

The background features a dark blue field with a complex network of fine, glowing blue and white lines that resemble optical fibers or neural connections. Overlaid on this are several concentric circles of varying shades of blue, some solid and some dashed, creating a sense of depth and technological sophistication.

Computer Vision 2023  
Final Project Topic

# Pupil Tracking

Ganzin Technology, Inc.

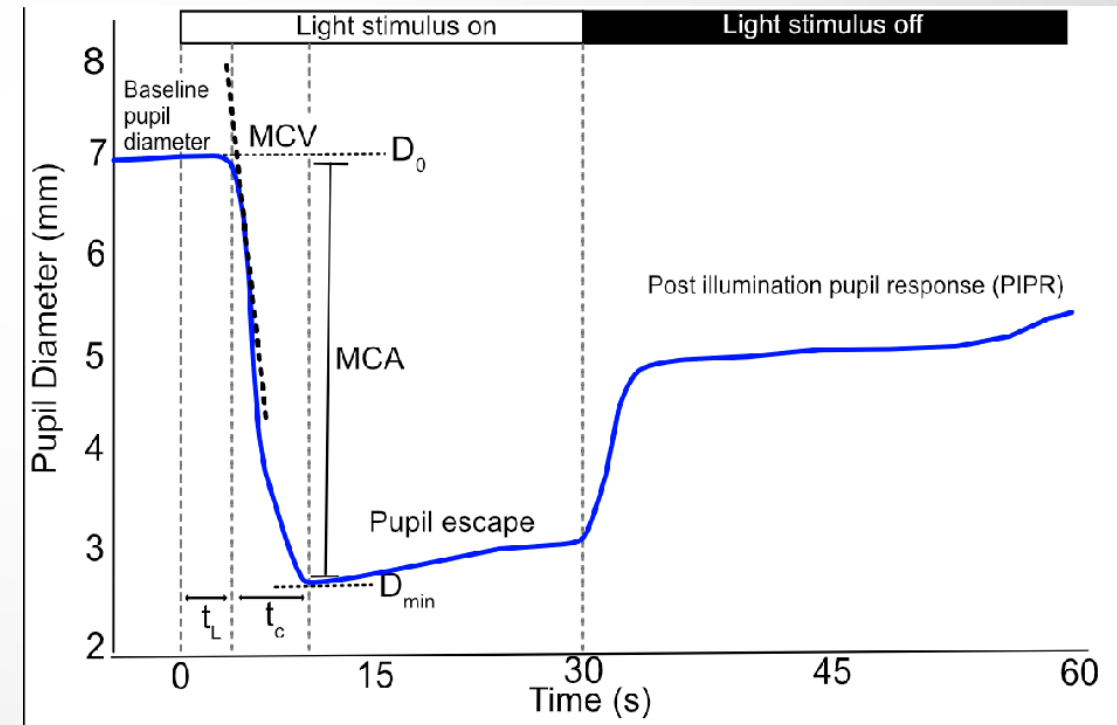
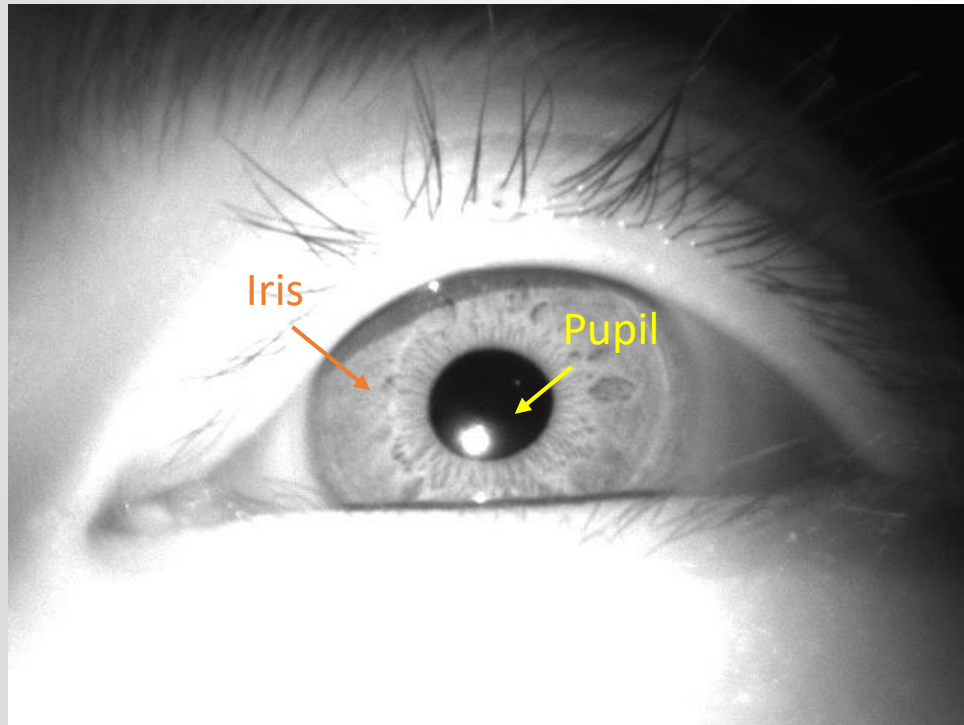
見臻科技

- Introduction
- Schedule
- Submission

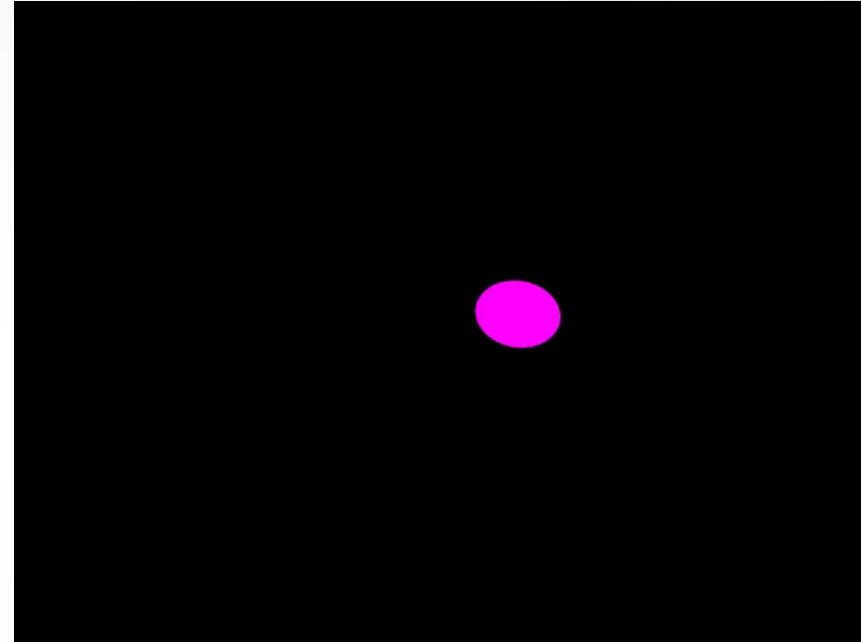


# Pupillometry

- The measurement of pupil size and reactivity, is a key part of the clinical neurological exam for patients with a wide variety of neurological injuries

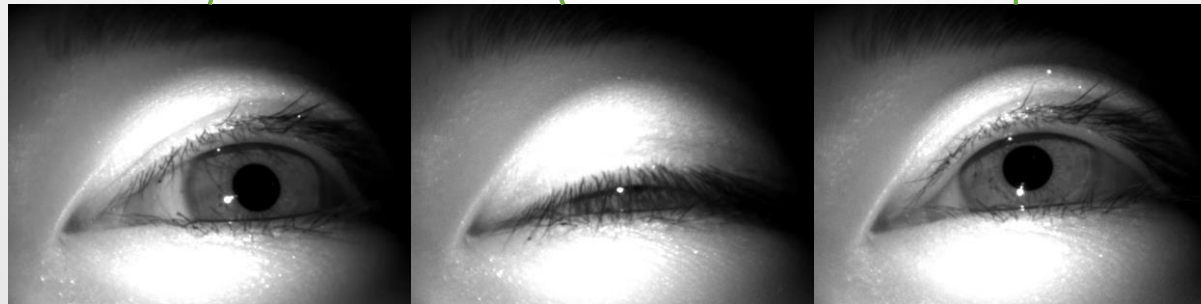
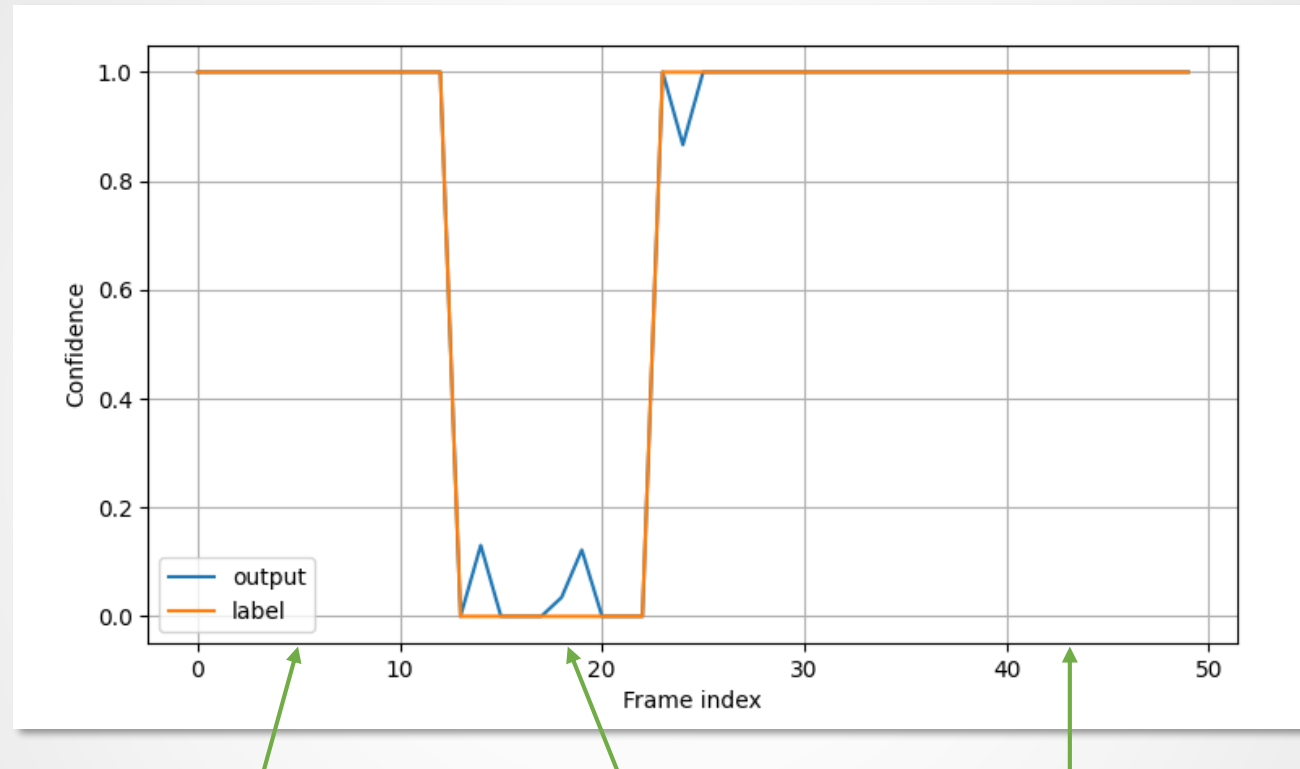


# Pupil Tracking

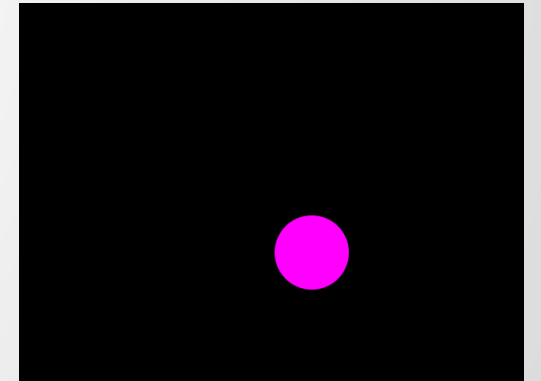
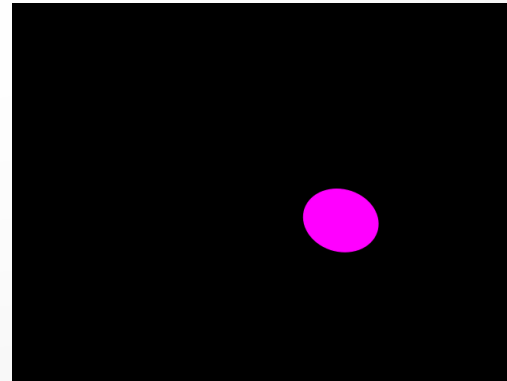
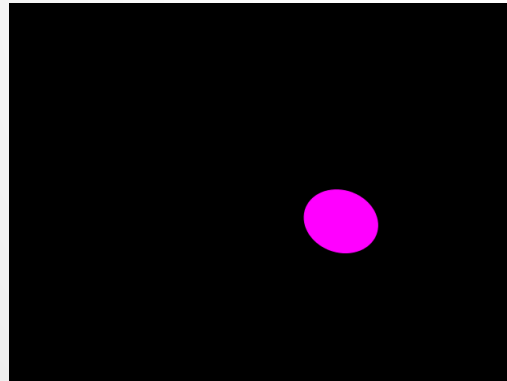
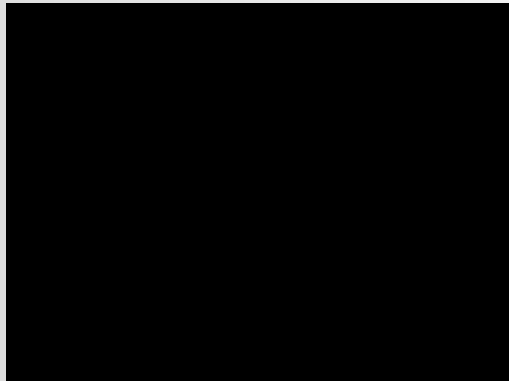
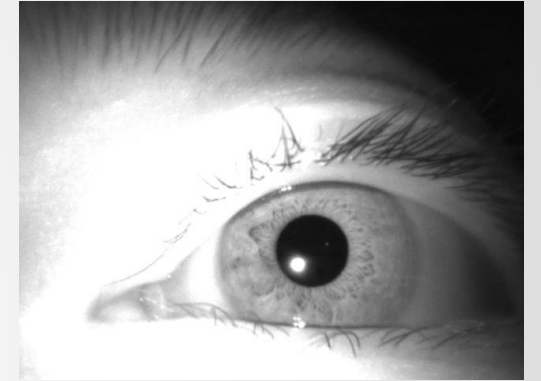
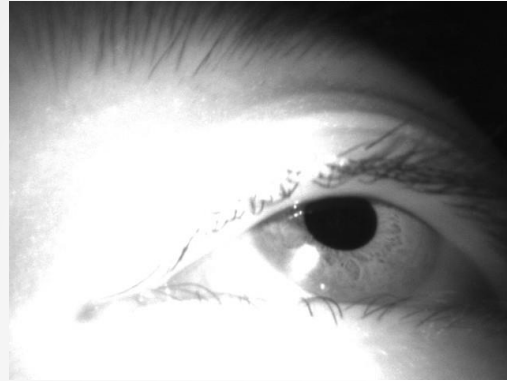
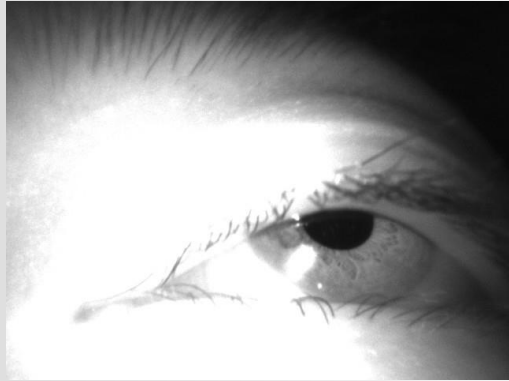


- Segment pupils in eye images
- Return the segmentation mask with a confidence value  $\omega \in [0, 1]$
- We can threshold  $\omega$  to obtain a binary sequence indicating the existence of pupils

# Example of Confidence

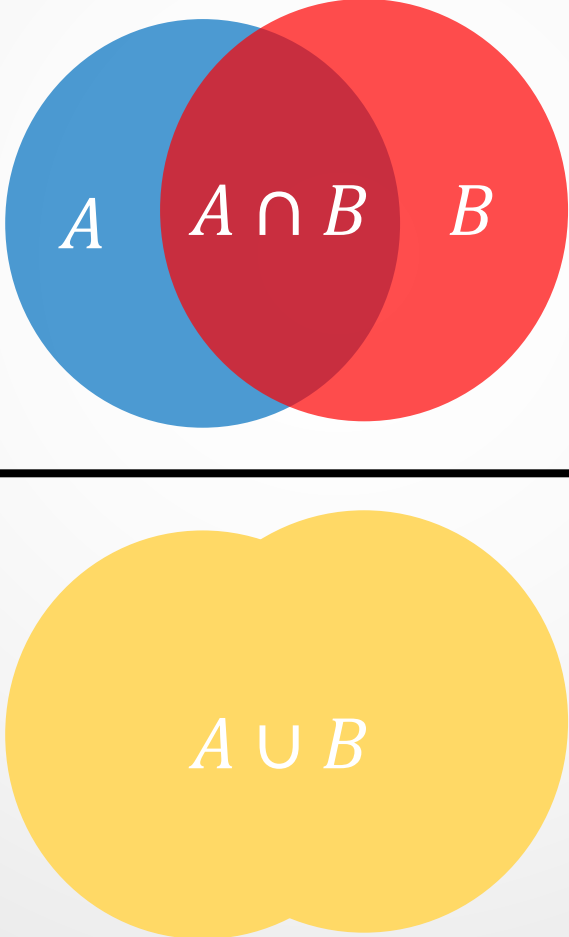


# Occluded Pupil



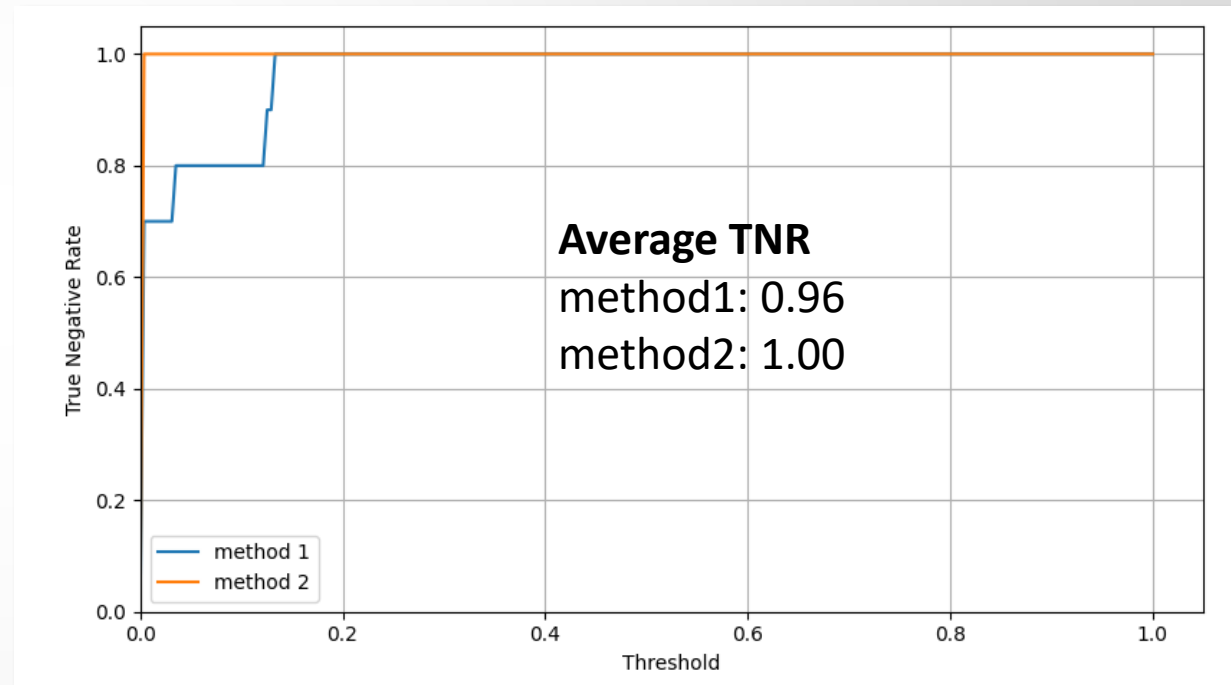
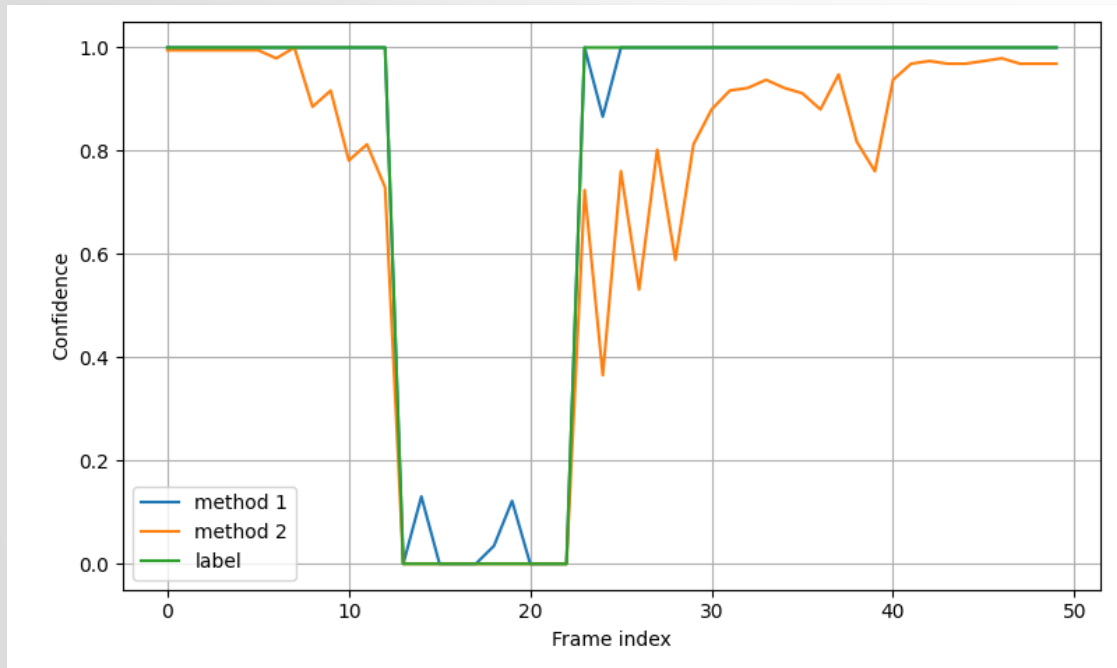
# Evaluation Metric

- Intersection over union (IoU)


$$IoU = \frac{A \cap B}{A \cup B}$$

# Evaluation Metric

- True negative rate (TNR)



$$TNR = \frac{TN}{N} = \frac{TN}{TN + FP}$$

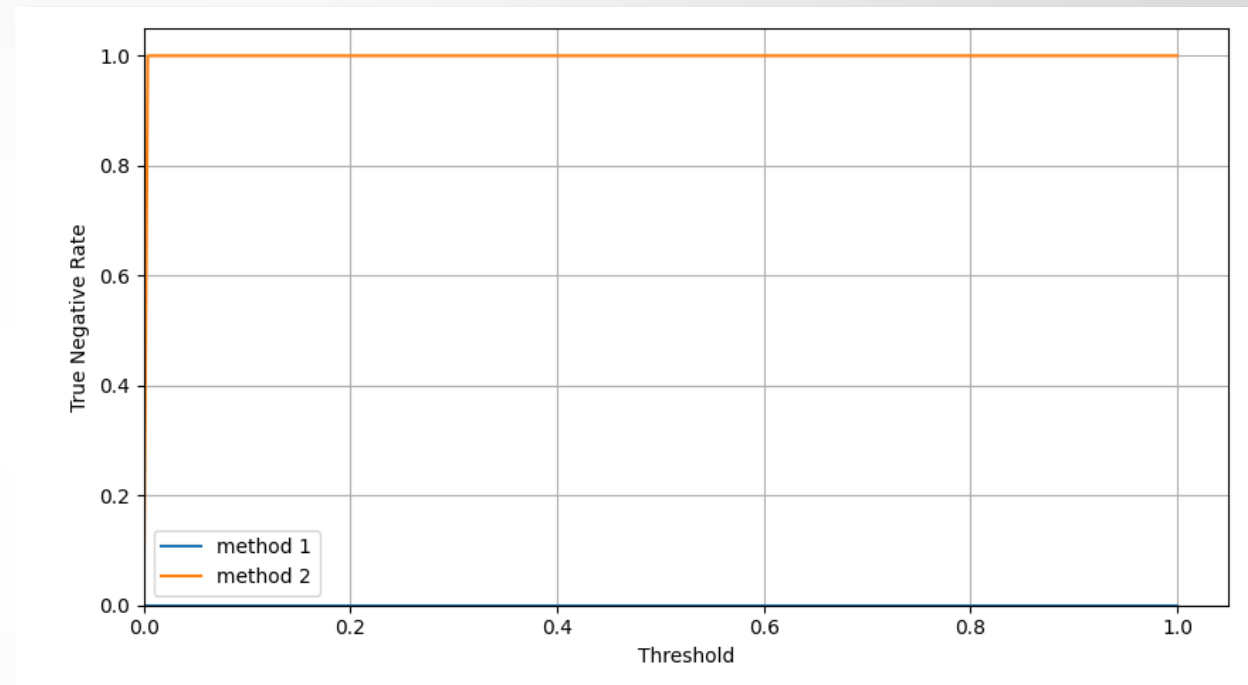
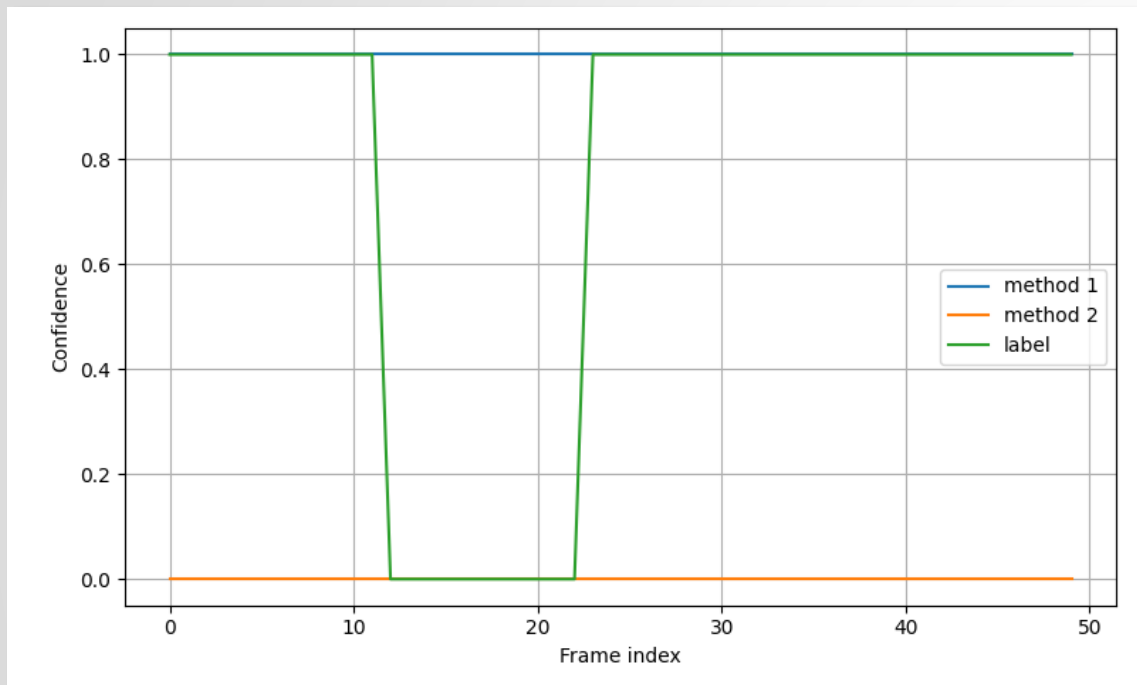


# Evaluation Metric

- Weighted IoU: 70%
  - $N_{valid}$ : Number of valid frames whose labels are not empty
- ATNR: 30%
  - Computed using 1000 thresholds uniformly sampled from 0 to 1
  - Accumulated over all data frames

$$Score = 0.7 \cdot \frac{\sum_i \omega_i \cdot IoU_i}{N_{valid}} + 0.3 \cdot ATNR$$

# 不想努力了



$$Score = 0.7 \cdot WIoU + 0.3 \cdot ATNR$$

# Possible Directions

- Fancy approaches
  - Show how you formulate the problem into deep learning
  - How do you supervise the confidence estimation?
  - How do you leverage the unlabeled data?
  - Object detection? Object tracking?
  - Pre-training on semantic segmentation?
- Classical CV may also be useful
  - Edge detection
  - Motion segmentation
  - Correlation filter
- Hybrid solution

# Dataset

- Public set (S1-S5)
  - 130 clips of eye movement
  - ~26k frames in total (~90% eyes open)
- Hidden test set (S6-S8)
- External dataset
  - You are welcome to use any dataset to facilitate your project
  - Note it in your report

# You will be given...

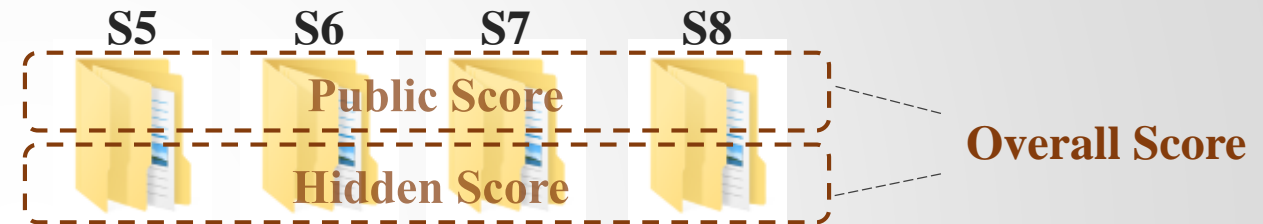
- Dataset (S1-S4, labels are given; S5-S8, labels are *not* given)
- Evaluation Scripts



# Dataset Structure



Both images and labels are given

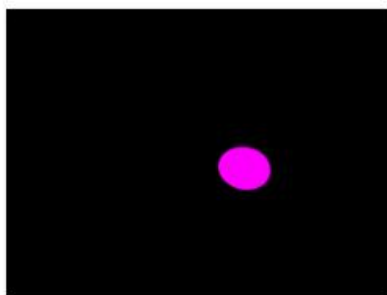


Only images are given. **Test on the evaluation server**

The scores for these data will not be released directly. Instead, they will be **divided into two portions**, with the results of the public section being publicly reported as the **public score** on the server, while the score of the hidden section will be kept **hidden until the server is closed**.



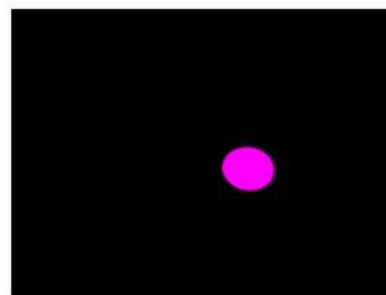
0.jpg



0.png



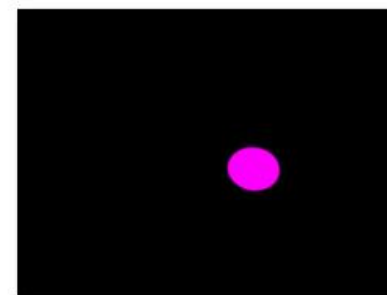
1.jpg



1.png



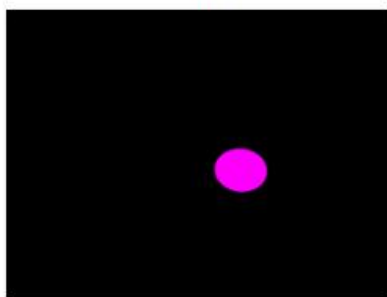
2.jpg



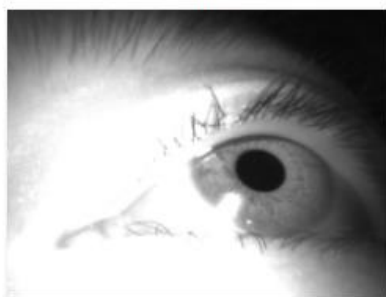
2.png



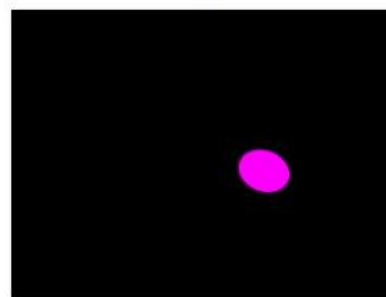
3.jpg



3.png



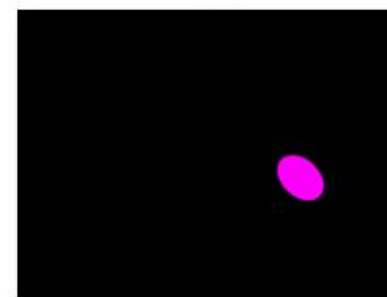
4.jpg



4.png



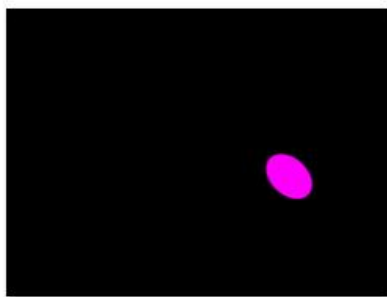
5.jpg



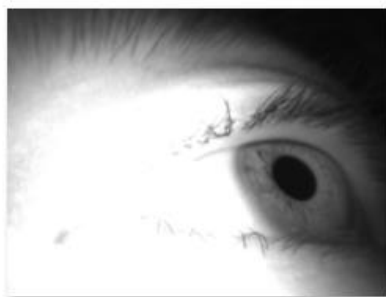
5.png



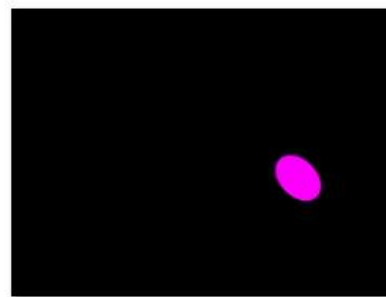
6.jpg



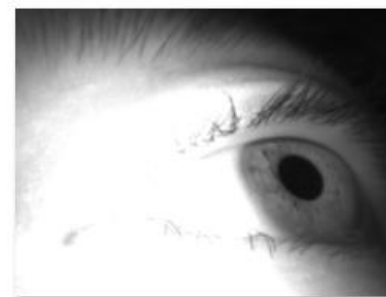
6.png



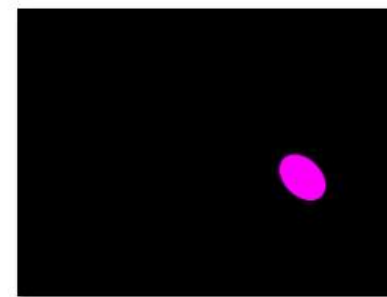
7.jpg



7.png



8.jpg



8.png

# Evaluation Scripts

- See **eval.py** for details
- You may need to modify the code to evaluate your method:
  - **Line 77-80:** Run your code here

```
# TODO: Modify the code below to run your method or load your results from disk
# output, conf = my_awesome_algorithm(image)
output = label
conf = 1.0
```

- **Line 102-103:** Change the path to dataset; you may also partially evaluate the dataset

```
dataset_path = r'D:\CV23S_Ganzin_final_project\dataset\public'
subjects = ['S1', 'S2', 'S3', 'S4']
```

- **Line 69-71:** This script by default will skip evaluating a sequence if ground truths are not available

```
label_name = os.path.join(image_folder, '0.png')
if not os.path.exists(label_name):
    print(f'Labels are not available for {image_folder}')
    continue
```

# Grading

- Quantitative: 50%
  - Overall score (not just public score) of S5-S8 will be considered
- Presentation: 50% (top 10 teams)
  - Novelty and technical contribution (20%)
  - Completeness (25%)
    - Ablation studies, visualization, experiments, analysis, etc
  - Presentation (5%)
- Report: 50% (other teams)
  - Novelty and technical contribution (25%)
  - Completeness (25%)
    - Ablation studies, visualization, experiments, analysis, etc

Score	Points	# of teams
highest ↓ lowest	50%	1
	48%	1
	46%	1
	42%	4
	38%	4
	34%	4
	30%	4

**Note** Only the top 10 teams on the final leaderboard (overall score) will be chosen for the final presentation.

- Introduction
- **Schedule**
- Submission



# Schedule

- **Evaluation Server Open**
  - 2023/05/20 00:00
- **Evaluation Server Close**
  - 2023/06/05 23:59
- **Code Submission**
  - 2023/06/06 23:59
- **Oral Presentation**
  - 2023/06/09 14:20~17:20 (Tentative)
- **Report Submission (ppt or pdf)**
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# Submission: Evaluation Server

- The evaluation server serves the purpose of **testing the S5-S8** dataset's performance and **ranking**
- It will be held on the Codalab competition server. Please read all the rules on the project page carefully.
- Project Page: [https://codalab.lisn.upsaclay.fr/competitions/13285?secret\\_key=a43074bb-381f-4163-967f-bc310d743cba](https://codalab.lisn.upsaclay.fr/competitions/13285?secret_key=a43074bb-381f-4163-967f-bc310d743cba)
- During the server's operation, **only the public score will be visible**. The overall score will not be disclosed to the participants until the server is closed.
- Maximum submission: 60
- Maximum submission per day: 5

# Submission: Evaluation Server

- Your prediction submitted to the server should be arranged as follows:

## **solution/ (top folder)**

S5/

- 01/ {all predicted mask in png format & conf.txt}

- 02/ 0.png, 1.png, ..., 421.png, conf.txt

...

- 26/ 0.png, 1.png, ..., 808.png, conf.txt

S6/ ...

S7/ ...

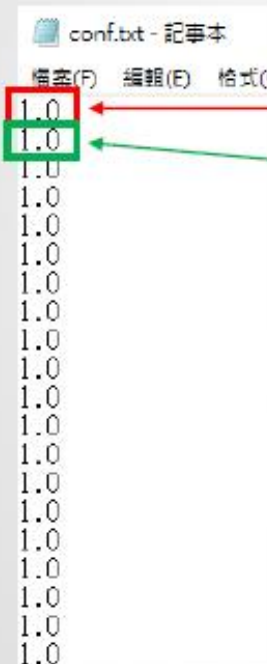
S8/ ...

- You need to **compress “solution” into a zip file**. The file name of the zip file is unrestricted.
  - After running \$unzip (on a Linux system), only one folder named "solution" should be generated
  - Example submitted file: [https://drive.google.com/file/d/1MwIOSBN1fVDcTBOyMWfhEMyXR-3\\_wYF1/view?usp=sharing](https://drive.google.com/file/d/1MwIOSBN1fVDcTBOyMWfhEMyXR-3_wYF1/view?usp=sharing)
- If any of the **file formats are wrong**, the evaluation process may fail, and you will **lose** your **submission quota** without compensation.
- More detailed submission instructions are provided on the project page (Participate -> Get Data) for reference.



# Submission: Evaluation Server

- In each sequence, you need to generate one “conf.txt” to save your predicted confidence values. The format of conf.txt is shown below.



conf.txt - 記事本  
檔案(F) 編輯(E) 格式(O)

1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0  
1.0

The confidence value of 0.jpg

The confidence value of 1.jpg

**Note: Before the server is closed, please ensure that each group uploads their scores to the leaderboard at least once.**

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# Submission: Code Submission

- Only the **team leader** needs to upload the code (including training & testing) to **NTU COOL**.
- You should also **upload the model file** (if any), which can generate the score on the Codalab leaderboard.
- **DO NOT** upload the dataset !!!
- All datasets used during training must be clearly stated. You can provide us with a download link.
- **Clearly describe** how to set up the environment, the steps to run your code (ideally by providing a bash script), and used datasets, so that TAs can **reproduce the results**.
- **Deadline: 2023/06/06 23:59**

# Submission: Code Submission

- R07654321/
  - **README file (Important!!!)**
    - Clearly describe how to set up the environment, the steps to run your training and testing, and the datasets you used
  - Model file (if any)
  - All your codes, environment settings, etc.
- Compress all files above in a zip file named StudentID.zip (e.g., R07654321.zip) and upload to NTU COOL
  - After TAs run “unzip R07654321.zip”, it should generate one directory named “R07654321”.
- If TAs cannot reproduce your results on the leaderboard (public and overall score), you will receive 0 points for the performance score. Minor errors are acceptable.
- **[非常重要用中文寫]**  
嚴禁手標S5-S8的mask與confidence label或是用不當的方式預測confidence score (例如: 肉眼查看jpg檔) , 助教們與Ganzin會重跑並檢查你們繳交的training與testing code , 確認是否符合evaluation server的結果及是否合理。不符合或作弊者會在performance項目 (Quantitative part) 直接獲得0分！

# Submission: Code Submission

- The following sample demonstrates **a possible submission format**. (not mandatory)
  - **README**: All specifics, including the environment, the steps to run your training and testing, and the datasets you used
  - **Environment file**: requirements.txt for pip install
  - **Training script/file**: bash pupil\_training.sh \$1 \$2 or python3 pupil\_training.py \$1 \$2
    - \$1 \$2... might be the dataset path, output model path, etc.
  - **Testing script/file**: bash pupil\_testing.sh \$1 \$2 or python3 pupil\_testing.py \$1 \$2
    - \$1 \$2... might be the testing images directory, output folder of predicted masks & confidence.
- Note that you should **NOT hard code any path** in your file or script. Use os.path.join to deal with path as often as possible.
- You must not use commands such as rm, sudo , CUDA\_VISIBLE\_DEVICES to change TA's setting.
- We will **execute** you code **on Linux system**, so try to make sure your code can be executed on Linux system before submitting your code.



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# Submission: Report Submission

- Only the **team leader** needs to upload the report (ppt or pdf) to **NTU COOL**.
- The teams selected for the final presentation need to upload your presentation slides **in pptx format**.
- The teams not selected for the final presentation need to upload your report **in pdf format**.
- **Deadline: 2023/06/09 23:59**

# Reminder

- Please start working on this as early as possible.
- Please read and follow the rules carefully.
- **Taking any unfair advantages (e.g., plagiarism) over other class members is strictly prohibited. Violating university policy would result in F for this course.**
- If not sure, please ask TAs!
  - NTU COOL 討論區 or Email [tzujliu@media.ee.ntu.edu.tw](mailto:tzujliu@media.ee.ntu.edu.tw)