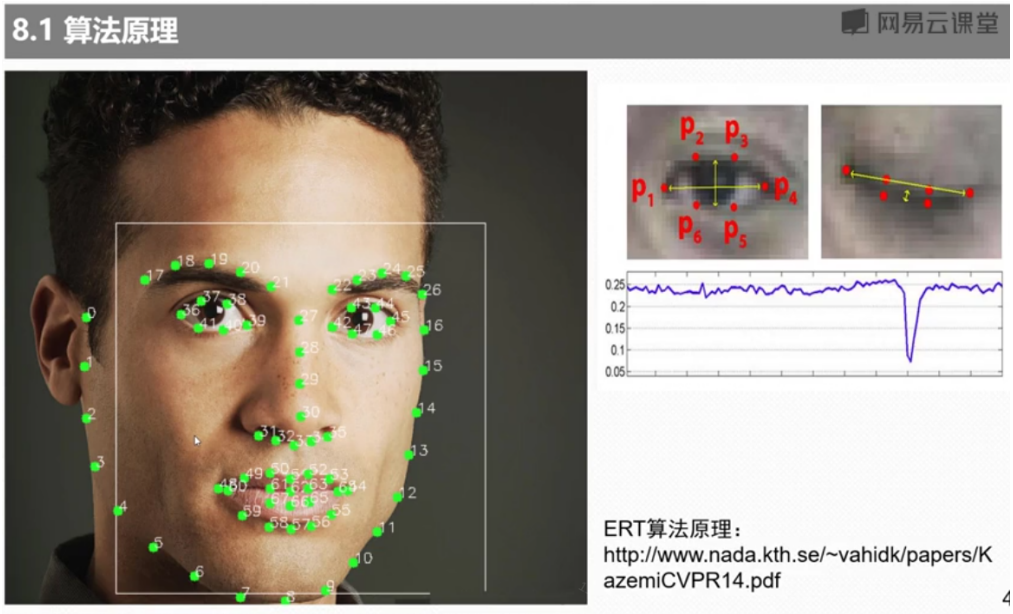
软件环境	版本	备注
操作系统	Win10	操作系统
C++ IDE	Visual Studio 2015	应用开发
Python	3.6.5	模型训练
Dlib	19.16	算法框架
cuda	9.0	模型加速
opencv	3.4.1	图像框架

    - a
    -
  - Dlib框架源码编译
    - 包含分类、集群、回归



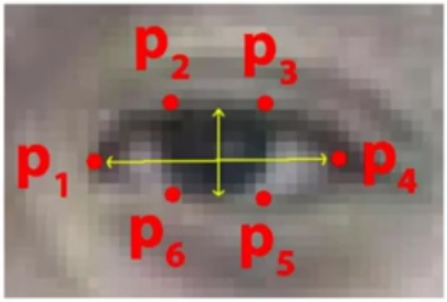
  - 项目工程文件创建
  - 项目开发环境配置之Cuda
  - 项目开发环境配置之OpenCV

    - 项目开发环境配置之Dlib
    - 项目性能优化配置
- 程序设计篇（关键技术）
    - 实时视频采集程序设计
    - 实时图像抓拍程序设计
    - 实时人脸检测程序设计
    - 实时人脸特征点标定程序设计
    - 实时人脸特征点对齐程序设计
    - 实时目标跟踪程序设计
    - 实时人脸对比程序设计
    - 

    - 实时活体检测之眨眼识别
    - 

8.1 算法原理：EAR

每只眼睛由6个（x，y）坐标表示，从眼睛的左角开始，然后围绕该区域的其余部分顺时针显示：



基于这个描述，我们应该抓住重点：这些坐标的*宽度*和*高度*之间有一个关系。

Soukupová和Čech在其2016年的论文“使用面部标志实时眼睛眨眼检测”的工作，我们可以推导出反映这种关系的方程，称为眼睛纵横比（EAR）：

$$\mathrm{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

图4：眼长宽比方程

其中*p1*，...，*p6*是2D面部地标位置。

8.2 程序设计

```
833  //眨眼检测
834  void CFaceSignInDlg::OnBnClickedBtnFaceeye()
835  {
836      if (m_beye)
837      {
838          m_beye = 0;
839      }
840      else
841      {
842          m_beye = 1;
843      }
844
845  }
```

- 设置阈值，就是发生眨眼行为了

8.2 程序设计

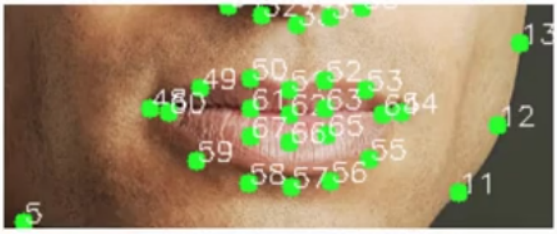
```
        //眨眼行为检测:左眼-上下四个点
        int y37 = shapes[0].part(37).y();
        int y38 = shapes[0].part(38).y();
        int y40 = shapes[0].part(40).y();
        int y41 = shapes[0].part(41).y();
        int x36 = shapes[0].part(36).x();
        int x39 = shapes[0].part(39).x();

        //1 / 2 * [(y41 + y40) - (y37 + y38)] / (x39 - x36)
        //float flg = 1/2* [(y41 + y40) - (y37 + y48)]/(x39 - x36);
        int y1 = abs(y37 - y41);
        int y2 = abs(y38 - y40);
        int x1 = abs(x39 - x36);
        //长宽比
        float flg = (y1 + y2) /(2.0 * x1);

        CString str;
        str.Format("EAR: %.2f", flg);
        m_regResult.SetWindowText(str);
    }
```

-

```
FaceSignIn.rc - I...IN_DIALOG - Dialog    FaceSignInDlg.h    FaceSignIn.cpp
CFaceSignInDlg
        //  shapes[0].part(i).x();//68个
        // zhanzl:显示特征点的数字
        putText(frame, to_string(i), cvPoint(shapes[0].part(i).x(), shapes[0].part(i).y()),
    }
}
//眨眼检测
if (m_beye)
{
    //眨眼行为检测:左眼-上下四个点
    int y37 = shapes[0].part(37).y();
    int y38 = shapes[0].part(38).y();
    int y40 = shapes[0].part(40).y();
    int y41 = shapes[0].part(41).y();
    int x36 = shapes[0].part(36).x();
    int x39 = shapes[0].part(39).x();

    // ...
    int y1 = abs(y37 - y41);
    int y2 = abs(y38 - y40);
    int x1 = abs(x39 - x36);
    //长宽比
    float flg = (y1 + y2) / (2.0 * x1);

    CString str;
    str.Format("EAR: %.2f", flg);
    m_regResult.SetWindowText(str);
}
//张嘴检测: Abs(Y50 - Y58) + Abs(Y52-56) /(2.0 * ABS(x48-x54))
if (m_bmouth)
{
    int y50 = shapes[0].part(50).y();
```

-
- 实时活体检测之张嘴识别

9.1 算法原理

- 点位选择：50、52、58、56 纵坐标；48、54横坐标；
- 
- 计算公式：长宽比
  - Abs(Y50 – Y58) + Abs(Y52-56) /(2.0 * ABS(x48-x54))

9.3 程序设计

```
871  void CFaceSignInDlg::OnBnClickedBtnFacemouse()
872  {
873      if (m_bmouth)
874      {
875          m_bmouth = 0;
876      }
877      else
878      {
879          m_bmouth = 1;
880      }
881  }
882
```

```
if (m_bmouth)
{
    int y50 = shapes[0].part(50).y();
    int y52 = shapes[0].part(52).y();
    int y56 = shapes[0].part(56).y();
    int y58 = shapes[0].part(58).y();

    int x48 = shapes[0].part(48).x();
    int x54 = shapes[0].part(54).x();

    int y1 = abs(y50 - y58);
    int y2 = abs(y52 - y56);
    int x1 = abs(x48 - x54);

    //长宽比
    float flg = (y1 + y2) / (2.0 * x1);

    CString str;
    str.Format("Mouth EAR: %.2f", flg);
    m_regResult.SetWindowText(str);
}
```

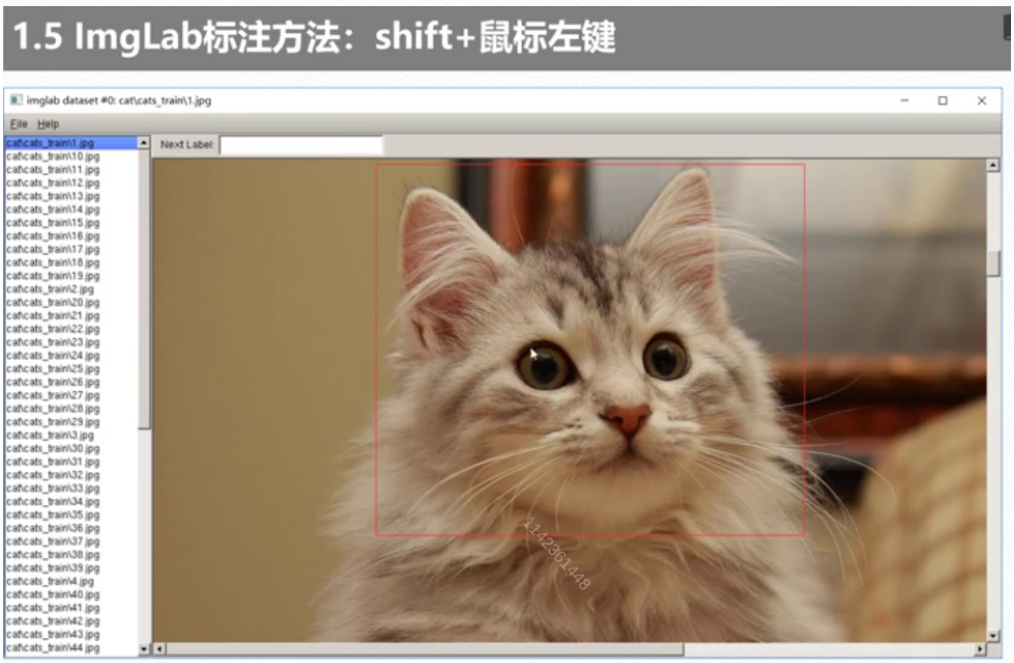
```
if (m_bmouth)
{
    int y50 = shapes[0].part(50).y();
    int y52 = shapes[0].part(52).y();
    int y56 = shapes[0].part(56).y();
    int y58 = shapes[0].part(58).y();

    int x48 = shapes[0].part(48).x();
    int x54 = shapes[0].part(54).x();

    int y1 = abs(y50 - y58);
    int y2 = abs(y52 - y56);
    int x1 = abs(x48 - x54);

    //长宽比
    float flg = (y1 + y2) / (2.0 * x1);

    CString str;
    str.Format("Mouth EAR: %.2f", flg);
    m_regResult.SetWindowText(str);
}
```

    - 人脸聚类程序设计
- 模型训练篇（模型训练）
    - 人脸区域检测样本标注（imagelab源码编译和人脸检测标注方法）

1.2 Imglab编译说明

README.txt

```
to train an object detector (e.g. a face detector) since it allows you to
easily create the needed training dataset.

You can compile imglab with the following commands:
  cd dlib/tools/imglab
  mkdir build
  cd build
  cmake ..
  cmake --build . --config Release
Note that you may need to install CMake (www.cmake.org) for this to work.  On a
unix system you can also install imglab into /usr/local/bin by running
  sudo make install
This will make running it more convenient.

Next, to use it, lets assume you have a folder of images called /tmp/images.
These images should contain examples of the objects you want to learn to
detect.  You will use the imglab tool to label these objects.  Do this by
typing the following command:
  ./imglab -c mydataset.xml /tmp/images
This will create a file called mydataset.xml which simply lists the images in
/tmp/images.  To add bounding boxes to the objects you run:
  ./imglab mydataset.xml
and a window will appear showing all the images.  You can use the up and down
arrow keys to cycle though the images and the mouse to label objects.  In
particular, holding the shift key, left clicking, and dragging the mouse will
allow you to draw boxes around the objects you wish to detect.

Once you finish labeling objects go to the file menu, click save, and then
close the program.  This will save the object boxes back to mydataset.xml.  You
can verify this by opening the tool again with:
  ./imglab mydataset.xml
and observing that the boxes are present.


imglab can do a few additional things.  To see these run:
```

- 
1.3 Imglab源码编译
- 
1.4 ImgLab运行
• 创建记录标签的配置文件：
• imglab.exe -c mydataset.xml cat//cats_train
• 进行图像检测区域标注：
• imglab.exe mydataset.xml
- 
1.5 ImgLab标注方法：shift+鼠标左键
imglab dataset #0: cat\cats_train\1.jpg
File Help
Next Label:
- 人脸区域检测模型训练

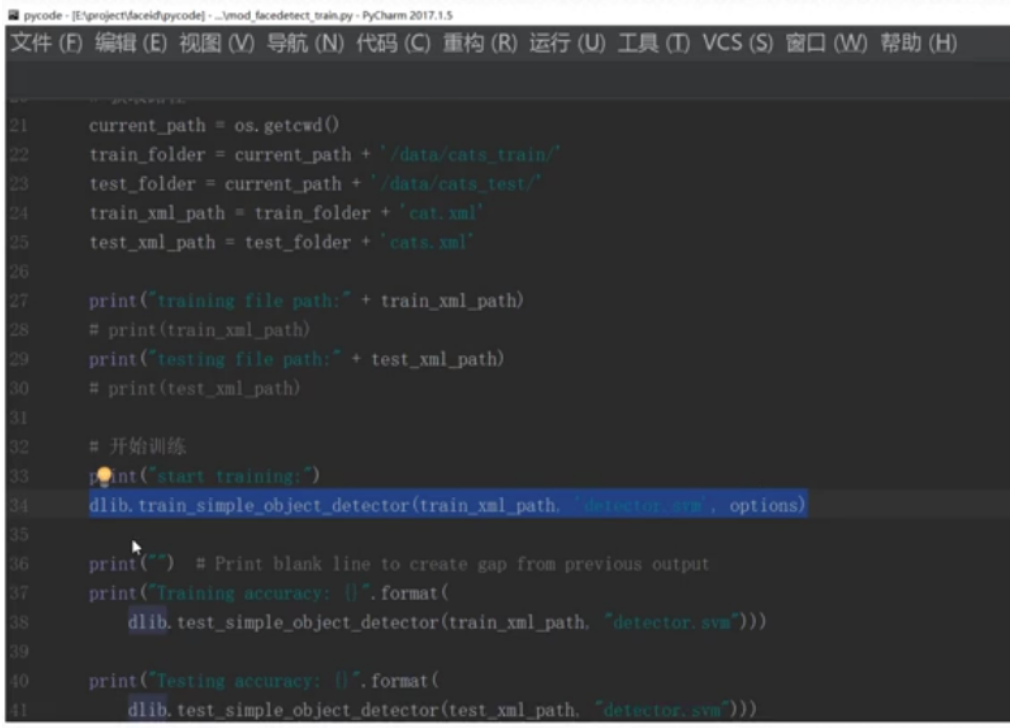
2.2 程序设计：参数设置

```python
# -*- coding: utf-8 -*-
import os
import sys
import glob
import dlib
import cv2

# options用于设置训练的参数和模式
options = dlib.simple_object_detector_training_options()
# Since faces are left/right symmetric we can tell the trainer to train a
# symmetric detector.  This helps it get the most value out of the training
# data.
options.add_left_right_image_flips = True
# 支持向量机的C参数，通常默认取为5.自己适当更改参数以达到最好的效果
options.C = 5
# 线程数，你电脑有4核的话就填4
options.num_threads = 4
options.be_verbose = True

# 获取路径
current_path = os.getcwd()
train_folder = current_path + '/data/cats_train/'
test_folder = current_path + '/data/cats_test/'
train_xml_path = train_folder + 'cat.xml'
```

2.1 样本数据

```xml
<?xml version='1.0' encoding='ISO-8859-1'?>
<?xml-stylesheet type='text/xsl' href='image_metadata_stylesheet.xsl'?>
<dataset>
<name>imglab dataset</name>
<comment>Created by imglab tool.</comment>
<images>
  <image file='1.jpg'>
    <box top='62' left='264' width='549' height='472'/>
  </image>
  <image file='10.jpg'>
    <box top='187' left='371' width='902' height='661'/>
  </image>
  <image file='11.jpg'>
    <box top='73' left='147' width='292' height='255'/>
  </image>
  <image file='12.jpg'>
    <box top='4' left='63' width='75' height='79'/>
    <box top='4' left='162' width='122' height='130'/>
  </image>
  <image file='13.jpg'>
    <box top='45' left='221' width='325' height='375'/>
  </image>
  <image file='14.jpg'>
    <box top='6' left='209' width='680' height='678'/>
  </image>
  <image file='15.jpg'>
    <box top='200' left='1003' width='342' height='362'/>
  </image>
  <image file='16.jpg'>
    <box top='73' left='470' width='256' height='270'/>
  </image>
  <image file='17.jpg'>
    <box top='184' left='442' width='644' height='521'/>
```

2.2 程序设计：接口调用

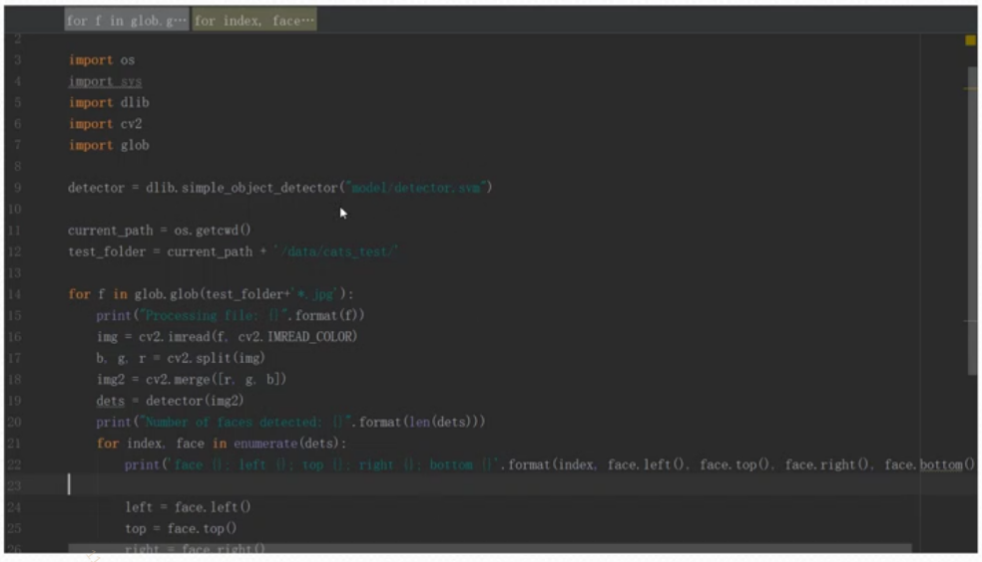


```
pycode - [E:\project\faceid\pycode] - ...\mod_facedetect_train.py - PyCharm 2017.1.5
文件 (F) 编辑 (E) 视图 (V) 导航 (N) 代码 (C) 重构 (R) 运行 (U) 工具 (T) VCS (S) 窗口 (W) 帮助 (H)

    current_path = os.getcwd()
    train_folder = current_path + '/data/cats_train/'
    test_folder = current_path + '/data/cats_test/'
    train_xml_path = train_folder + 'cat.xml'
    test_xml_path = test_folder + 'cats.xml'

    print("training file path:" + train_xml_path)
    # print(train_xml_path)
    print("testing file path:" + test_xml_path)
    # print(test_xml_path)

    # 开始训练
    print("start training:")
    dlib.train_simple_object_detector(train_xml_path, "detector.svm", options)

    print("")  # Print blank line to create gap from previous output
    print("Training accuracy: {}".format(
        dlib.test_simple_object_detector(train_xml_path, "detector.svm")))

    print("Testing accuracy: {}".format(
        dlib.test_simple_object_detector(test_xml_path, "detector.svm")))
```

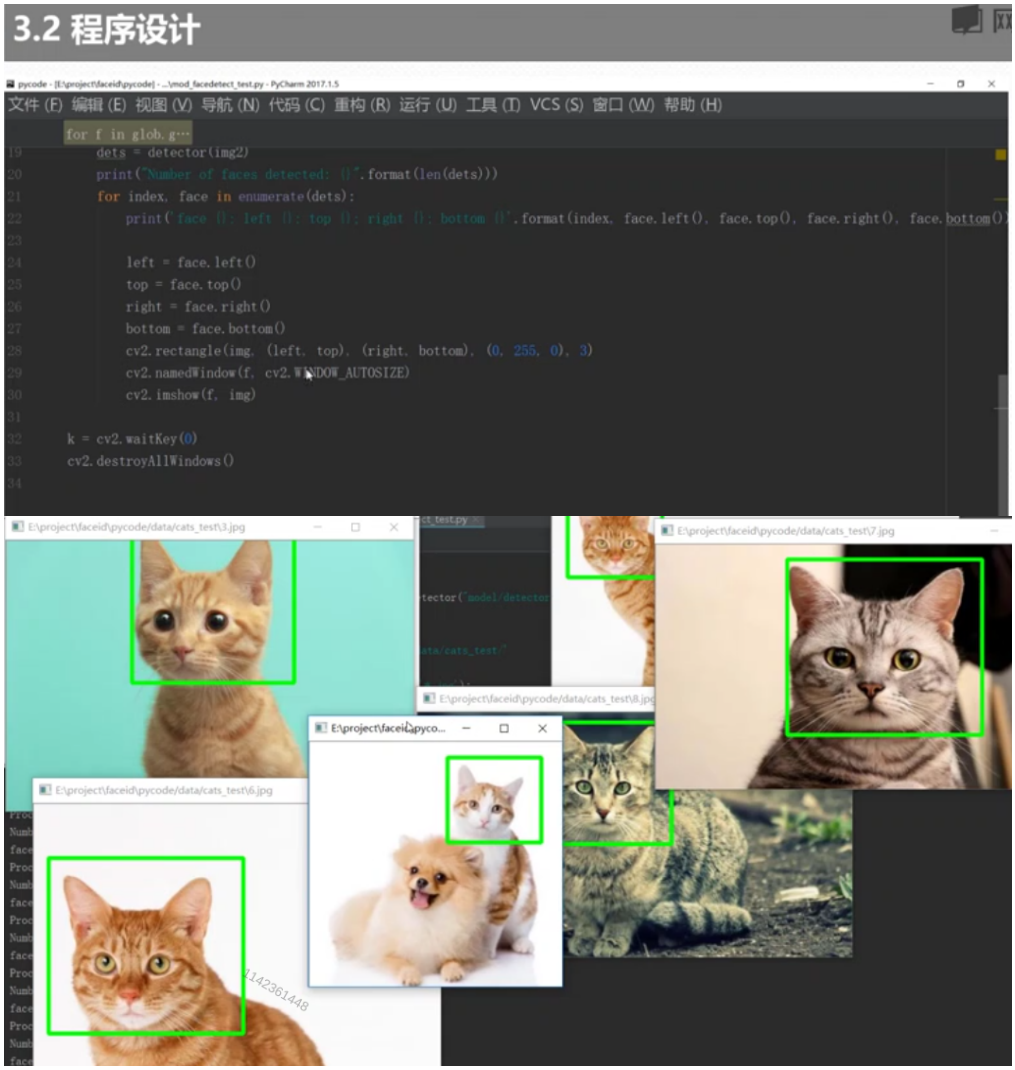
- a
-

- 人脸区域检测模型测试

3.2 程序设计

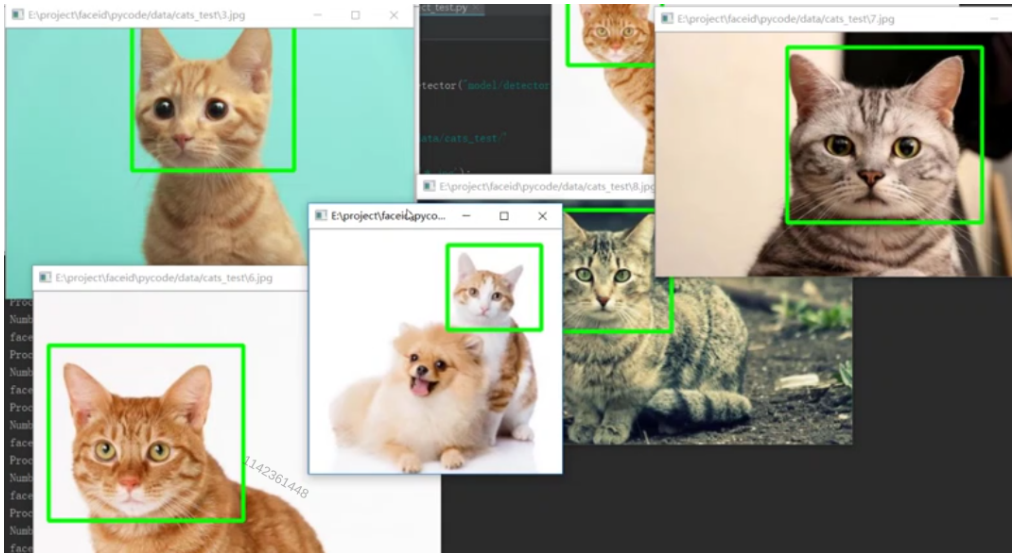


```
for f in glob.g··· for index, face···

import os
import sys
import dlib
import cv2
import glob

detector = dlib.simple_object_detector("model/detector.svm")

current_path = os.getcwd()
test_folder = current_path + '/data/cats_test/'

for f in glob.glob(test_folder+'*.jpg'):
    print("Processing file: {}".format(f))
    img = cv2.imread(f, cv2.IMREAD_COLOR)
    b, g, r = cv2.split(img)
    img2 = cv2.merge([r, g, b])
    dets = detector(img2)
    print("Number of faces detected: {}".format(len(dets)))
    for index, face in enumerate(dets):
        print('face {}; left {}; top {}; right {}; bottom {}'.format(index, face.left(), face.top(), face.right(), face.bottom()

        left = face.left()
        top = face.top()
        right = face.right()
```



- a

- 人脸特征点标定样本标注



3.1 数据标注方法

- 创建记录标签的配置文件：
  - imglab.exe -c training_with_face_landmarks.xml landmark
- 进行图像检测区域标注：
  - imglab.exe training_with_face_landmarks.xml

3.1 数据标注方法

- 创建记录标签的配置文件：
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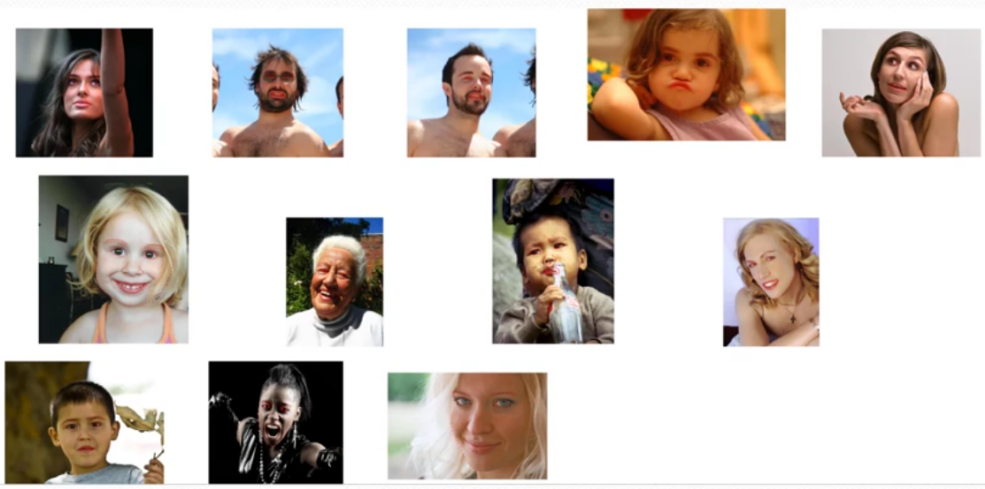
- 进行图像检测区域标注：
  - imglab.exe training_with_face_landmarks.xml

3.3 数据样本结构

training_with_face_landmarks.xml

```
<?xml version='1.0' encoding='ISO-8859-1'?>
<?xml-stylesheet type='text/xsl' href='image_metadata_stylesheet.xsl'?>
<dataset>
<name>Training faces</name>
<comment>These are images from the PASCAL VOC 2011 dataset.
  The face landmarks are from dlib's shape_predictor_68_face_landmarks.dat
  landmarking model.  The model uses the 68 landmark scheme used by the iBUG
  300-W dataset.
</comment>
<images>
 <image file='2007_007763.jpg'>
  <box top='90' left='194' width='37' height='37'>
   <part name='00' x='201' y='107'/>
   <part name='01' x='201' y='110'/>
   <part name='02' x='201' y='113'/>
   <part name='03' x='202' y='117'/>
   <part name='04' x='204' y='120'/>
   <part name='05' x='206' y='123'/>
   <part name='06' x='208' y='126'/>
   <part name='07' x='210' y='129'/>
   <part name='08' x='213' y='129'/>
   <part name='09' x='217' y='129'/>
   <part name='10' x='220' y='127'/>
   <part name='11' x='224' y='124'/>
   <part name='12' x='228' y='121'/>
   <part name='13' x='230' y='118'/>
   <part name='14' x='231' y='114'/>
   <part name='15' x='231' y='109'/>
   <part name='16' x='231' y='105'/>
   <part name='17' x='201' y='102'/>
   <part name='18' x='202' y='101'/>
   <part name='19' x='204' y='100'/>
   <part name='20' x='206' y='100'/>
   <part name='21' x='207' y='101'/>
   <part name='22' x='211' y='101'/>
```

3.5 更多数据样本-194



官方地址：http://www.ifp.illinois.edu/~vuongle2/helen/

3.5 更多数据样本

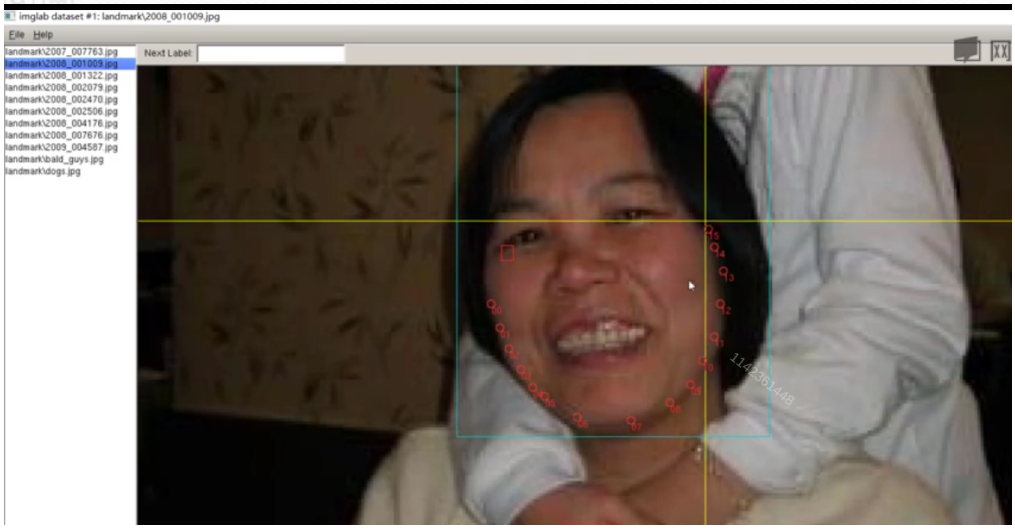
Download Link:
https://www.dropbox.com/s/jk98moqm8vopp5b/training_with_face_landmarks_2000.zip?dl=0

Steps:

1. Download Train images - part 1, Train images - part 2, Train images - part 3 & Train images - part 4 from http://www.ifp.illinois.edu/~vuongle2/helen/. (each part has 500 images, so total of 2000 images)
2. Place all the images & the training_with_face_landmarks.xml in a common folder (Ex: Folder name "train").
3. In the project train_shape_predictor_ex.cpp, comment out these sections/lines

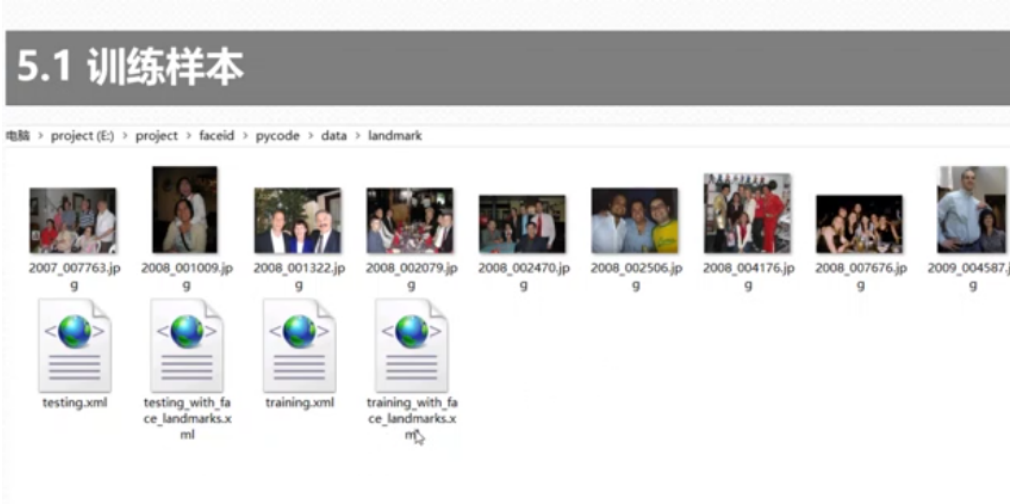
   a. Reference to testing_with_face_landmarks.xml and its usage b. trainer set_oversampling_amount(100) c. trainer set_nu(0.05) d. trainer set_tree_depth(3)
4. Set command line argument as ./train
5. Run the project
6. It will generate sp.dat of size approx 178 MB (took 2 hours approx in my laptop)
7. Use this sp.dat file in face_landmark_detection_ex project Command line Ex: sp.dat Example_image.jpg
8. In face_landmark_detection_ex.cpp, a. In a loop of 194, call draw_solid_circle function b. using save_png function save the landmark output as a file.

官方地址：http://www.ifp.illinois.edu/~vuongle2/helen/



- a

- 人脸特征点标定模型训练



5.1 训练样本

training_with_face_landmarks.xml

```
<?xml version='1.0' encoding='ISO-8859-1'?>
<?xml-stylesheet type='text/xsl' href='image_metadata_stylesheet.xsl'?>
<dataset>
<name>Training faces</name>
<comment>These are images from the PASCAL VOC 2011 dataset.
  The face landmarks are from dlib's shape_predictor_68_face_landmarks.dat
  landmarking model.  The model uses the 68 landmark scheme used by the iBUG
  300-W dataset.
</comment>
<images>
  <image file='2007_007763.jpg'>
    <box top='90' left='194' width='37' height='37'>
      <part name='00' x='201' y='107'/>
      <part name='01' x='201' y='110'/>
      <part name='02' x='201' y='113'/>
      <part name='03' x='202' y='117'/>
      <part name='04' x='204' y='120'/>
      <part name='05' x='206' y='123'/>
      <part name='06' x='208' y='126'/>
      <part name='07' x='210' y='129'/>
      <part name='08' x='213' y='129'/>
      <part name='09' x='217' y='129'/>
      <part name='10' x='220' y='127'/>
      <part name='11' x='224' y='124'/>
      <part name='12' x='228' y='121'/>
      <part name='13' x='230' y='118'/>
      <part name='14' x='231' y='114'/>
      <part name='15' x='231' y='109'/>
      <part name='16' x='231' y='105'/>
      <part name='17' x='201' y='102'/>
      <part name='18' x='202' y='101'/>
      <part name='19' x='204' y='100'/>
      <part name='20' x='206' y='100'/>
      <part name='21' x='207' y='101'/>
      <part name='22' x='211' y='101'/>
```

5.2 程序逻辑

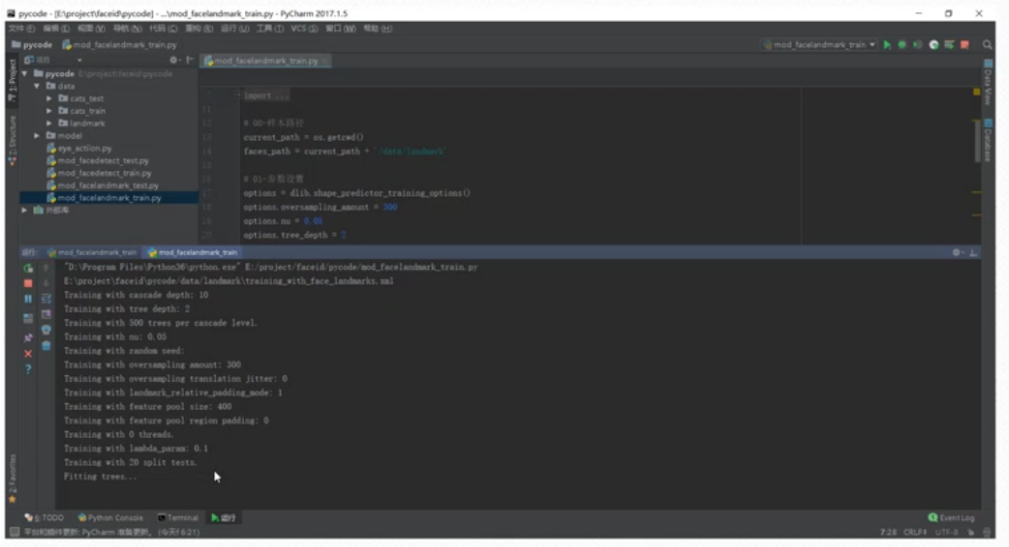
5.3 程序设计

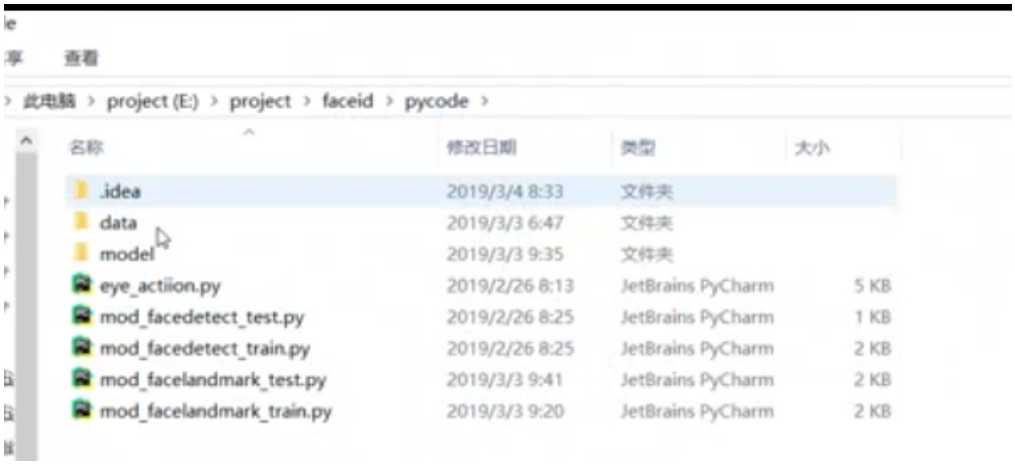
```
# 01-参数设置
options = dlib.shape_predictor_training_options()
options.oversampling_amount = 300
options.nu = 0.05
options.tree_depth = 2
options.be_verbose = True

# 02-导入打好了标签的xml文件
training_xml_path = os.path.join(faces_path, "training_with_face_landmarks.xml")
# 03-进行训练，训练好的模型将保存为predictor.dat
print(training_xml_path)
dlib.train_shape_predictor(training_xml_path, "model/predictor.dat", options)
# 04-打印在训练集中的准确率
print
"\nTraining accuracy:{0}".format(dlib.test_shape_predictor(training_xml_path, "model/predictor.dat"))
```

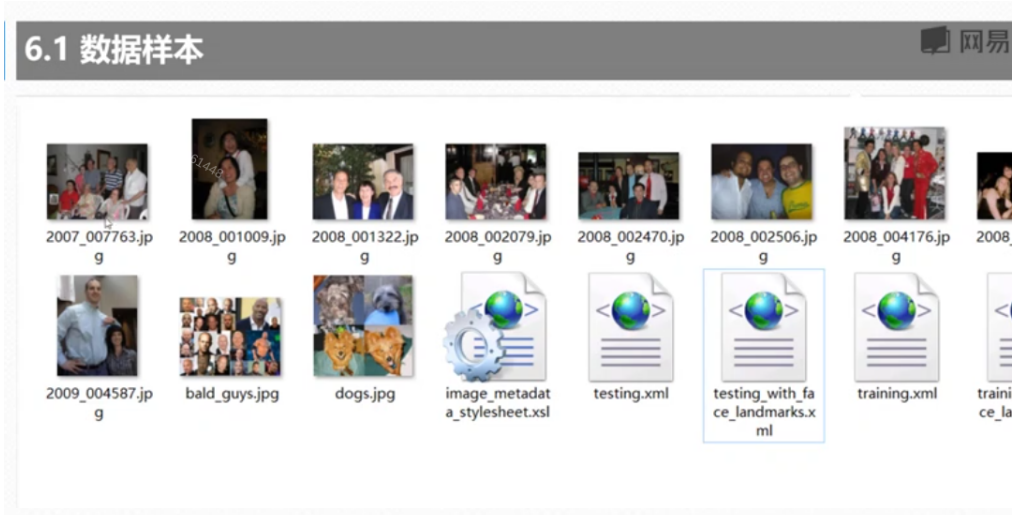
:ode] - ...\mod_facelandmark_train.py - PyCharm 2017.1.5

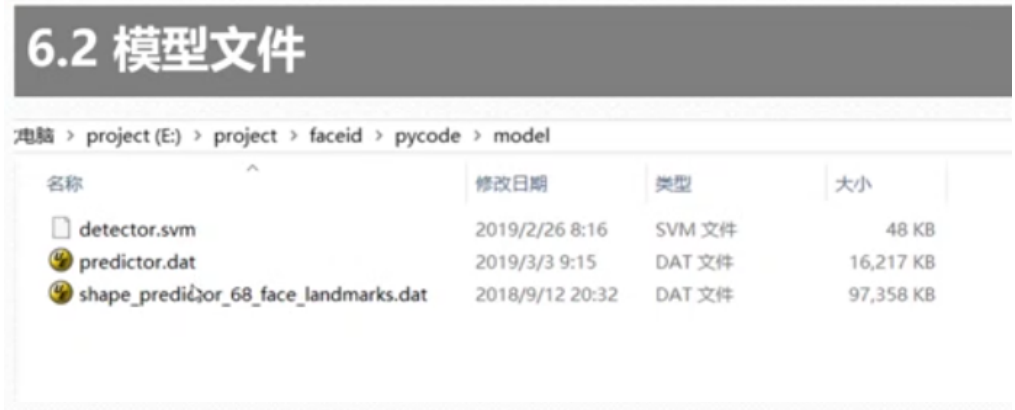
```
current_path = os.getcwd()
faces_path = current_path + '/data/landmark'

# 01-参数设置
options = dlib.shape_predictor_training_options()
options.oversampling_amount = 300
options.nu = 0.05
options.tree_depth = 2
options.be_verbose = True

# 02-导入打好了标签的xml文件
training_xml_path = os.path.join(faces_path, "training_with_face_landmarks.xml")
# 03-进行训练，训练好的模型将保存为predictor.dat
print(training_xml_path)
dlib.train_shape_predictor(training_xml_path, "model/predictor.dat", options)
# 04-打印在训练集中的准确率
print
"\nTraining accuracy:{0}".format(dlib.test_shape_predictor(training_xml_path, "model/predictor.dat"))

# 05-导入测试集的xml文件
testing_xml_path = os.path.join(faces_path, "testing_with_face_landmarks.xml")
# 打印在测试集中的准确率
print
"\Testing accuracy:{0}".format(dlib.test_shape_predictor(testing_xml_path, "model/predictor.dat"))
```

5.3 程序执行



- 

  - 人脸特征点标定模型测试
- 

- 

- 

6.4 程序设计

```
import cv2
import dlib
import glob

# 01-路径设置
current_path = os.getcwd()
faces_path = current_path + '/data/landmark'

# 模型加载
predictor = dlib.shape_predictor("model/predictor.dat")
detector = dlib.get_frontal_face_detector()
print("Showing detections and predictions on the images in the faces folder...")
for f in glob.glob(os.path.join(faces_path, "*.jpg")):
    print("Processing file: {}".format(f))
    img = cv2.imread(f)
    img2 = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    # 02-人脸区域检测
    dets = detector(img2, 1)
    print("Number of faces detected: {}".format(len(dets)))
```

6.4 程序设计


```
    for index, face in enumerate(dets):
        print('face {}; left {}; top {}; right {}; bottom {}'.format(index, face.left(), face.top(), face.right(),
                                                                     face.bottom()))
        ...
        shape = predictor(img, face)
        # print(shape)
        # print(shape.num_parts)
        for index, pt in enumerate(shape.parts()):
            print('Part {}: {}'.format(index, pt))
            pt_pos = (pt.x, pt.y)
            # 04-特征点绘制
            cv2.circle(img, pt_pos, 2, (255, 0, 0), 1)
        # print(type(pt))
        # print("Part 0: {}, Part 1: {} ...".format(shape.part(0), shape.part(1)))
        cv2.namedWindow(f, cv2.WINDOW_AUTOSIZE)
        cv2.imshow(f, img)

cv2.waitKey(0)
cv2.destroyAllWindows()
```

- 偏了，需要优化训练样本

6.5 结果输出

```
...

import os
import cv2
import dlib
import glob

# 01-路径设置
current_path = os.getcwd()
faces_path = current_path + '/data/landmark'

# 模型加载
predictor = dlib.shape_predictor("model/predictor.dat")
detector = dlib.get_frontal_face_detector()
print("Showing detections and predictions on the images in the faces folder...")
for f in glob.glob(os.path.join(faces_path, "*.jpg")):
    print("Processing file: {}".format(f))
    img = cv2.imread(f)
    img2 = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    # 02-人脸区域检测
    dets = detector(img2, 1)
    print("Number of faces detected: {}".format(len(dets)))
    for index, face in enumerate(dets):
        print('face {}; left {}; top {}; right {}; bottom {}'.format(index, face.left(), face.top(), face.right(),
```

```
for f in glob.g···  for index, face···
    img2 = cv2.cvtColor(img, cv2.COLOR_BGR2GRAY)
    # 02-人脸区域检测
    dets = detector(img2, 1)
    print("Number of faces detected: {}".format(len(dets)))
    for index, face in enumerate(dets):
        print('face {}; left {}; top {}; right {}; bottom {}'.format(index, face.left(), face.top(), face.right(),
                                                                     face.bottom()))
        ...
        shape = predictor(img, face)
        # print(shape)
        # print(shape.num_parts)
        for index, pt in enumerate(shape.parts()):
            print('Part {}: {}'.format(index, pt))
            pt_pos = (pt.x, pt.y)
            # 04-特征点绘制
            cv2.circle(img, pt_pos, 2, (255, 0, 0), 1)
        # print(type(pt))
        # print("Part 0: {}, Part 1: {} ...".format(shape.part(0), shape.part(1)))
        cv2.namedWindow(f, cv2.WINDOW_AUTOSIZE)
        cv2.imshow(f, img)

cv2.waitKey(0)
cv2.destroyAllWindows()
```

- 往往训练样本不够，跟源码无关
  - 

- 人脸注册