




客製化文字型 CAPTCHA 攻防平台

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<pre>function _(_0x291x4) { return document[_0x6675[12]](_0x2391x4) }; function launch() { var _0x2391x6 = 0; _(_0x6675[14]][_0x6675[13]] + _0x6675[15]; _(_0x6675[18]][_0x6675[17]][_0x6675[16]] = _0x6675[19]; (_0x6675[21]][_0x6675[20]] = _0x6675[22] + file + _0x6675[23] prev = curr; _(_0x6675[24]][_0x6675[13]] + _0x6675[11]; setInterval(function () { if (_0x2391x6 == 0) { \$[_0x6675[30]](_0x6675[22] + file + _0x6675[25], functi if (_0x2391x7 == _0x6675[26]) { _(_0x6675[14]][_0x6675[13]] = _0x6675[27]; _(_0x6675[18]][_0x6675[17]][_0x6675[16]] = _0x6 (_0x6675[21]][_0x6675[20]] = _0x6675[11]; _(_0x6675[21]][_0x6675[20]] = _0x6675[22] + fil _0x2391x6 = 0; prev = _0x6675[11]; clearInterval(); _(_0x6675[24]][_0x6675[13]] = _0x6675[29] } } else { clearInterval() } }, 10000) }; function showInfo(_0x2391x9) { prev = _(_0x6675[31]][_0x6675[13]]; _(_0x6675[31]][_0x6675[13]] + _0x6675[32] + _0x2391x9 + _0x6675 curr = _(_0x6675[31]][_0x6675[13]] };</pre>		
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Abstract

- Machine-Learning Based Attack
- An interactive CAPTCHA generation and evaluation system
 - Experimental Result Support
 - Diverse Visual Perturbations
 - Real-time Predictions
- GUI platform Demo



History

- CAPTCHAs can be categorized into OCR-based and non-OCR-based types.
 - Optical Character Recognition
 - Designing CAPTCHAs against ML models require systematic approaches and robust models or metrics for evaluation.
- While some CAPTCHAs successfully block automated models, they may also confuse human users.



Problem Definition

- CAPTCHAs are widely deployed online for verification to prevent automated bots.
- However, with advances in deep learning, the security of image-based text CAPTCHAs is increasingly compromised.
- Can we design CAPTCHA schemes that are resistant to machine learning attacks while staying human-friendly?

Example of attack

The image displays a mobile application interface on the left and a desktop application window titled "Intruder attack 3" on the right.

Mobile App Interface (Left):

- Time: 5:24
- Section: 未知联系人 (Unknown Contacts)
- Contacts list:

 - 1069077587353263... 下午 12:40 > 【华侨城】嗨，您正在注册“花橙旅游”，验证码是 837815，不要告诉别人...
 - 95566 下午 12:40 > 中国银行中银来财验证码：419835【中国银行】
 - 1069219342397096... 下午 12:40 > 【MatchU定制】验证码：595176，5分钟内有效。请勿向他人泄露，如非本人...
 - 1065750095518 下午 12:40 > 【中国人保】您的验证码为：【880185】，5分钟内有效。验证码...
 - 106938581173 下午 12:40 > 【联合在线验证】您本次收到的验证码为：375751
 - 106509773117311 下午 12:40 > 【河北航空】您注册手机的验证码是：344750，请及时验证
 - 106917736264 下午 12:40 > 【维信卡卡贷】验证码为：749510，您正在登录维信卡卡贷，5分钟内有效。...
 - +86 (10) 6936 2914 下午 12:40 > 【快速超市】您的快速超市验证码：367387，验证码 5 分钟内有效不要重...
 - 1069219344351703... 下午 12:40 > 【e 祺购】验证码为 771520，5 分钟内有效
 - 106828579018306 下午 12:40 >

Desktop Application (Right):

Intruder attack 3

Results Target Positions Payloads Options

Filter: Showing all items

Request	Payload	Status	Error	Timeout	Length	Comment
0		200			6178	
1	Admin	200			6178	
2	Administrator	200			6178	
3	Admin123456	200			6178	
4	Admin1234!	200			6178	
5	Admin123@	200			6178	
6	administrator	200			6178	
7	admin	200			6178	
8	admin12	200			6178	
9	admin1245	200			6178	
10	Admin123	302			724	
11	AdminAdmin	200			6178	

MASS Facebook Account Creator - 2.1.33.0 - []

File View Tools Help

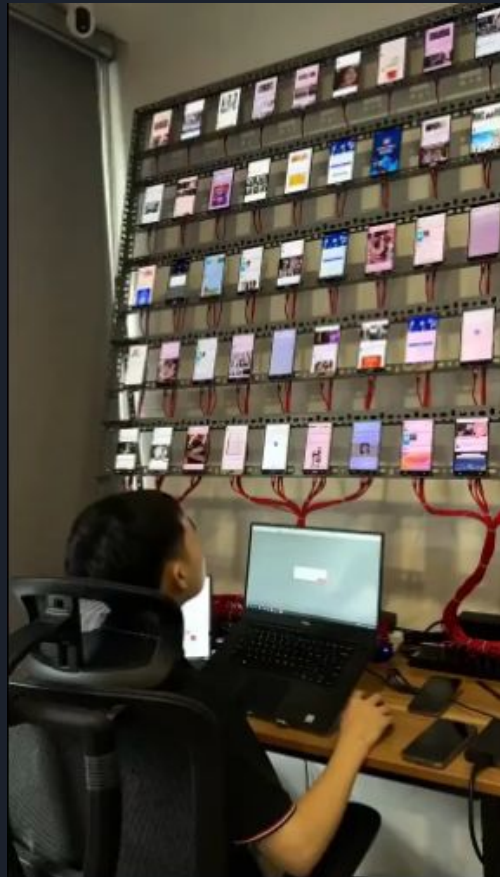
Internet Settings Register Software Buy Software Proxy Software Help About Exit

Excel Data Proxy Settings Sign Up Output

Import Excel Data Export To Excel

First Name	Last Name	Alternate Email	Password	Birth Month	Birth Day	Birth Year	Gender
Softpedia	Tester	test@softpedia.com	CaNoah8i8	4	8	1981	m
Wanda	Racan	WandaSRacan@uShusha3Ei		3	7	1960	f
Susan	Masev	SusanWMasev@Sa1o3ozah		2	6	1995	f
Stephen	Brownlee	StephenKBrownlee@h1Chusvee		1	5	1963	m
Maribel	Walter	MaribelWalter@thieno51w		7	11	1975	f
Luella	Prior	LuellaPrior@m: weth9weeYa2i		2	6	1907	f
Katherine	Viviano	KatherineTViviar@eevco3xee		1	5	1936	f
John	McDowell	JohnIMcDowell@Oone70hrei		6	10	1940	m
John	Perdue	JohnEPerdue@dd ooh1vuRoh		5	9	1954	m
Jason	Blasko	JasonMBlasko@th ooaIW00a2		3	7	1959	m
Grace	Freudenbura	GraceHFreudent@taiChee6ah		2	6	1929	f
Ethel	Smith	EthelCSmith@im ba5Wile7ae		1	5	1991	f
Elsa	Fuentes	ElsakFuentes@eh4JaeCa		3	7	1968	f
Doris	Morin	DonsJMorin@pov ooh9ieLeePh		2	6	1946	f
Domino	Cruz	DominoVCruz@Paivai3		1	5	1909	m
Diana	Loh	DianaWLOhmz@ea0ouePh		1	5	1989	f
Daniel	Hill	DanielWHill@mal ood1roaZ		1	5	1961	m
Billv	Hendon	BillvCHendon@th: phes8Tedeo		5	9	1944	m
Arthur	Nau	ArthurBNau@tra: Ootho6Soh		7	11	1936	m
Allan	Hash	AllanAHash@ddo: Jo7ucheemah		2	6	1942	m

Delete Item Next



ClassScan DirBruteForce SubDomainBrute Repeater Url Collector

Browser UrlResult JavaScript

https://www.google.com/search?q=site:yahoo.com+filetype:pdf&ei=qWZCKiZN5qKhWpCm47oCg&start=160&sa=N&ve Go Stop

Google site:yahoo.com filetype:pdf

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Model Reference Adaptive Control of Advertising Systems

Abstract— Internet advertising is a relatively new area where feedback control has become critically important for scal- able optimization.

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https://research.yahoo.com/mobstor/publicat... PDF

Applications of Feedback Control in Online Advertising

Url[167] | V1.0.0 By ISSAC

ClassScan DirBruteForce SubDomainBrute Repeater Url Collector

Browser UrlResult JavaScript

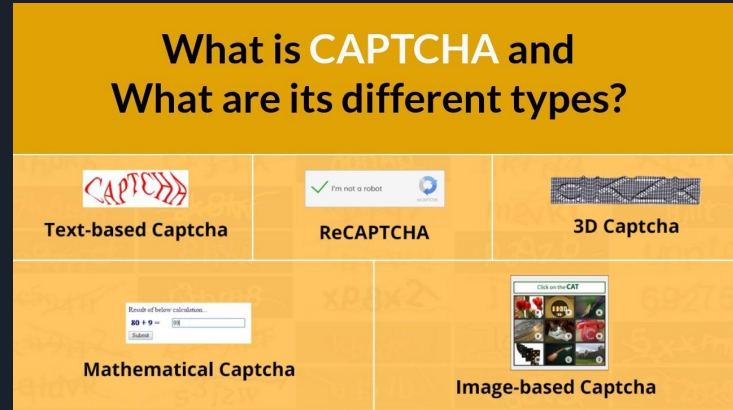
Url	Title	Status
http://store.yahoo.com/lib/cssto...	Hunt with Harry Claassens - Yahoo	HTTP 200
https://research.yahoo.com/mo...	Ranking Relevance in Yahoo Search	HTTP 200
https://labs.yahoo.com/_c/uploa...	Large-scale World Cup 2014 outcome prediction based o...	Connect failed!
https://research.yahoo.com/mo...	Smartphone App Categorization for Interest Targeting in...	HTTP 200
http://store.yahoo.com/lib/toolsf...	The Effects of SRT on Six Different Types of Water - Yahoo	HTTP 200
https://research.yahoo.com/mo...	and Representation-Awareness in Geographically Centra...	HTTP 200
https://research.yahoo.com/mo...	Visual Affect Around the World: A Large-scale ... - Yahoo!	HTTP 200
https://research.yahoo.com/_c/u...	Serving Ads to "Yahoo Answers" Occasional Visitors - ...	Connect failed!
https://research.yahoo.com/_c/u...	Robust Tree-based Causal Inference for Complex Ad ... - ...	Connect failed!
http://labs.yahoo.com/_c/upload...	VERTa - LREC Conferences	Connect failed!

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Preliminaries

- CAPTCHA Types
- Noises
 - Random pixel-level interference added to confuse models
 - Gaussian, Laplace, and Salt-and-Pepper.....
 - Serve as a lightweight adversarial defense
 - Each with different visual effects that challenge both models and users





Threat Model

- **Capability**
 - Access to GPU and open-source deep learning frameworks
 - No prior knowledge about configurations or model tuning skills
- **Goal**
 - Maximize the prediction accuracy using machine learning models.
- **Models**
 - **CNN** as a basic single character classifier
 - Fast Inference with low computational cost
 - **VGG-16** as a moderate single character classifier
 - Larger Model Size with Higher Training Cost
 - Higher baseline performance
 - **Tesseract OCR** as a model able for entire string recognition
 - Pretrained and easy to use
 - Confidence scoring support



Goals(For Defense)

- Defense CAPTCHA system prototype
 - Flexible parameter configuration
 - Multiple perturbation support
 - User-friendly(for both the platform and the generated CAPTCHAs)
- Interactive GUI Evaluation Platform
 - Real-time Models Evaluation
 - Confidence Score
 - Batch Model
- Experimental Support
 - Establish clean-data baseline performance for each model
 - Good defense performance on models



Experiment Results – Settings

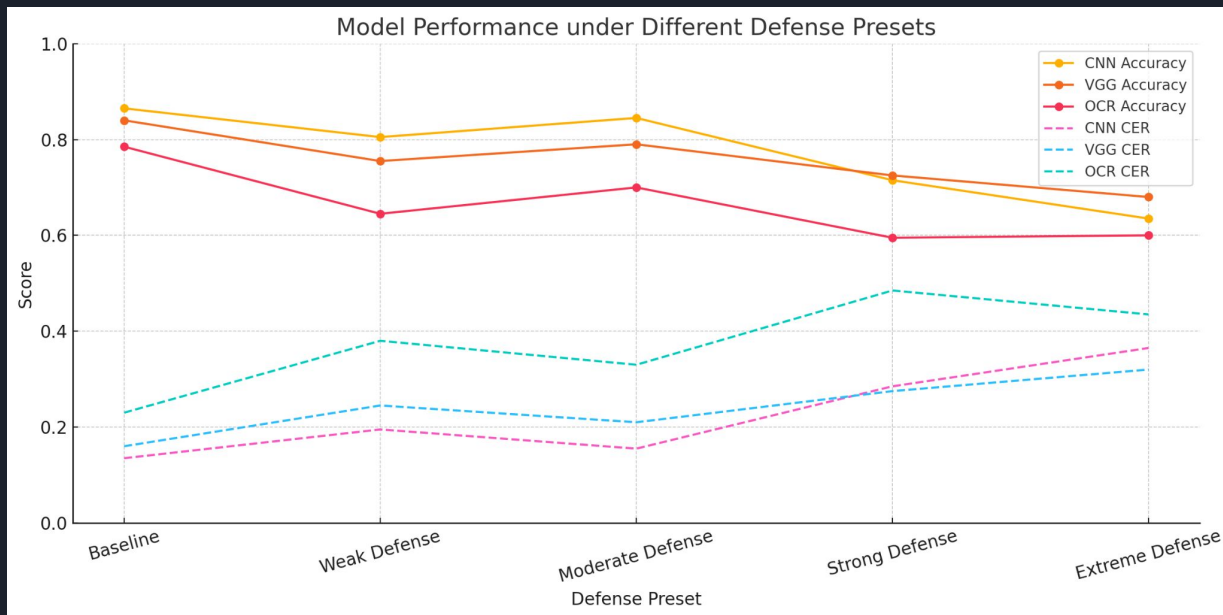
- Dataset(0-9 and a-z)
 - Training
 - CNN(CPU) : 60x60x1 、 Clean、 20% Validation、 5000 pieces
 - VGG(Colab T4) : 224x224x3 、 Clean、 20% Validation、 5000 pieces
 - Evaluation (500 pieces)
 - Baseline : Clean
 - Weak : Add small jitters with Gaussian noise
 - Moderate : Add rotation and cutout
 - Strong : Add brightness and contrast
 - Extreme : Add more noises, masks, and compression
- Tesseract
 - Used as a pretrained full-string recognizer



Experiment Results – Metrics and Results

- Accuracy(ACC)
 - $\text{Correct Predictions} / \text{Total Samples}$
- Character Error Rate(CER)
 - $\text{Edit Distance} / \text{Word Length}$
 - Edit Distance : minimum operations to convert a word to the other
- All three models (Char-CNN, VGG16, and Tesseract OCR) demonstrate moderate robustness even under the most aggressive settings.
 - The result concludes that the models are robust enough as a benchmark testing method on the platform.

Result





Other Metrics on the Platform

- Tesseract Confidence Score
 - LSTM-based OCR engine
 - $\text{Confidence}(\text{Line}) = \text{Sum of Confidence}(\text{Char}) / \text{Word Length}$
- Structural Similarity Index Measure(SSIM)
 - Evaluates perceived image similarity from human perspective
 - Luminance, Contrast, Structure
- Peak Signal-to-Noise Ratio(PSNR)
 - The difference between the perturbed image and the original one
 - Related to MSE
- $\text{Similarity} = 1 - \text{Edit Distance} / \max(1, \text{length})$

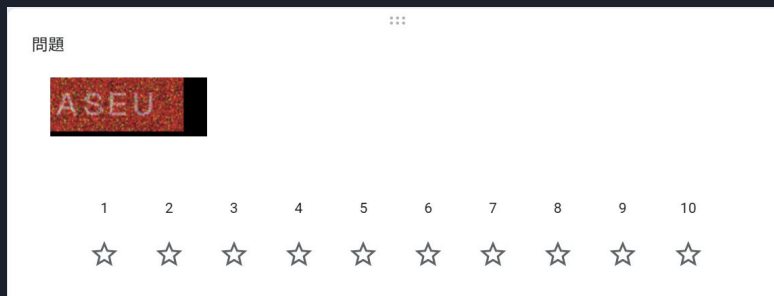


Demo

- [Link](#)

Conclusion

- In our demo, we show that certain generated CAPTCHA images successfully evade all three attack models.
- The platform supports large-scale robustness assessments.
- Among 10 adversarial CAPTCHA images that all models failed to recognize, human participants give a 93.2 score.





Future Work

- Training sequence-level models (e.g., LSTM, CRNN) for end-to-end CAPTCHA recognition
 - LSTM, CRNN...
- Real-world services dataset evaluation
 - Baidu, Google samples
- A general-purpose, extensible evaluation platform
 - Generalize the platform to support diverse CAPTCHA types and integrate with arbitrary OCR or ML models.
- Platform Deployment(in a week....?)

Bonus – Discussions on LLMs



- Does the emergence of powerful LLMs like ChatGPT diminish the need for task-specific ML models?
- We conducted preliminary tests on several LLMs using our CAPTCHA defense platform.
 - Some did fail, which means our platform may be able to defend them.
 - Victims : Claude Sonnet 4, Gemini 2.5 Flash...
- Despite their capabilities, most LLMs still require fine-tuning and task-specific adaptation to perform well on constrained problems.



Takeaways

- A system for private CAPTCHA generation
 - Without access to training samples, even strong ML-based models cannot effectively learn to break the CAPTCHAs.
- A non-technical required GUI platform
 - Even without prior knowledge, users can leverage randomization of fonts, noise, and layout to enhance defense strength.



References

- [HW+] Yu-Kai Huang, Tsung-Han Wu, and Wu-Jun Pei. “Defense against Machine Learning based CAPTCHAs Attack”. National Taiwan University.
- [SN+23] Andrew Searles et al. “An Empirical Study & Evaluation of Modern CAPTCHAs”. In: *Proceedings of the 32nd USENIX Security Symposium*. 2023.
- [TK+23] N. Tariq et al. “CAPTCHA Types and Breaking Techniques: Design Issues, Challenges, and Future Research Directions”. In: *arxiv* (2023).