Yet Another text CAPtCha Solver

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Work in Collaboration with

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西北大学肇始于1902年的陕西大学堂和京师大学堂速成科仕学馆。

1912年始称西北大学。

1923年改为国立西北大学。

1950年复名西北大学。

现为首批国家“世界一流学科建设高校”，国家“211工程”建设院校、教育部与陕西省共建高校。

Our Team

房鼎益

陈晓江

汤战勇

无线网络&系统安全

实验室近三年主要成果

- **2018年**

SIGCOMM’18 1篇、CCS’18 1篇 、MOBICOM’18 2篇、AAAI’19 1篇、 UbiCom’18 2篇、 IJCAI’18 3篇、

PerCom’18 1篇、SECON 1篇

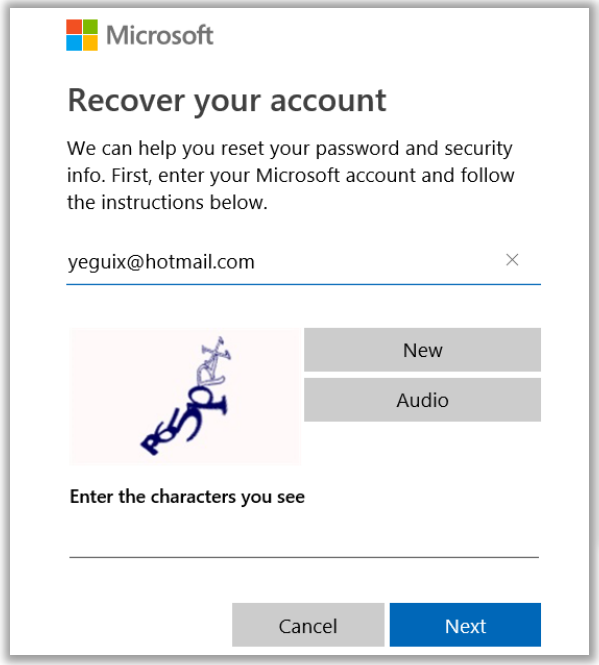
- **2017年**

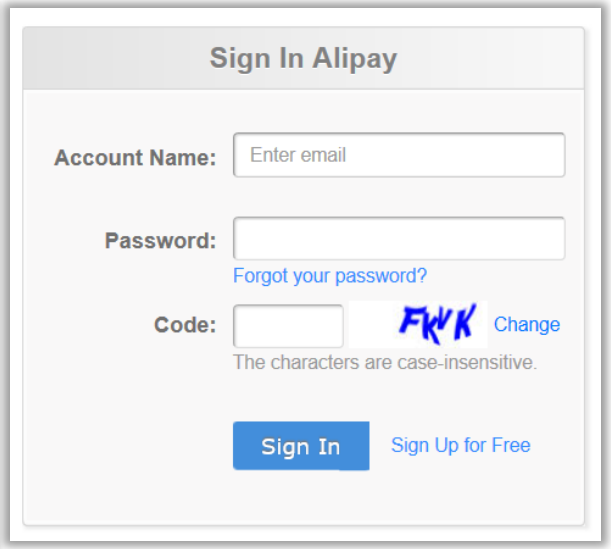
NDSS’17 1篇、MOBICOM’17 2篇、INFOCOM’17 1篇、CoNext’17 1篇、ICDCS’17 1篇

- **2016年**

MOBICOM’16 1篇、INFOCOM’16 2篇、ICNP’16 1篇

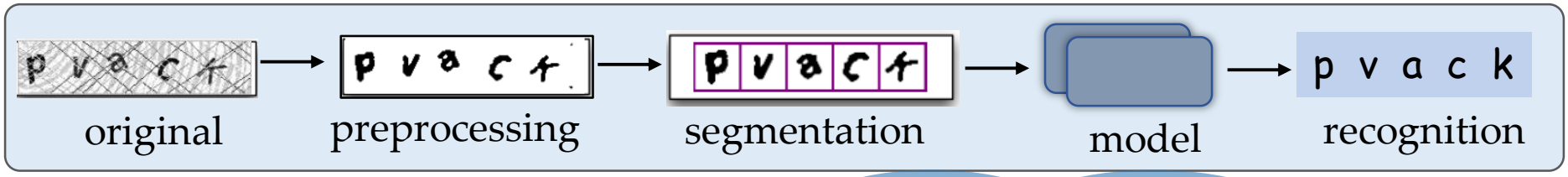
Captchas are WIDELY used



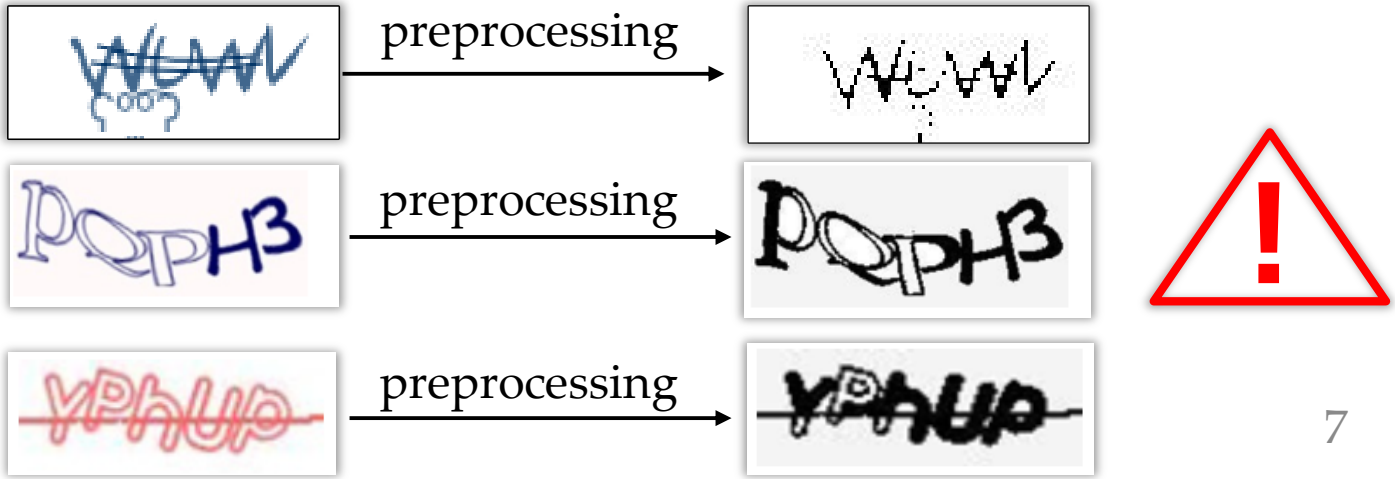


32 of TOP-50 websites

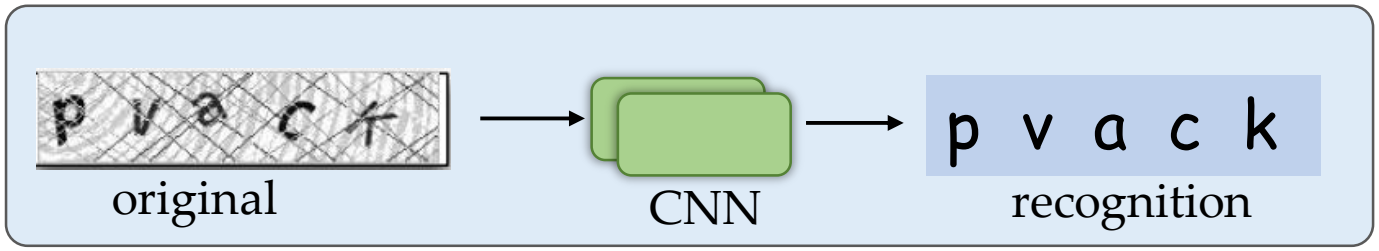
Model-based Approach

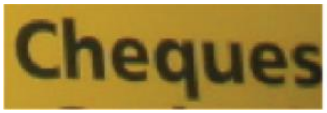


Extensive Human Involvements



Deep Learning based approach



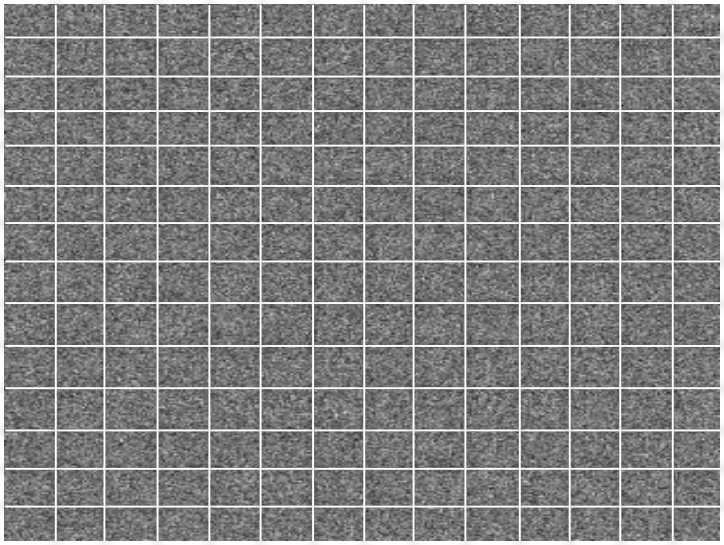
Scheme	Example	Training Set	Acc.
reCaptcha		**2.3 M**	89.9%
PhotoOCR		**7.9 M**	1.9%
Baidu		**50K**	0.1%
Google		**50K**	0%

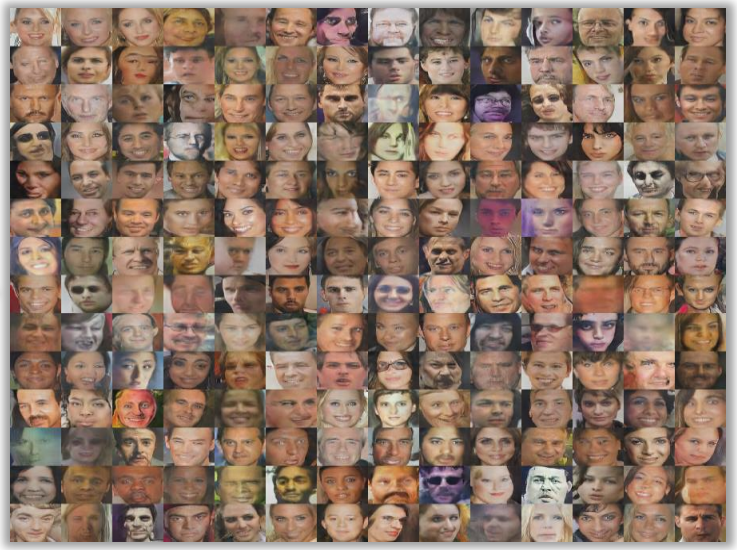
Getting A Large Number of Captchas is difficult

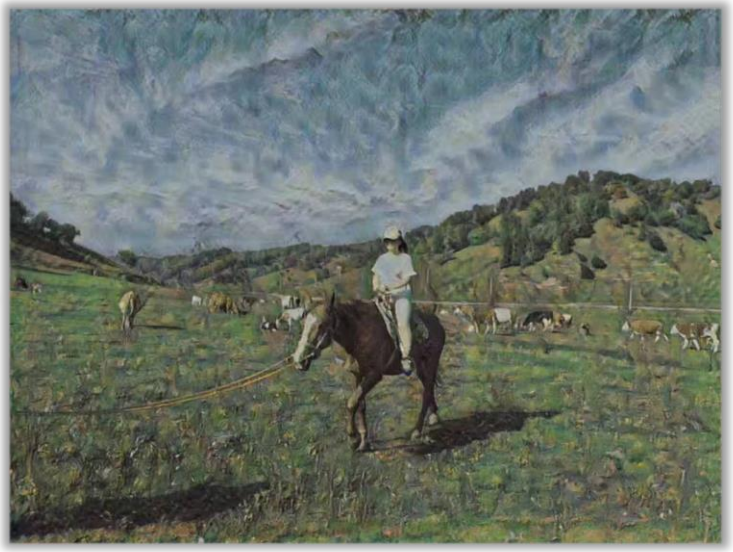
Anti-crawling mechanisms

Frequent changing captchas styles

Inspired by GANs

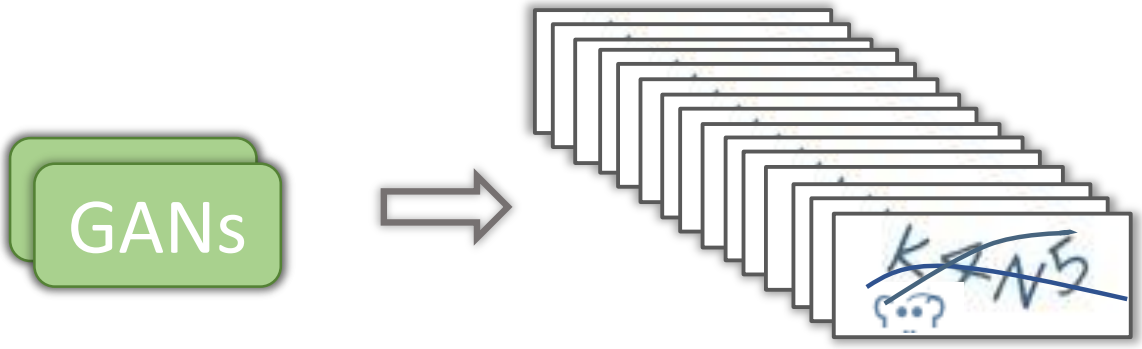






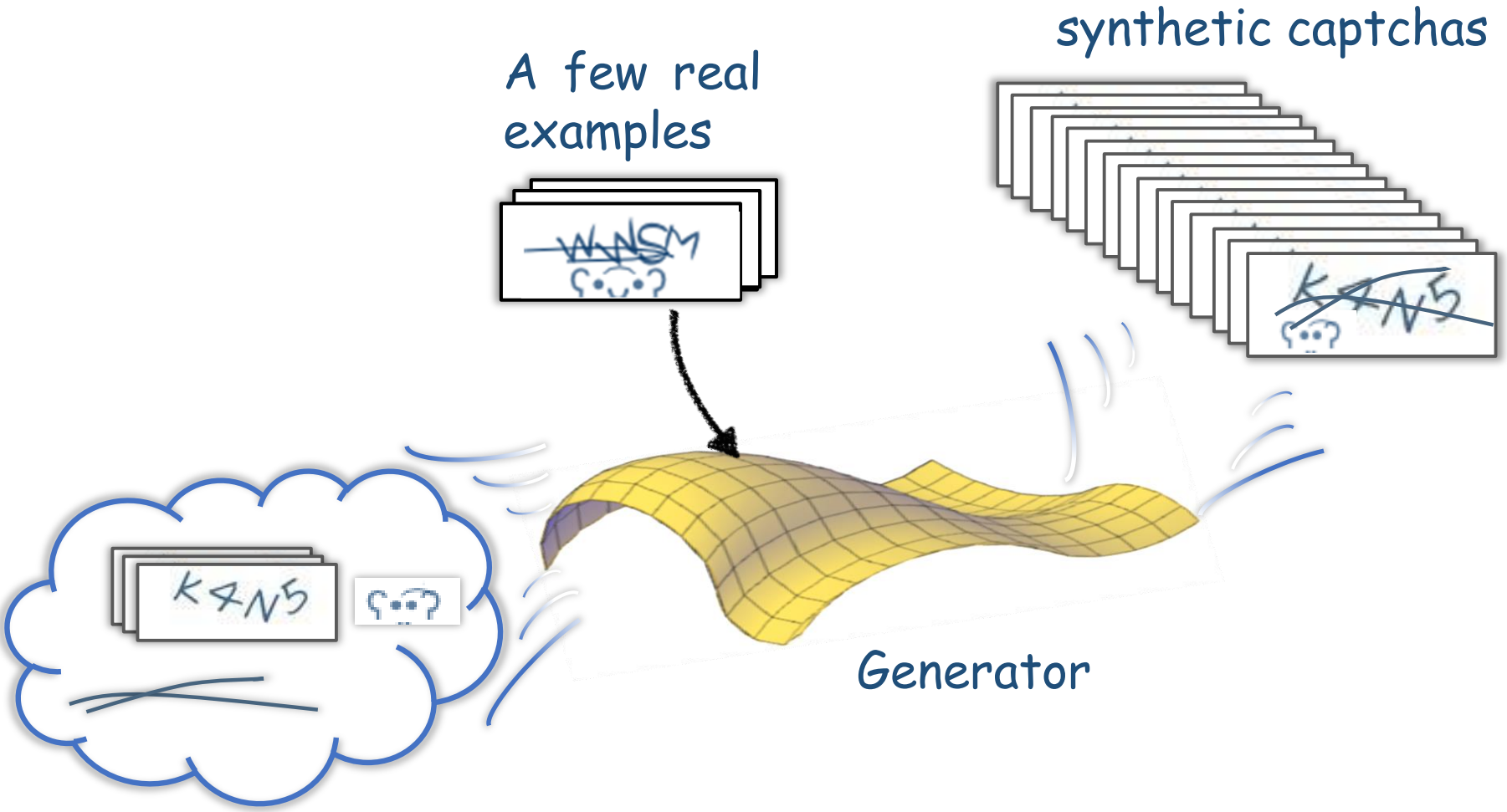
Transfer to Captcha

☐ Synthesize Captchas



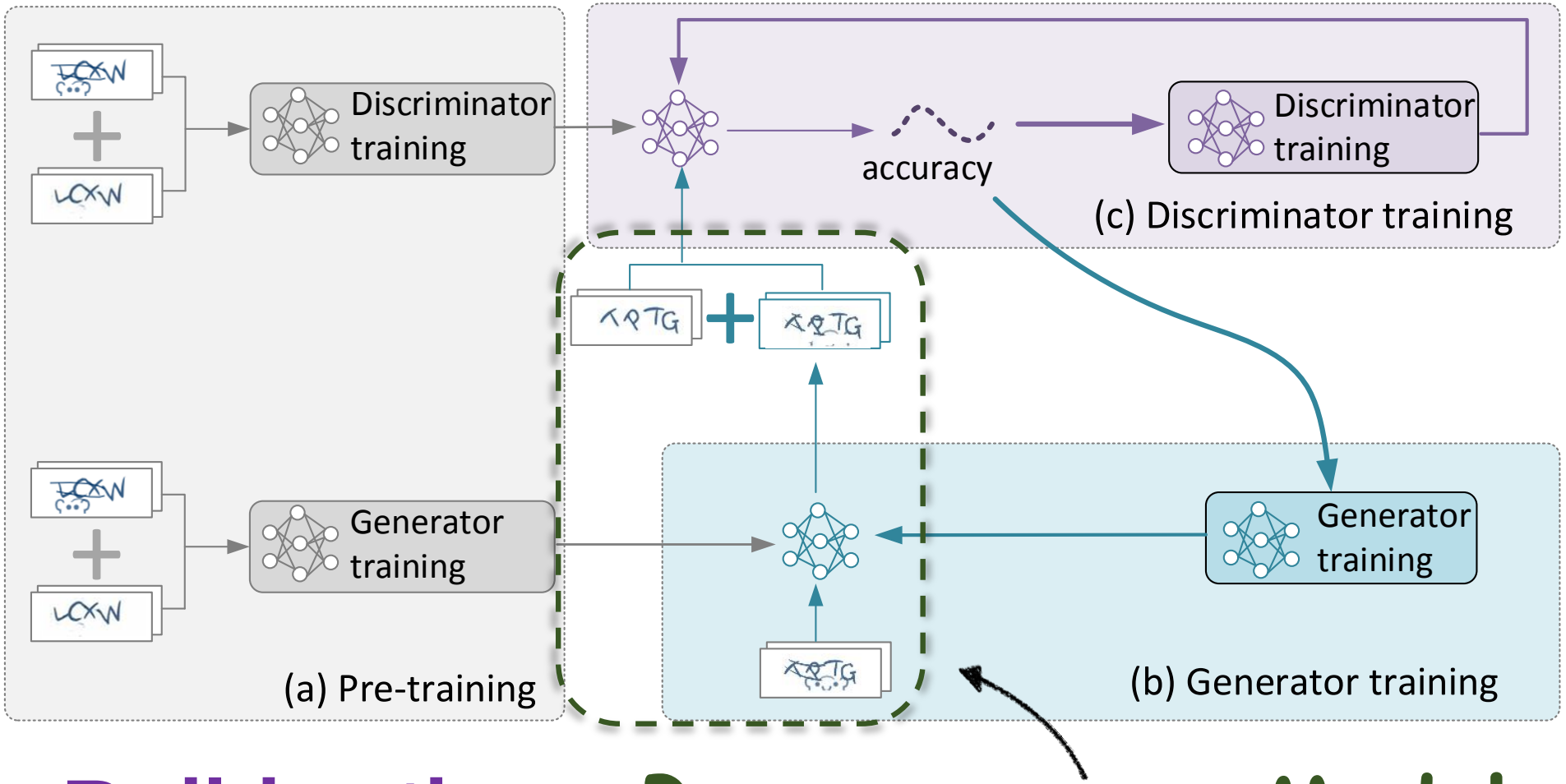
☐ Remove Security Features

Our Approach



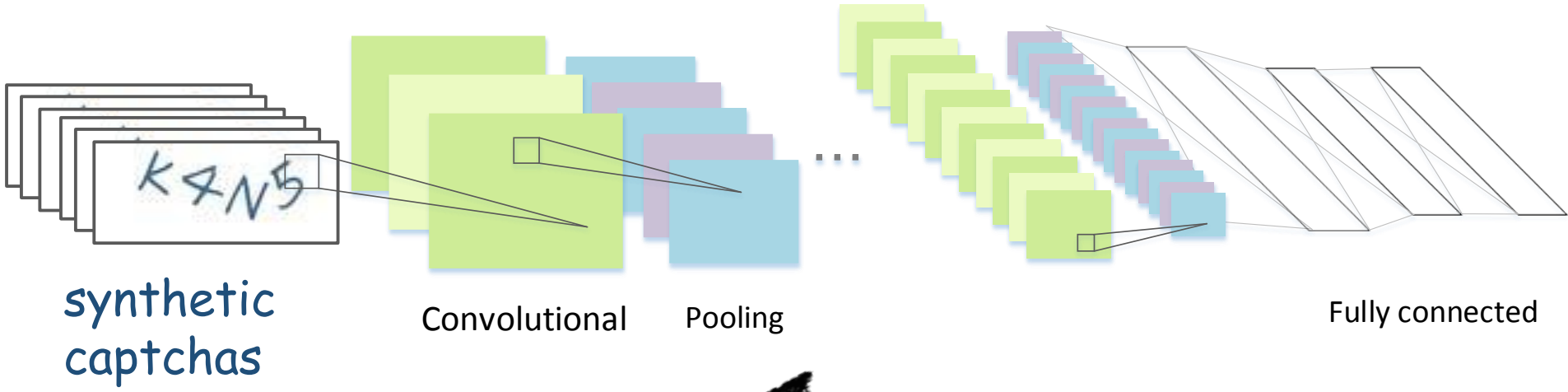
Automatically Generate Millions of synthetic captchas

Our Approach



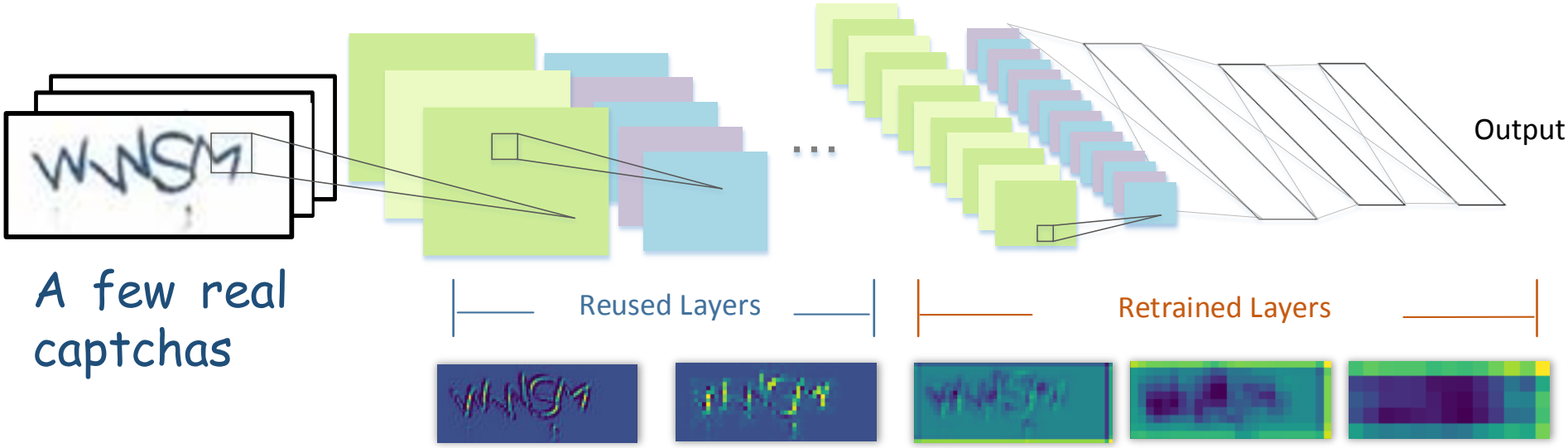
Build the Pre-process Model using the synthetic captchas

Our Approach



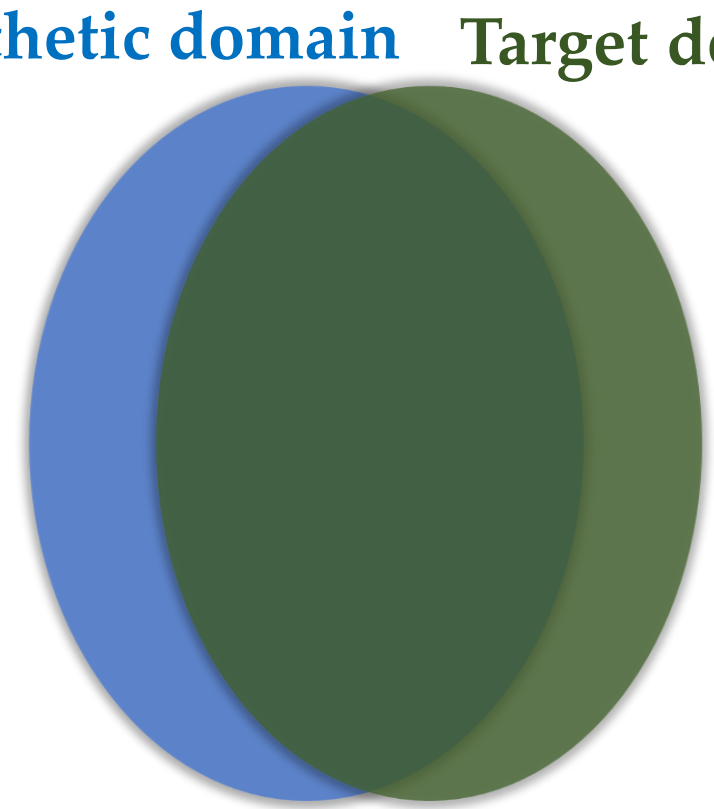
Base solver was built using synthetic captchas

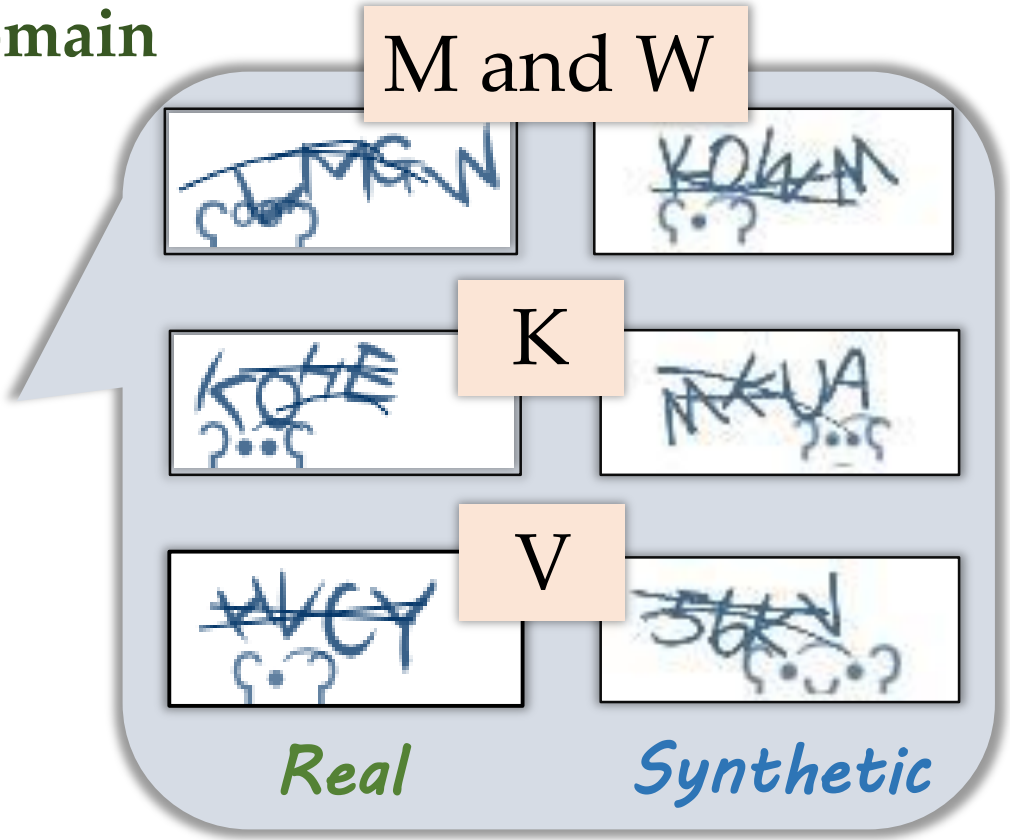
Our Approach



Build the fine-tuned solver

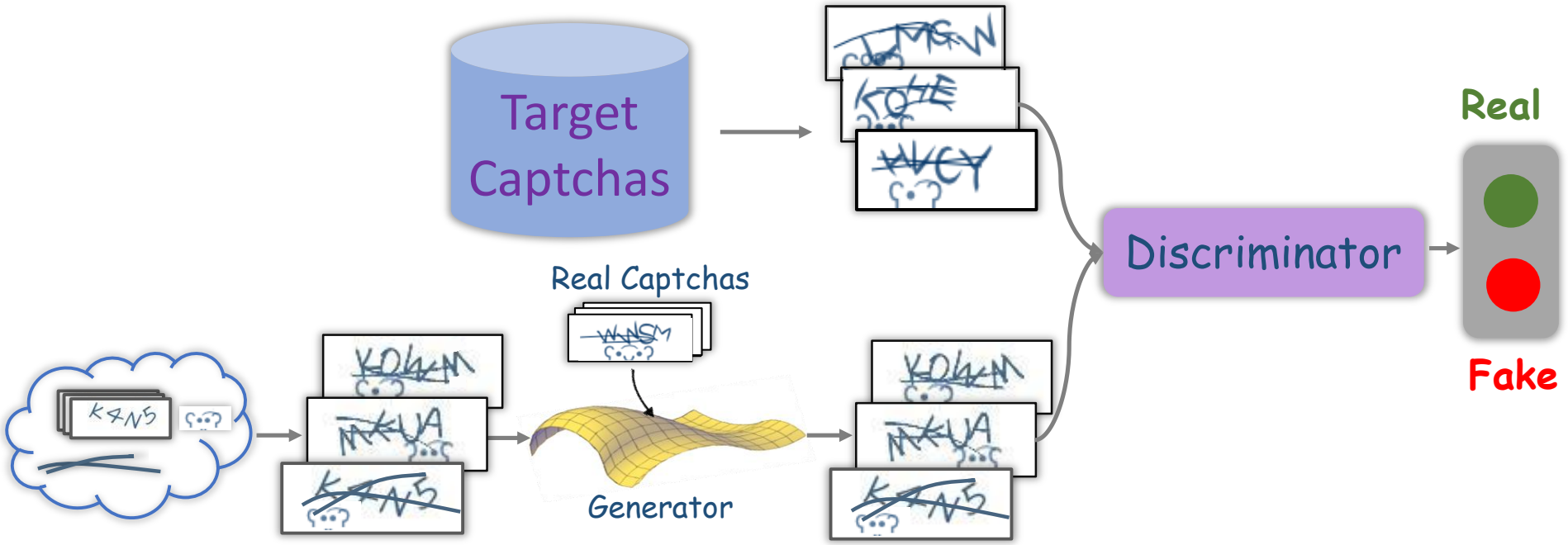
Reason for Tuning Base solver





Synthetic captchas are subtle difference from the real ones.

Generative Adversarial Network based Synthesizer



Make sure synthetic captchas are similar to the target ones

Captcha Schemes Used

- **11 from 32 of the top-50 websites**

- **Prior 22 schemes used by other works**

Megaupload, Blizzard, Authorize, Captcha.net, NIH, Reddit, Digg, Slashdot, QQ, Taobao, reCAPTCHA(2011), reCAPTCHA(2013), Amazon, Microsoft(2016), Yahoo!(2016), Yahoo!(2014), Baidu(2016), Baidu(2013), Baidu(2011), CNN, Papal, Sina(2016)

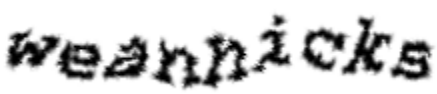
All captchas have multiple complex security features

eBay

Google

Microsoft

Sohu



Wikipedia

JD

Weibo

Alipay

Sina

Baidu

Qihu360

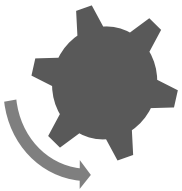
Excluded Characters

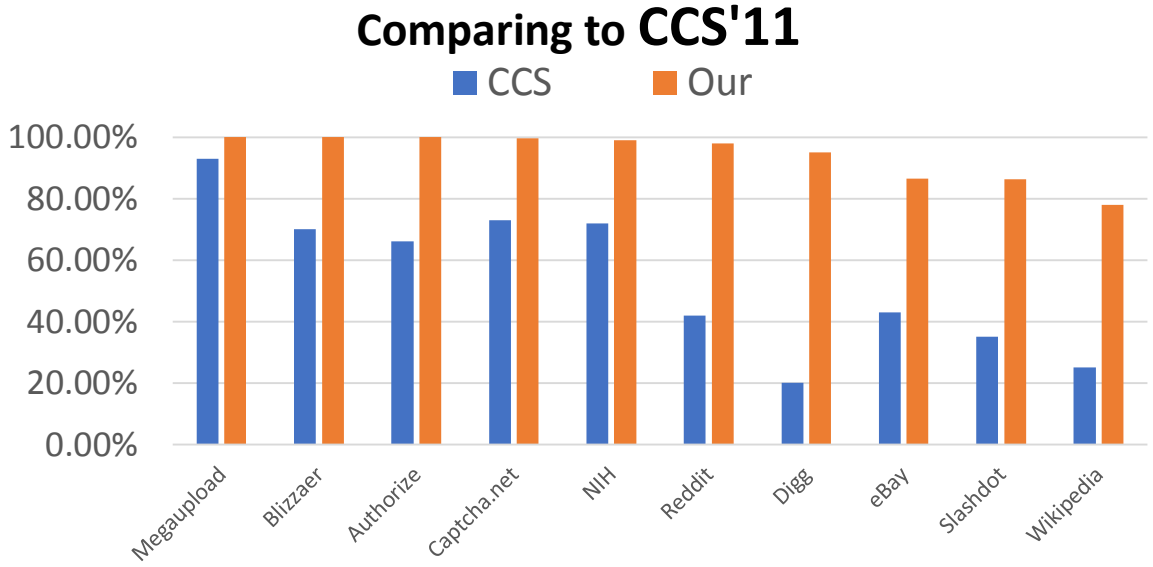
Scheme	Used Characters	Excluded Characters
Sohu	a-z, 0-9	0,1, i,l,o,z
JD	A-Z, 0-9	0,1,2,7,9, D,G,I,J,L,O,P,Q,Z
Microsoft	A-Z, a-z, 0-9	0,1,5, D,G,I,Q,U
Alipay	A-Z, 0-9	0,1, I,L,O
Qihu360	A-Z, a-z, 0-9	0, I,L,O,T, i,l,o,t,q

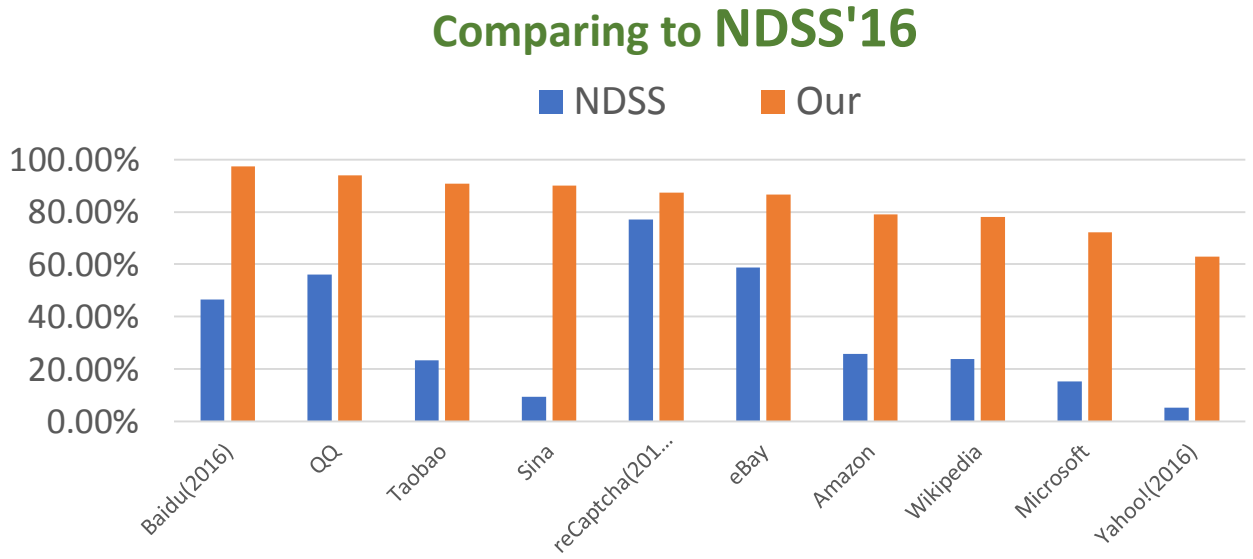
High Success Rate

#	Scheme	Before tuning	After Tuning
1	Sohu	83%	92%
2	Ebay	52%	86.6%
3	JD	60%	86%
4	Wikipedia	7%	78%
5	Microsoft	36.6%	69.6%
6	Alipay	23%	61%
7	Qihu360	48.5%	56%
8	Sina	40.6%	52.6%
9	Weibo	4.7%	44%
10	Baidu	6%	34%
11	Google	0%	3%

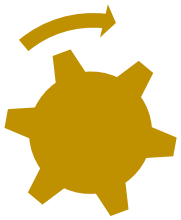
Better Performance

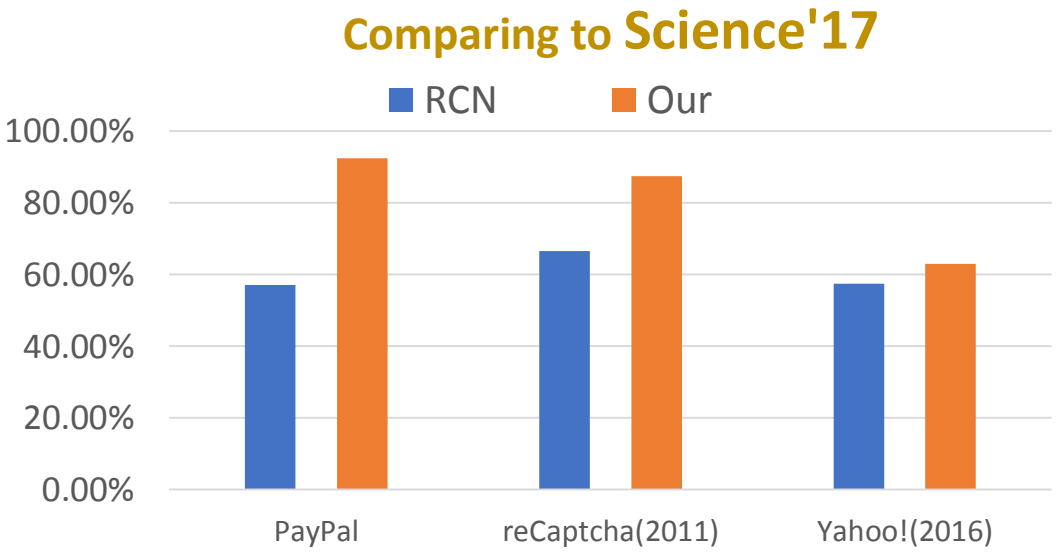


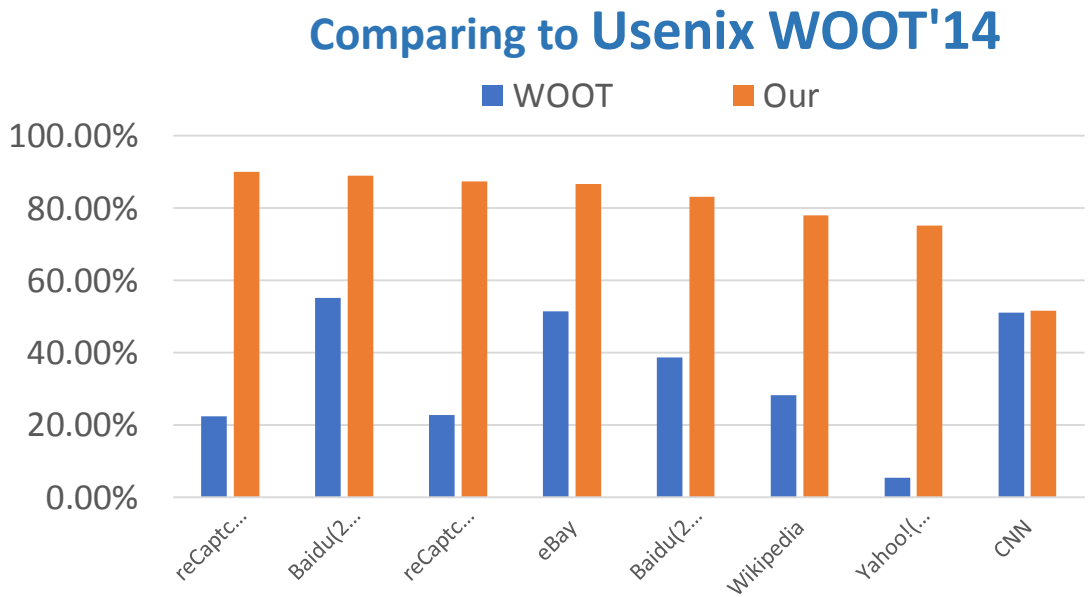




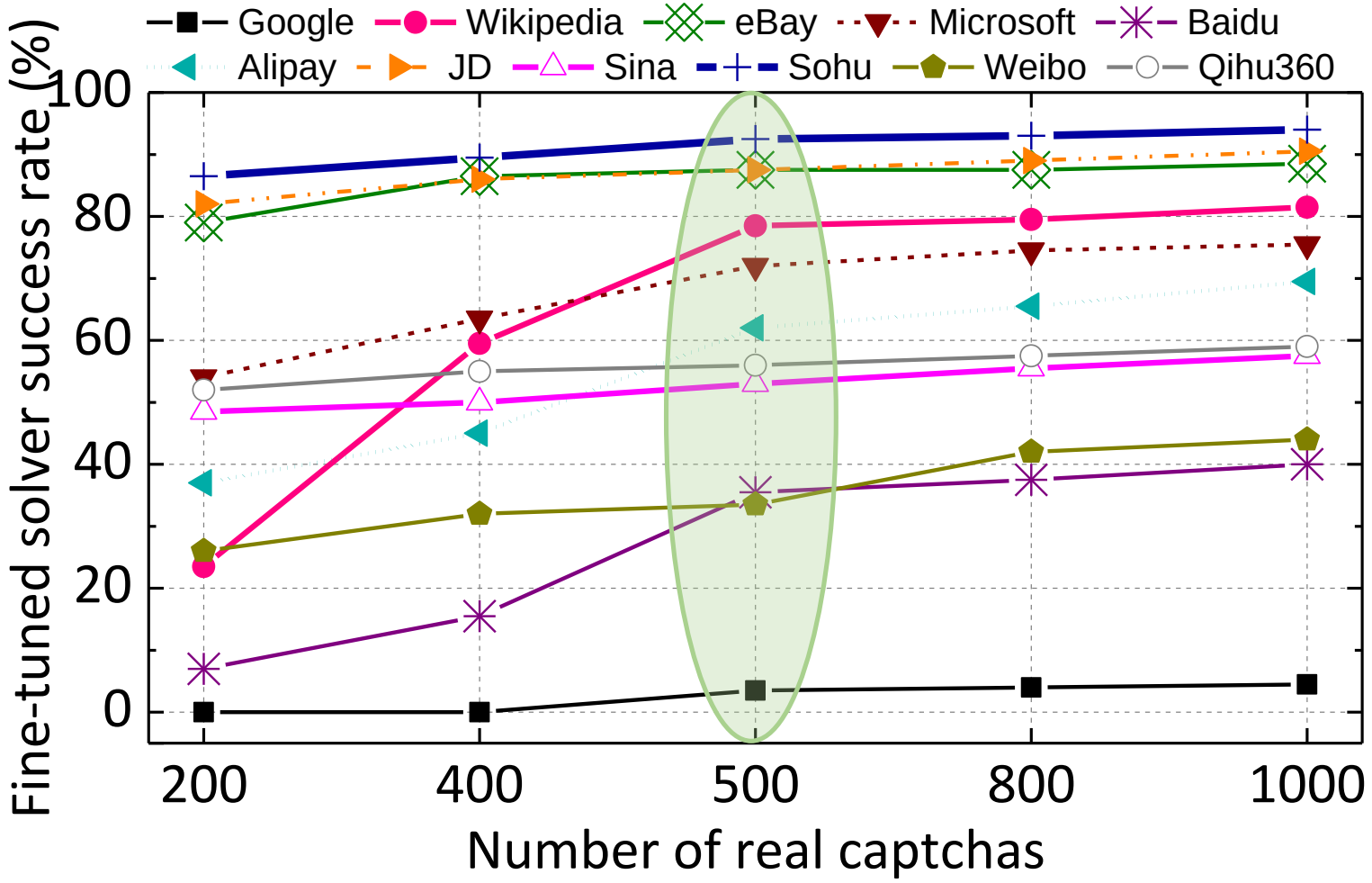
Better Performance





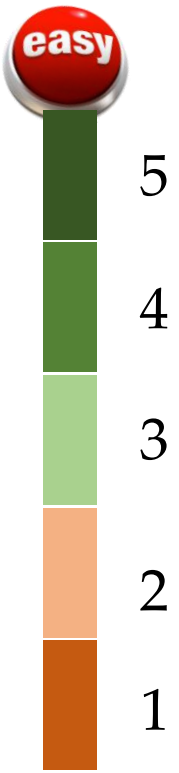


500 real captchas are enough

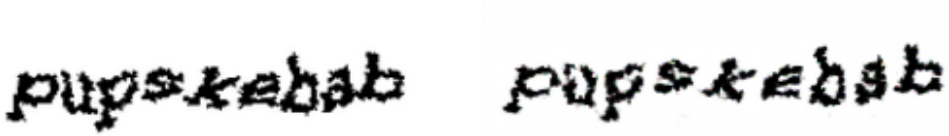


User Study

No.	Example	Success Rate		Usability Score
		Human	Our approach	
1		95.25%	100%	4
2		90.25%	88%	2.75
3		91%	96%	2.8
4		89.25%	86%	2.7
5		79.75%	77%	2.8
6		68.75%	40%	2.1



GAN-based Segmentation Approach



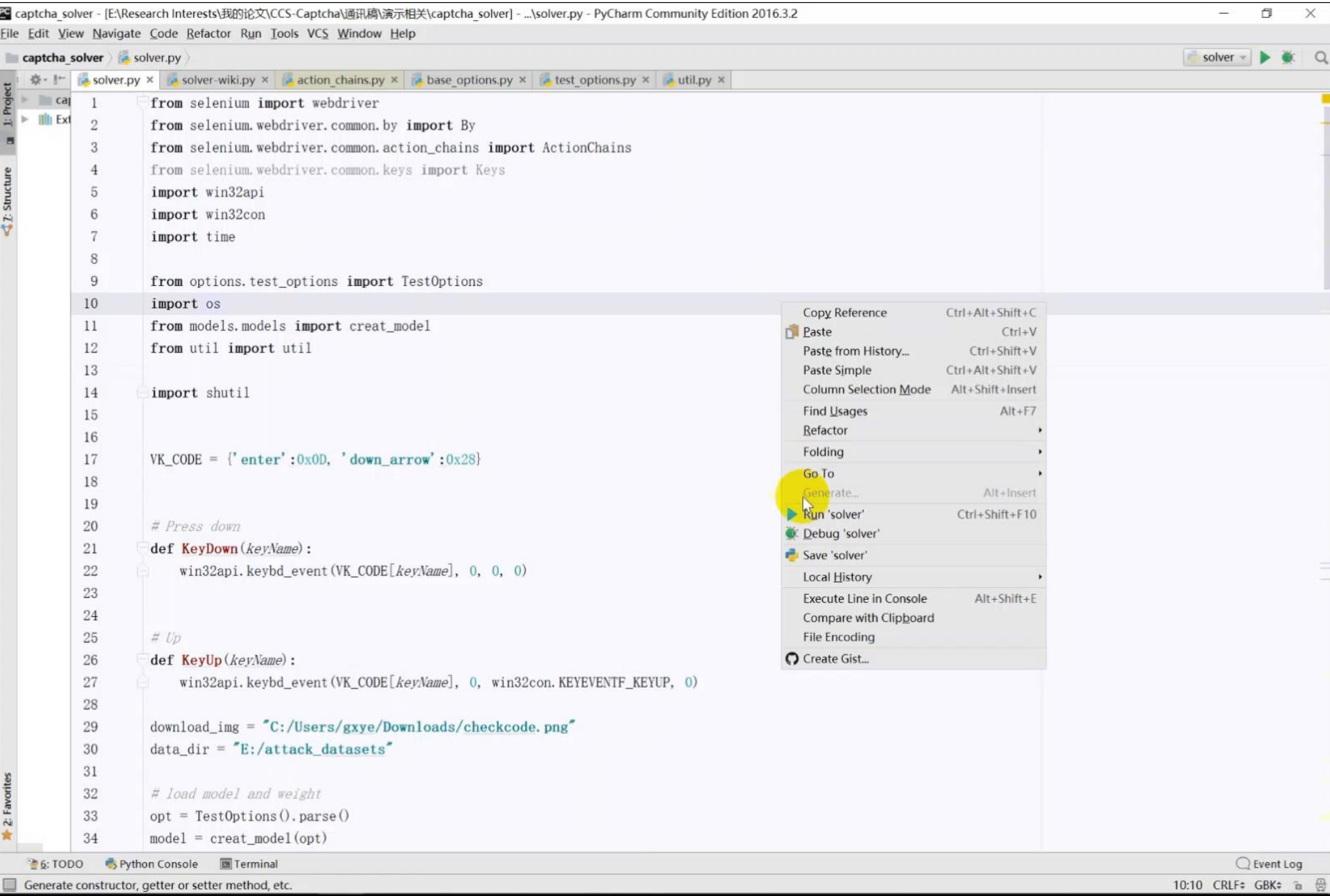
(a) Wikipedia captcha and its pre-processing version

(b) Microsoft captcha and its pre-processing version

(c) Sina captcha and its pre-processing version

(d) Baidu captcha and its pre-processing version

Demo


captcha_solver - [E:\Research Interests\我的论文\CCS-Captcha\通讯稿\演示相关\captcha_solver] - ...\solver.py - PyCharm Community Edition 2016.3.2
File Edit View Navigate Code Refactor Run Tools VCS Window Help
captcha_solver
solver.py
solver
solver.py
solver-wiki.py
action_chains.py
base_options.py
test_options.py
util.py
from selenium import webdriver
from selenium.webdriver.common.by import By
from selenium.webdriver.common.action_chains import ActionChains
from selenium.webdriver.common.keys import Keys
import win32api
import win32con
import time
from options.test_options import TestOptions
import os
from models.models import creat_model
from util import util
import shutil
VK_CODE = {'enter':0x0D, 'down_arrow':0x28}
# Press down
def KeyDown(keyName):
win32api.keybd_event(VK_CODE[keyName], 0, 0, 0)
# Up
def KeyUp(keyName):
win32api.keybd_event(VK_CODE[keyName], 0, win32con.KEYEVENTF_KEYUP, 0)
download_img = "C:/Users/gxye/Downloads/checkcode.png"
data_dir = "E:/attack_datasets"
# load model and weight
opt = TestOptions().parse()
model = creat_model(opt)
Copy Reference Ctrl+Alt+Shift+C
Paste Ctrl+V
Paste from History... Ctrl+Shift+V
Paste Simple Ctrl+Alt+Shift+V
Column Selection Mode Alt+Shift+Insert
Find Usages Alt+F7
Refactor
Folding
Go To
Generate... Alt+Insert
Run 'solver' Ctrl+Shift+F10
Debug 'solver'
Save 'solver'
Local History
Execute Line in Console Alt+Shift+E
Compare with Clipboard
File Encoding
Create Gist...
6: TODO
Python Console
Terminal
Event Log
Generate constructor, getter or setter method, etc.
10:10 CRLF GBK

COUNTERMEASURES

original captcha

adversarial example

P 3 K P R

ground truth

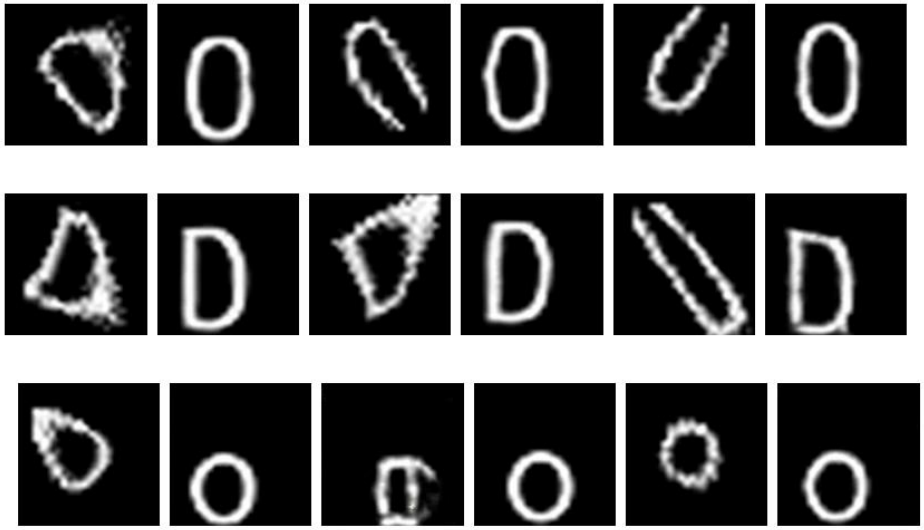
R 7 X 0 T

incorrect prediction

Other Findings

MNIST

Single character



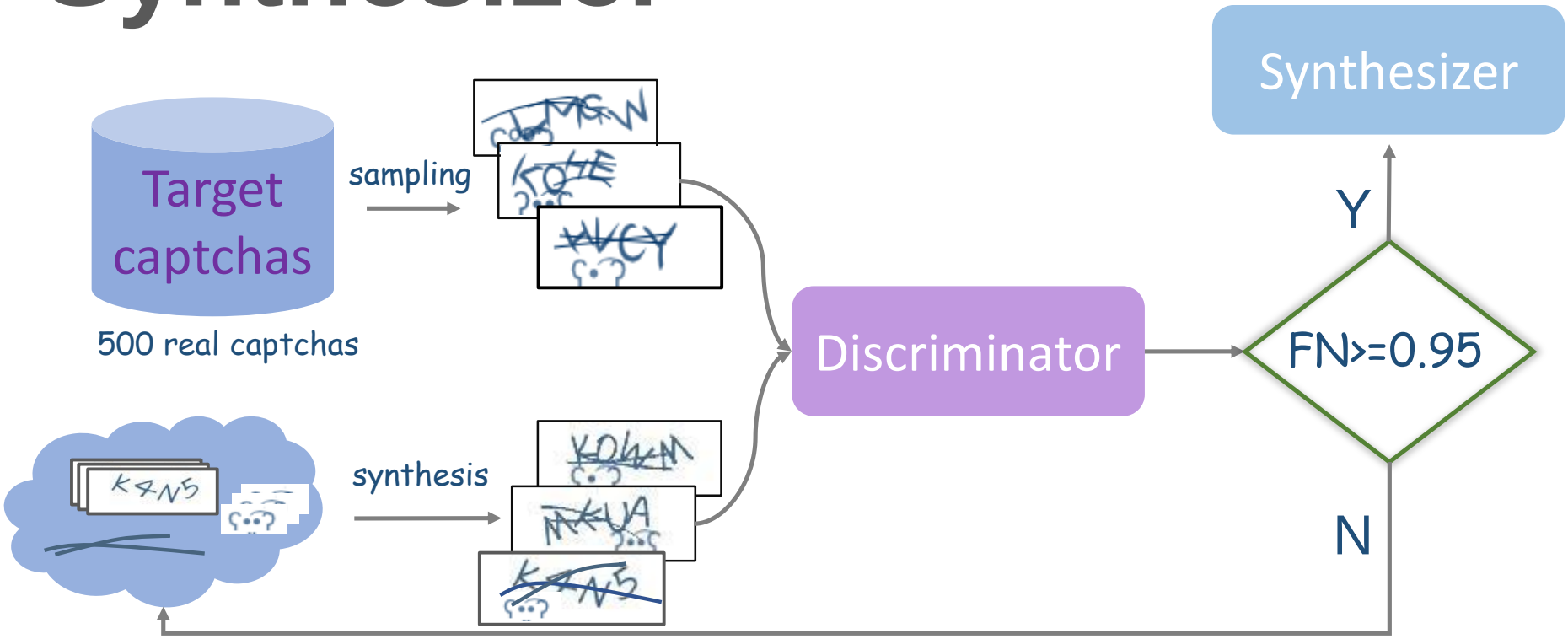
Conclusions

Text based captchas are vulnerable under generative adversarial network based solver.

Our approach needs less human involvements and requires a smaller number of real captchas.

Backup Slides

Training the Captcha Synthesizer

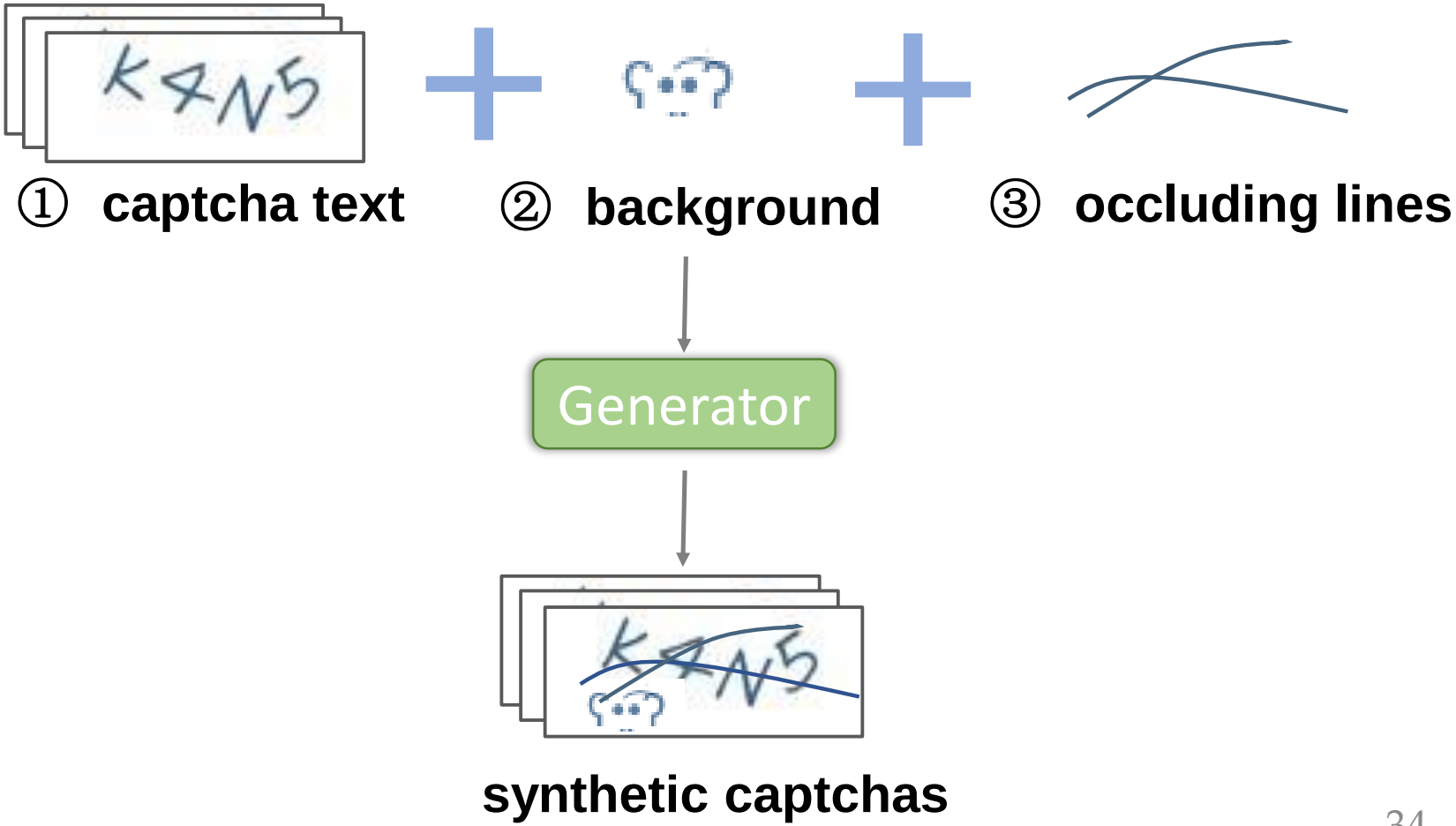


Synthesize the captchas whose style is similar to the real ones.

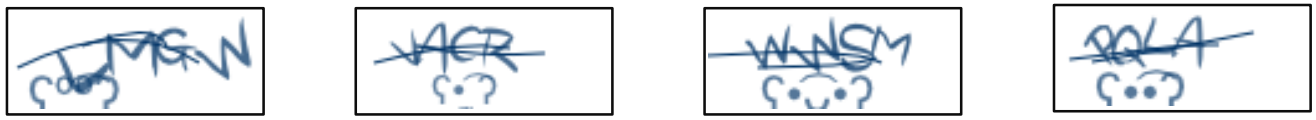
Google Captchas

Extremely Complex & More than 8 fonts

Generate captchas using security features

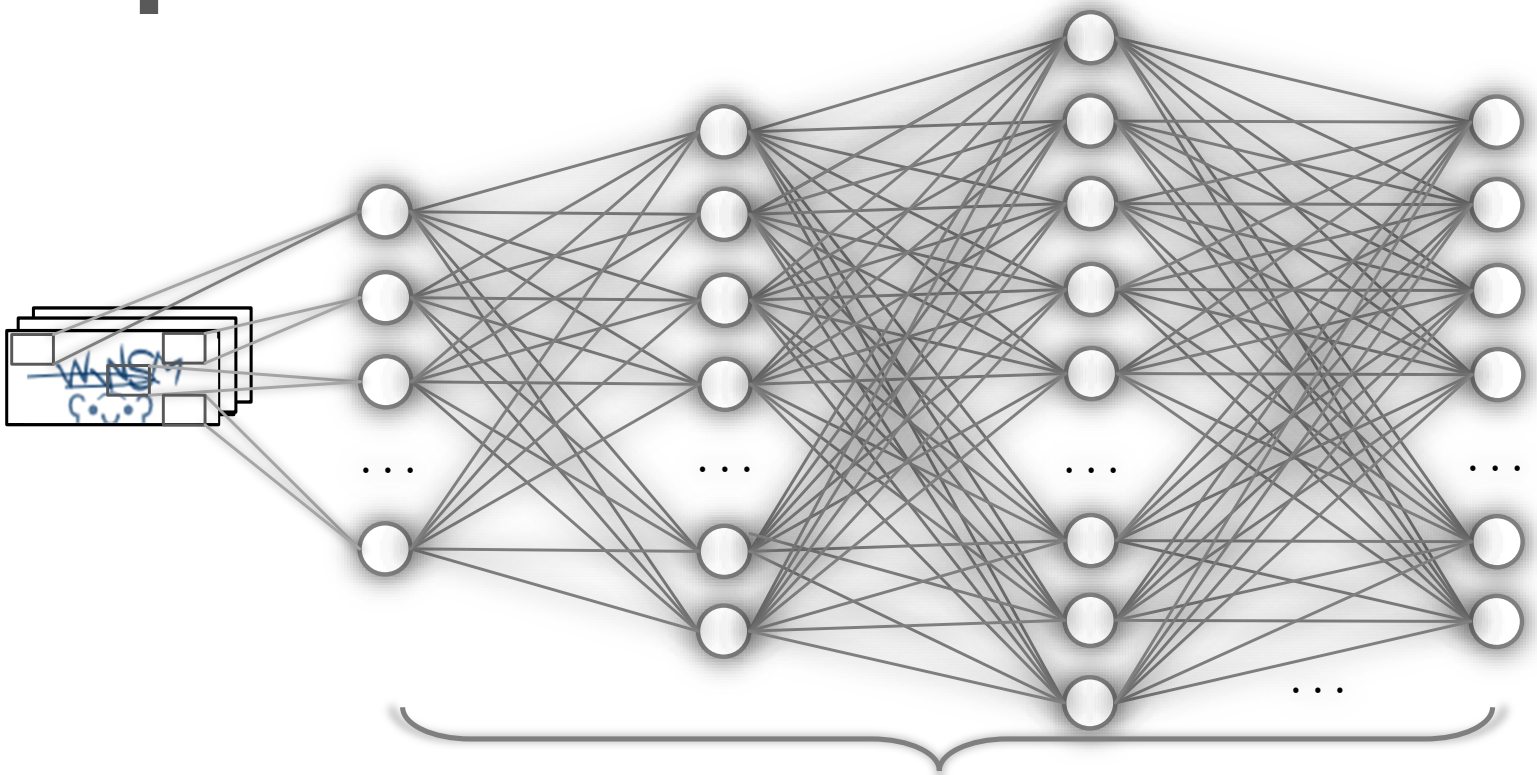


Security features of captcha



Security Feature	On/Off	#Options	Value Range
Noisy background(s)	On	5	[10, img.width]
Occluding lines	On	2	{Line, Sin, Quadratic, Bezieer}
Char. Overlapping	On	-	[-3, 10]
Character set	On	4	[A – Z]
Font style(s)	On	1	Solid
Font color(s)	On	1	RGB (65, 103, 141)
Distortion	On	-	{[0.1, 0.2], [0.2, 0.3]}
Rotation	On	-	[-30, 30]
Waving	Off	-	-

Captcha Solver Network



[32, 64, 128, 256, 512, 3072] nodes

LeNet-5 + 2x Conv. + 3x Pooling

$$y = f(x)$$

text captcha