Using Face Recognition to Detect "Ghost Writer" Cheating in Examination

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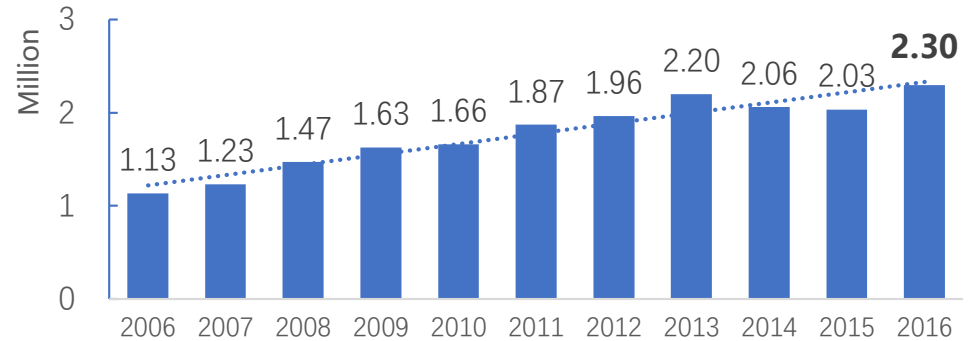
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Outline

- Background
- The architecture
- Experimental test
- Summary

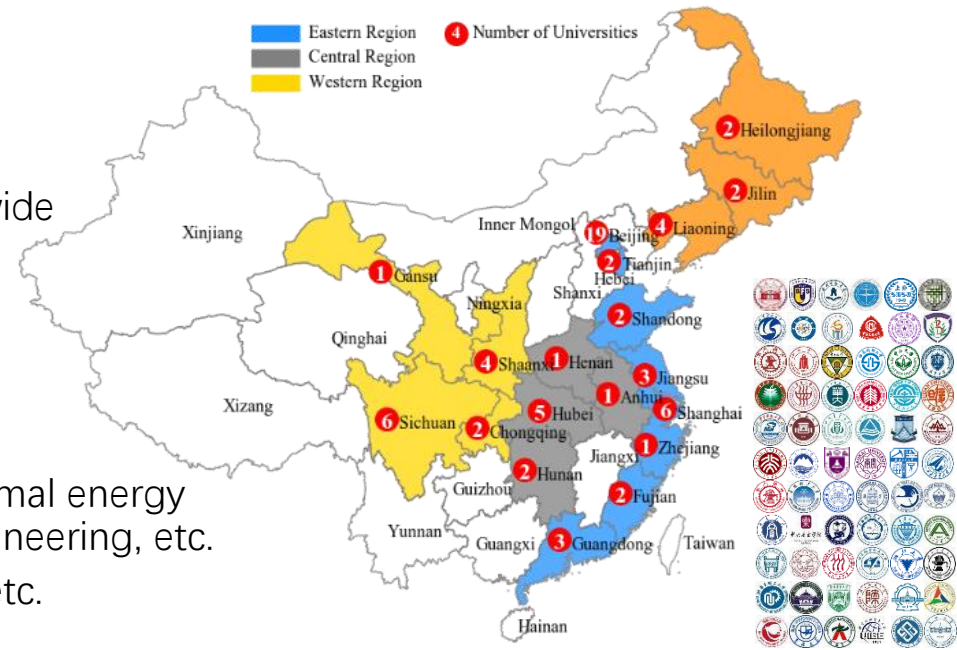# Background – Online Distance Education (ODE)

- The ODE in China
  - For the working population
  - Internet based
  - **Higher Education**

The national enrollment of ODE in China during 2006-2016

- The enrollment of ODE
  - Up to 2.3 million students per year
  - 68 universities
    - Approved by the MOE of China
    - Thousands of learning centers nationwide
  - 2 academic levels
    - Junior college degree
    - Bachelor degree
  - Dozens of specialties
    - Computer science, power system, thermal energy mechanical engineering, chemical engineering, etc.
    - Law, accounting, business admission, etc.
    - Nursing, Pharmacy, etc.

Geographical distribution of the 68 universities approved by MOE of China

Background – Online Distance Education (ODE)

- The examinations in ODE
  - Entrance exams: before starting online learning
    - Offline written examinations

  - Course exams: at the end of each semester
    - Offline written examinations + Online examinations

  - Large-scale student population
    - More than 70,000 students
    - 20~30 courses for each students

Offline entrance examinations

Offline course examinations

Online course examinations

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Background – Cheating in ODE

- Cheatings in ODE
  - Cheat sheets
  - Paging receiver
  - Wireless earphone

Cheat sheets

Paging receiver

Wireless earphone

- **Ghost Writer**

Fake photo on ID

Makeup

Limited items allowed

Metal detector

- Challenges of anti-ghostwriter
  - Accurate detection
  - Scalable
  - Affordable

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SIFR framework – Architecture

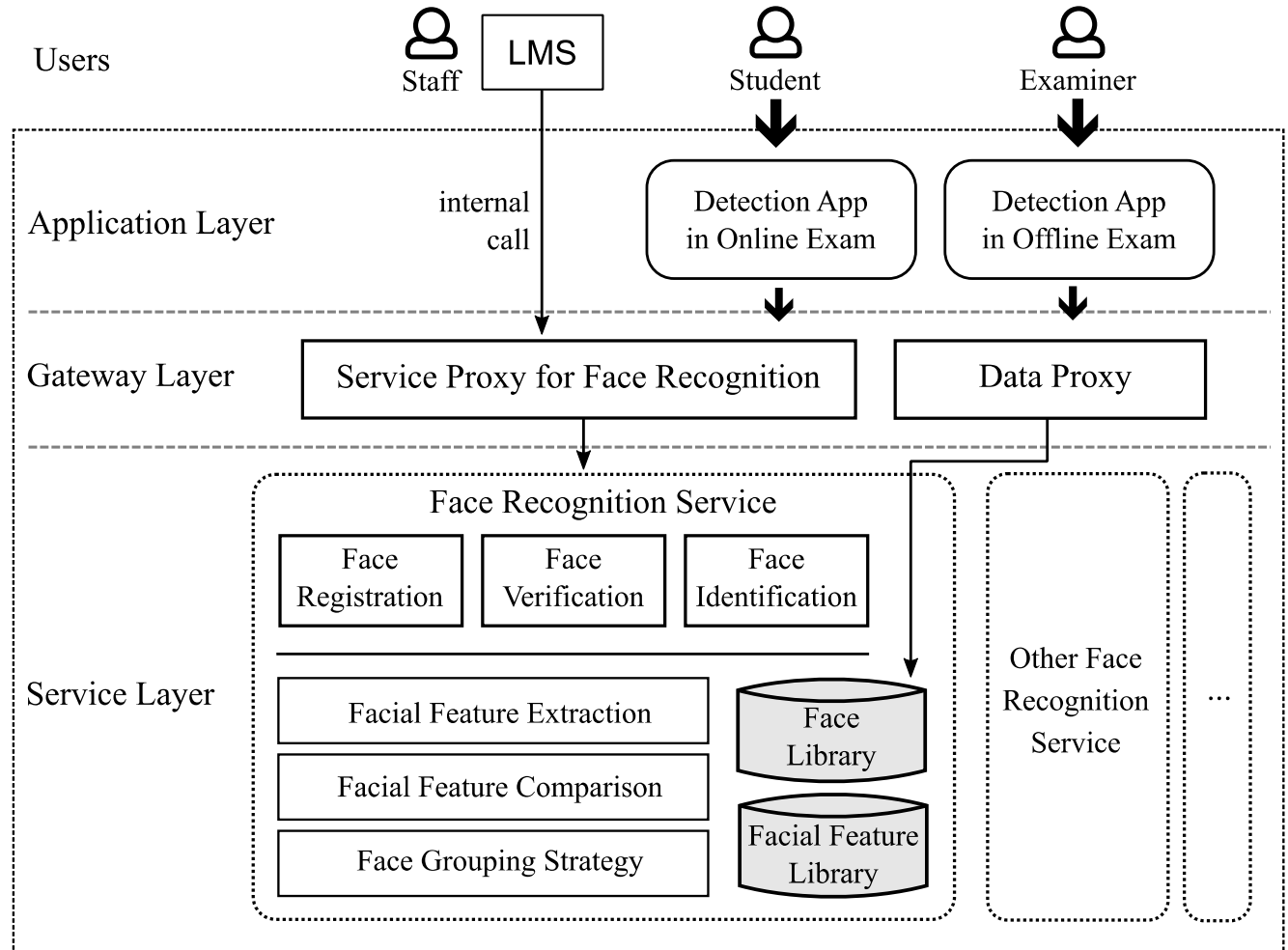- Student Identification by Face Recognition (SIFR)
  - Three layers
    - Service
    - Gateway
    - Application

  - Two types
    - Online exam
    - Offline exam

  - For
    - Staff
    - Student
    - Examiner

Users

Staff | LMS | Student | Examiner

Application Layer

internal call

Detection App in Online Exam | Detection App in Offline Exam

Gateway Layer

Service Proxy for Face Recognition | Data Proxy

Service Layer

Face Recognition Service

Face Registration | Face Verification | Face Identification

Facial Feature Extraction

Facial Feature Comparison

Face Grouping Strategy

Face Library

Facial Feature Library

Other Face Recognition Service

...

The architecture of the SIFR framework

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SIFR framework – Service Layer

- 3 interfaces
  - Face Registration

Group 1 […]

Group 2 […]

features

original picture

Face Libs

  - Face Verification

Input face [face] is { [face] 00114091234 } ?
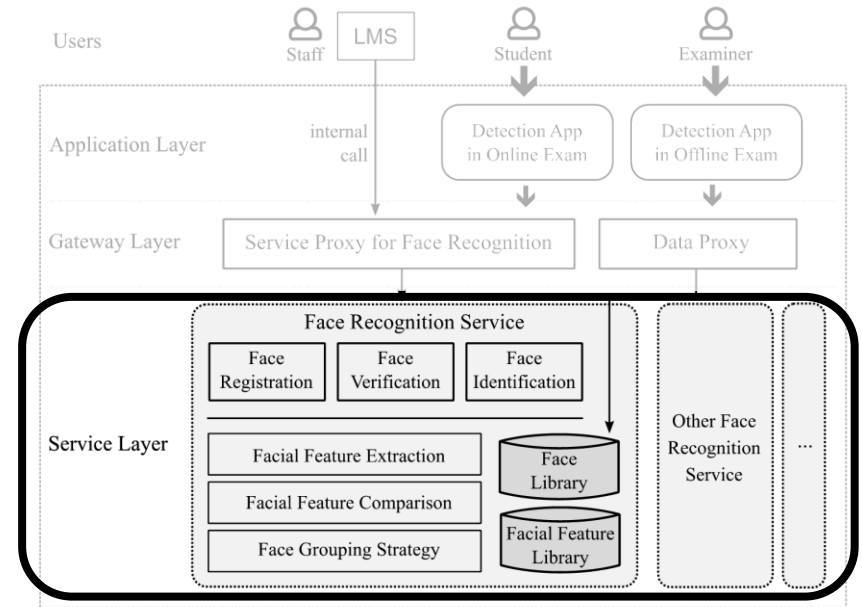
  - Face Identification
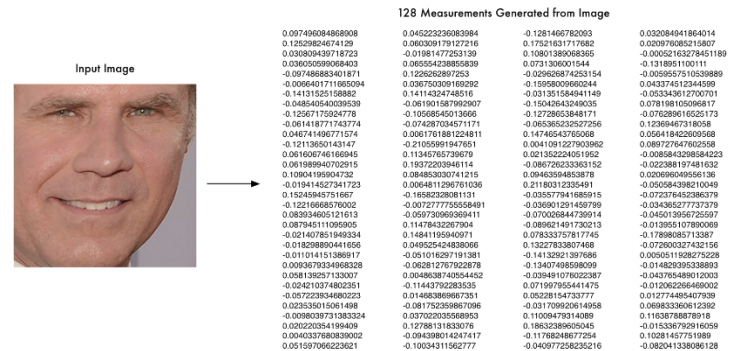
Input face [face] is one of […] ?

- Key technologies
  - Facial feature extraction
  - Facial feature comparison
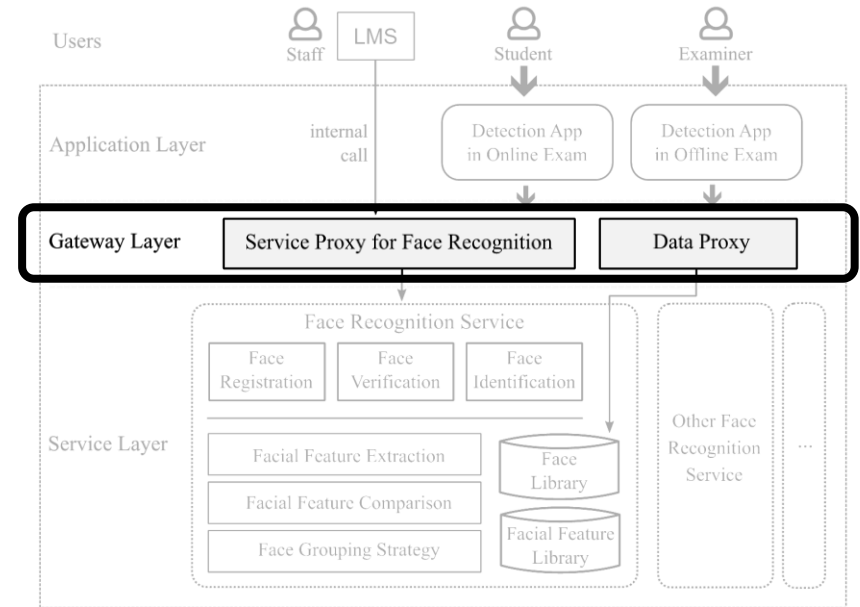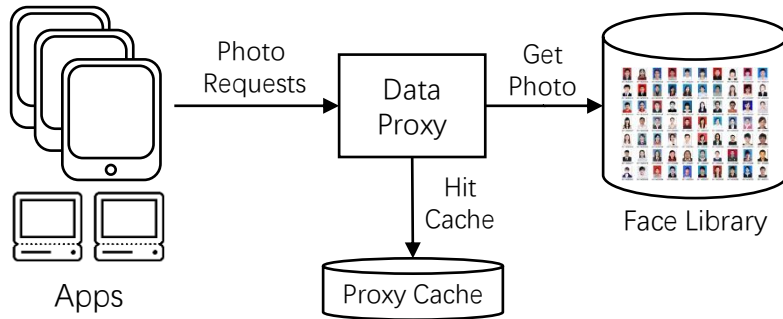 - Face grouping strategy

The architecture of the SIFR framework

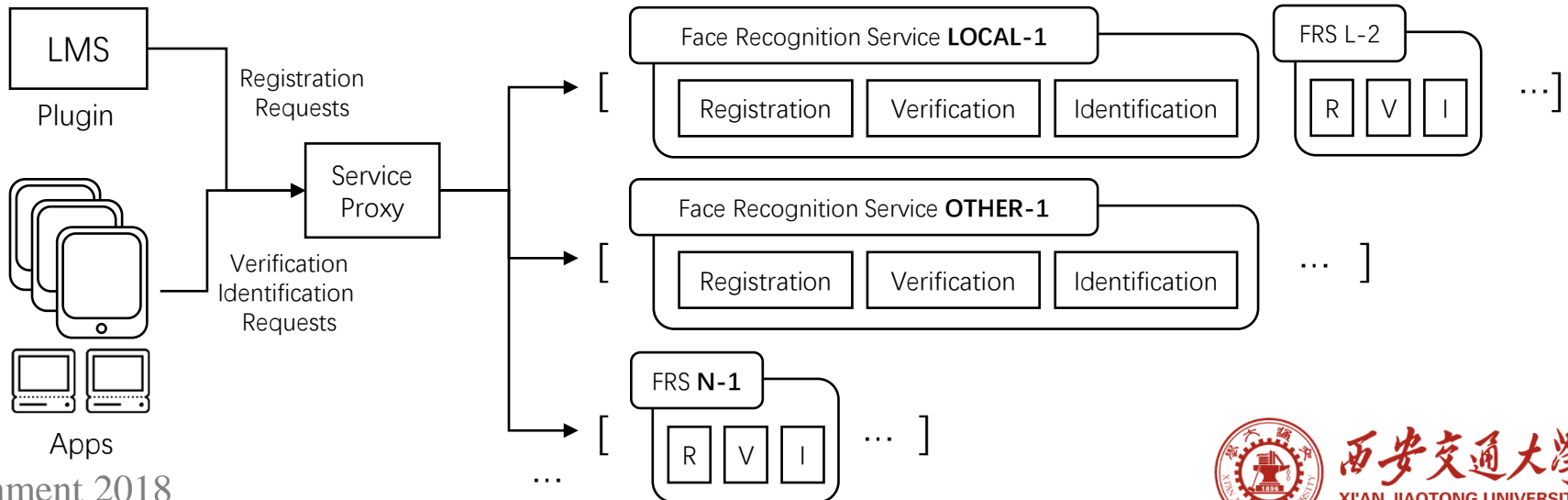Open source lib: OpenFace [1]

[1] B. Amos, B. Ludwiczuk, M. Satyanarayanan, "Openface: A general-purpose face recognition library with mobile applications," CMU-CS-16-118, CMU School of Computer Science, Tech. Rep., 2016.

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SIFR framework – Gateway Layer

- Two proxies
  - Data Proxy: photo requests

Photo Requests → Data Proxy → Get Photo → Face Library

Apps → Data Proxy

Hit Cache → Proxy Cache

The architecture of the SIFR framework

Users — Staff | LMS | Student | Examiner

Application Layer — internal call — Detection App in Online Exam — Detection App in Offline Exam

Gateway Layer — Service Proxy for Face Recognition — Data Proxy

Service Layer — Face Recognition Service — Face Registration | Face Verification | Face Identification — Other Face Recognition Service

Facial Feature Extraction — Face Library
Facial Feature Comparison
Face Grouping Strategy — Facial Feature Library

- Service Proxy: face recognition requests

LMS — Plugin

Registration Requests

Service Proxy

Verification Identification Requests

Apps

Face Recognition Service **LOCAL-1**
Registration | Verification | Identification

FRS L-2
R | V | I   ...]

Face Recognition Service **OTHER-1**
Registration | Verification | Identification   ...]

FRS **N-1**
R | V | I   ...]

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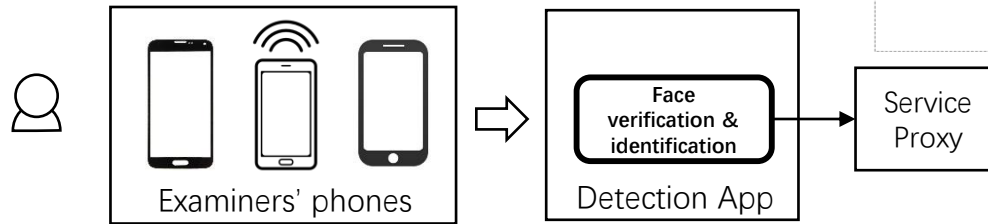XI'AN JIAOTONG UNIVERSITY

SIFR framework - Application Layer

- Three applications
  - Staff
  - Examiner
  - Student
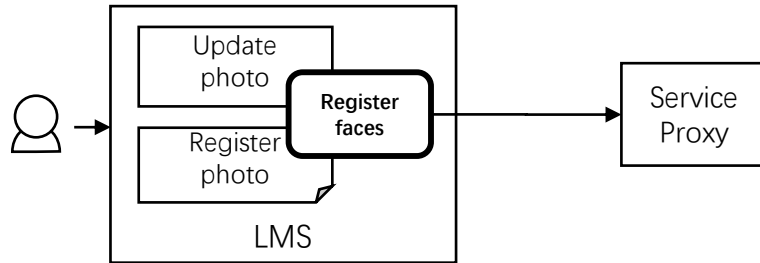
The architecture of the SIFR framework

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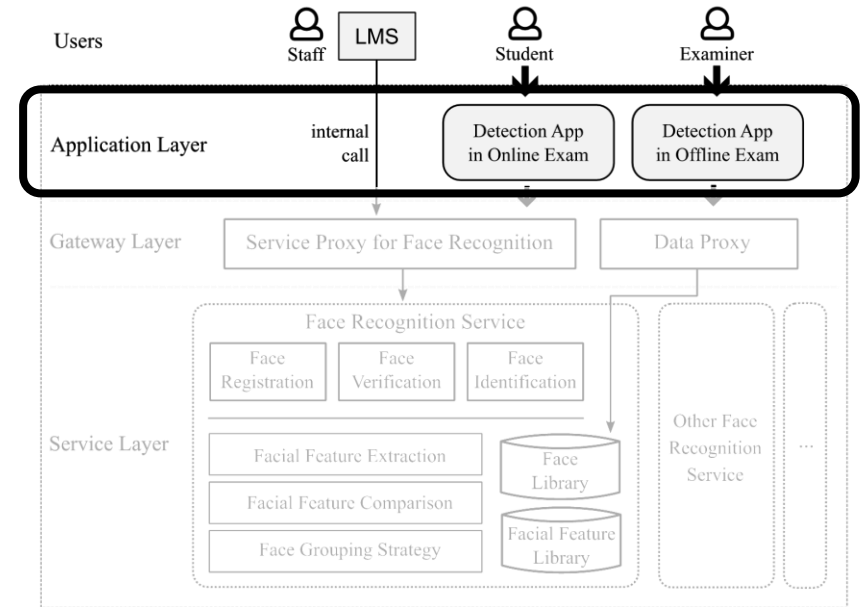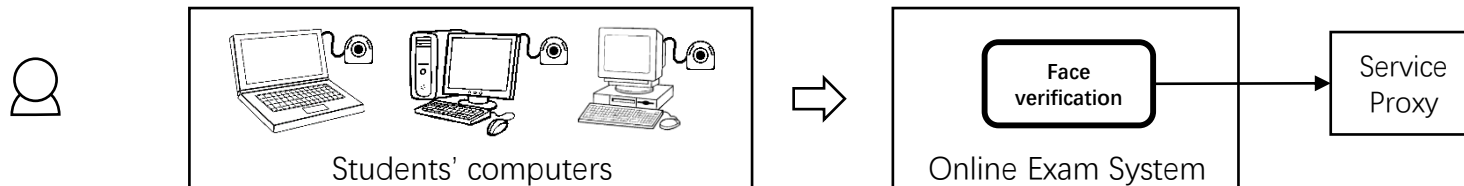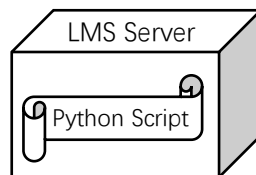
Implementation

- Prototype implementation
  - Application Layer
    - Python Script
    - JavaScript Plugin
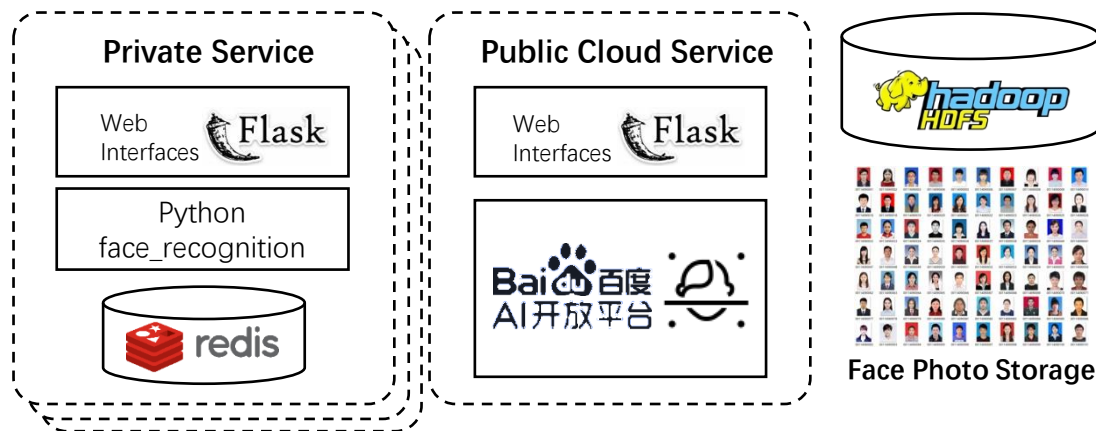   - HTML5 App
  - Gateway Layer
   - Nginx
    - Flask Web Server
  - Service Layer
    - Private
      - ageitgey/face_recognition[1]
      - Group by student attributes
    - Public cloud
      - Baidu AI [2]
      - More
    - Photo Storage
      - Hadoop HDFS

Service and Data Proxy

Private Service

Web Interfaces — Flask

Python face_recognition

redis

Public Cloud Service

Web Interfaces — Flask

Face Photo Storage

The prototype implementation of the SIFR framework

[1] ageitgey/face_recognition. https://github.com/ageitgey/face_recognition
[2] Baidu AI. http://ai.baidu.com/solution/faceprint

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Experimental test

- Experimental dataset: PubFig83[1]
  - 83 persons, 8,300 facial images, made up of 100+ images for each person
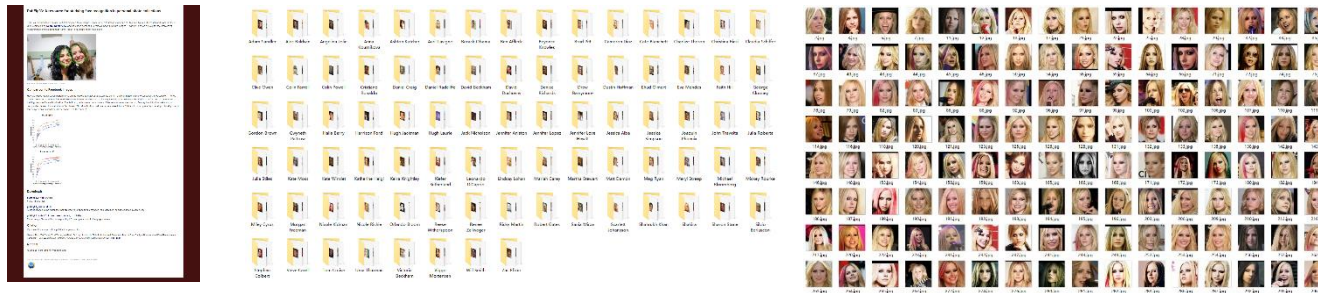
  - Test groups: 83 students + 17 ghostwriters

[   ] + [   ]

  randomly selected from PubFig83   random from internet

- Results

Service	Student		Ghostwriter		Accuracy	Precision
	Correct	Incorrect	Correct	Incorrect		
Private service	75.9	7.1	17	0	92.90%	91.45%
Public cloud service	78.9	4.1	17	0	95.90%	95.06%

[1] Nicolas Pinto, Zak Stone, Todd Zickler, and David D. Cox, "Scaling Up Biologically-Inspired Computer Vision: A Case Study in Unconstrained Face Recognition on Facebook", *Proc. Workshop on Biologically Consistent Vision (in conjunction with CVPR),* 2011

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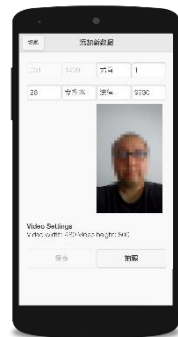
Experimental usage

- Online course exam

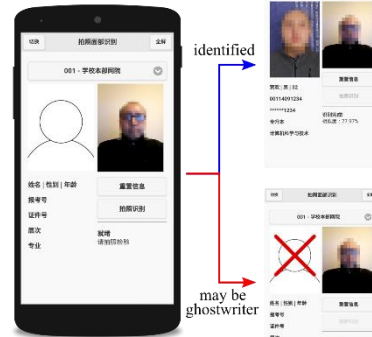face verification before starting exam

face verification during exam

- Offline entrance exam

register new student photo

face identification

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Summary

- Conclusion
    - A framework for detecting "Ghost Writer" cheating
    - A prototype system based on open source software and libraries
    - A experimental test

- Limitations
    - Accuracy
    - Large-scale tests

Thank you!

- Questions?

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