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FACE ANALYSIS CHALLENGE

PIXTA VIETNAM · Cohost AI Smarter Sharing · VIBLO · HUB NETWORK · iHUB

SOLUTION FOR FACE ANALYSIS

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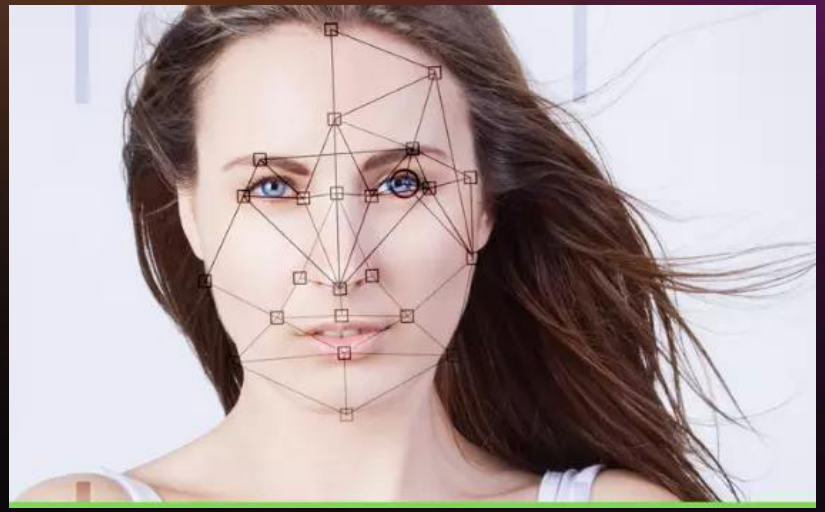
I. Introduction

- Face analysis is the process of using technology to analyze human facial features to understand information such as age, gender, mood, and many other factors
- => applied in many fields. ranging, including industrial, medical, security, and entertainment



- The competition poses a challenge to build ideas and apply technology to identify all facial features such as: Gender, Age, Ethnicity, Skin color, Wearing a mask/ Not wearing a mask, Feeling emoji, Face recognition, ...

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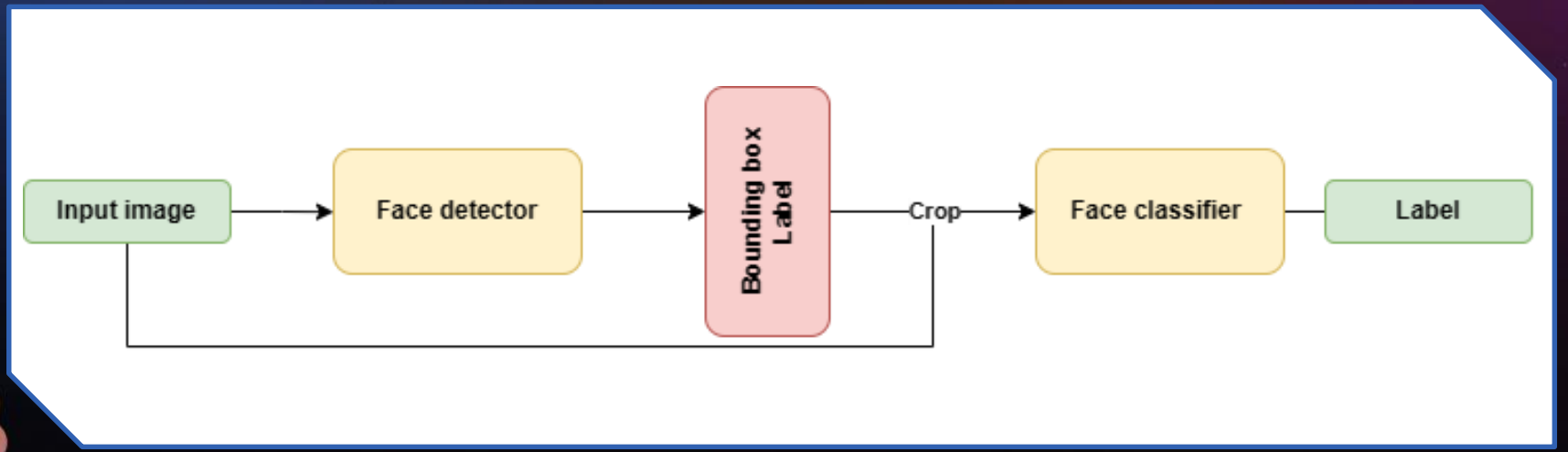
II. Proposed method

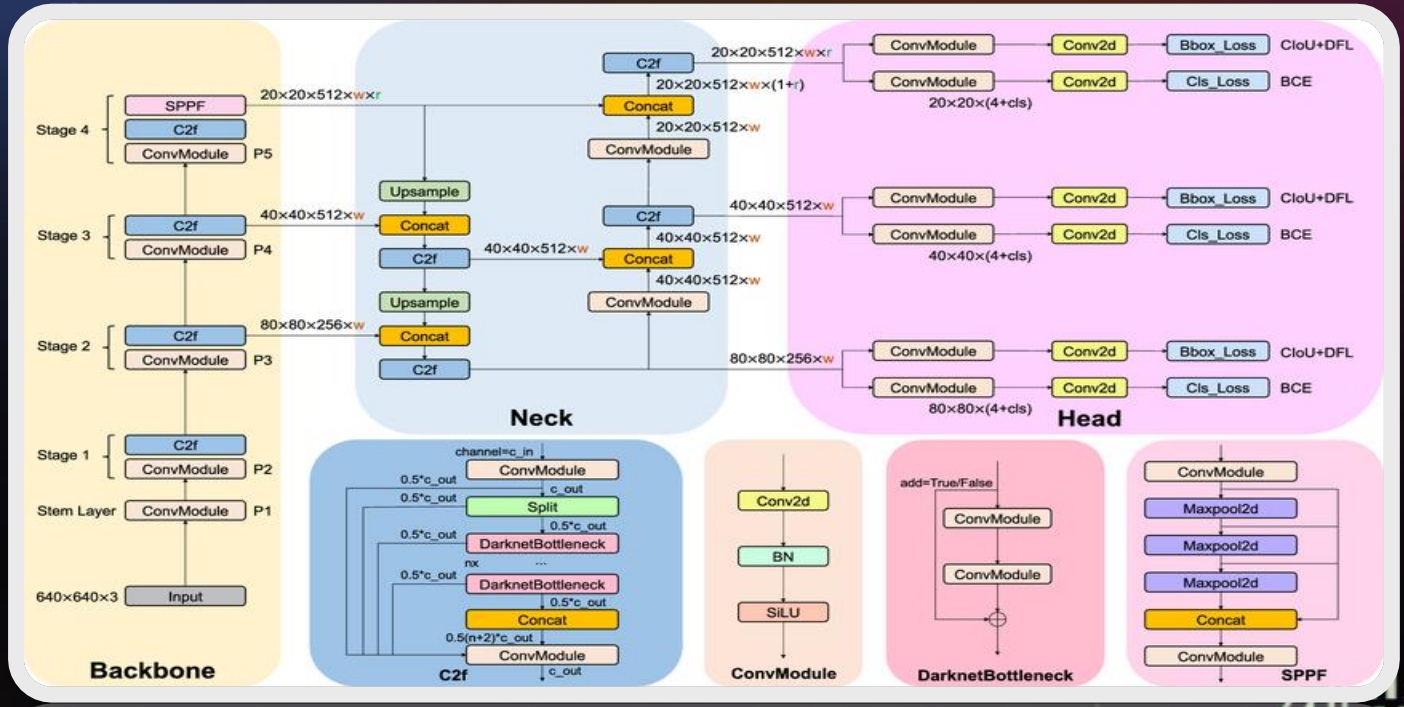


Overview of our pipeline

II. Proposed method

a. Face detector

Face detector: YOLOv8

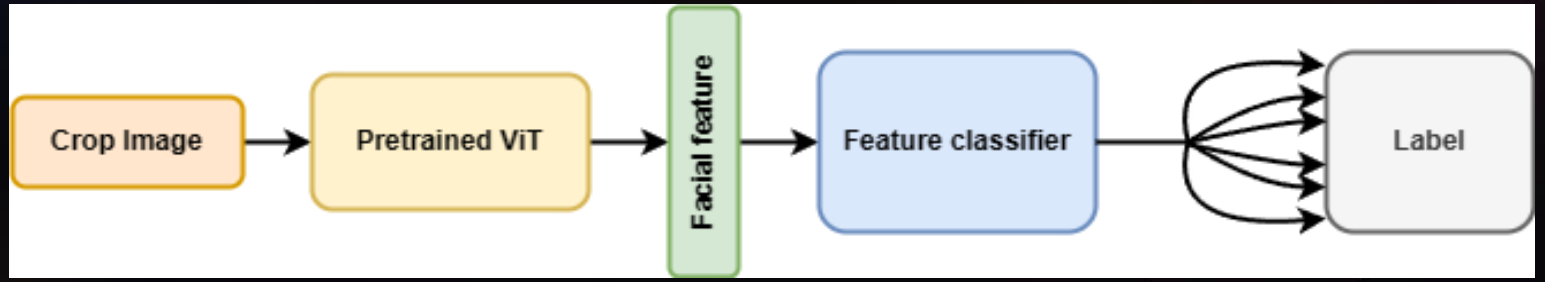


II. Proposed method

b. Face Attributes Classifier

Multi-model for classification task:
- Enormous memory
- Difficult to implement for real application

=> Using single model with multi-task classifier



Overview Face Attributes classifier

II. Proposed method

b. Face Attributes Classifier

Type of classifier:

- Custom SVM: $K(x, x') = (-\gamma \|x - x'\|_2^2 + c)^d$
- Transformer: 4 layers (encoder) – 8 heads
- Fully Connected Layer (MLP): 3 layers

Training strategy :

- Freeze VIT backbone and train Face Attributes Classifier
- Do not use augment data or extra data
- Use Balanced Binary Cross Entropy Loss for ViT (CVPR2023) for 6 attributes

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II. Proposed method

b. Face Attributes Classifier

$$\mathcal{L}_{\text{Bal-BCE}} = -\sum_{\mathbf{y}_i \in \mathcal{C}} w_i [\mathbb{1}(\mathbf{y}_i) \cdot \log \frac{1}{1 + e^{-[\mathbf{z}_{\mathbf{y}_i} + \log \pi_{\mathbf{y}_i} - \log(1-\pi_{\mathbf{y}_i})]}}$$

$$+ (1 - \mathbb{1}(\mathbf{y}_i)) \cdot \log(1 - \frac{1}{1 + e^{-[\mathbf{z}_{\mathbf{y}_i} + \log \pi_{\mathbf{y}_i} - \log(1-\pi_{\mathbf{y}_i})]}})]$$

Bal-BCE loss for ViT (adapted from [1])

[1] Zhengzhuo Xu et al. Learning Imbalanced Data with Vision Transformers.
In CVPR, pages 15793 – 15800, IEEE, 2023.

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III. Results

a. Results on scoreboard

We use VIT base for all following model with different classifier

Type of classifier	Training time (RTX 4090 24g)	Public test	Private test
Custom SVM	2 m/epoch	26.08	25.30
Transformer	3 m/epoch	26.06	**25.37**
Fully Connected Layer	2 m/epoch	**26.13 (2)**	25.06

III. Results

b. Performance and inference time

Model	mAP50/avg dev acc	Capacity	params	Time (s) on CPU i5 1135g7	Time (s) on GPU Tesla T4	Time (s) on GPU Tesla T4(quantized)
Yolov8 n	~0.9401	6mb	~3m	~0.45	~0.06	-
Yolov8 m	~0.9484	50mb	~26m	~0.61	~0.10	0.015 ± 0.005 (640 scale)
Yolov8 x	~0.9525	130mb	~68m	~1.45	~0.23	
VIT small + SVM	0.9088	85mb	~22m	~0.10	~0.02	-
VIT base + SVM	0.9123	140mb	~87m	~0.21	~0.04	-
VIT large +SVM	0.9096	1.2gb	~305m	~0.81	~0.19	-

IV. Self-evaluation

Aspect	Our method
Accuracy	• Top 2 on public test • Achieve 25.37 final score on private test
Business	• Both Yolov8 (face detector) and VIT(face attributes classifier) **have commercial use license** • Can improve performance with augment or extra data • Smaller variants can optimize capacity and inference time
Creativity	• Design custom SVM kernel for face attributes classifier with competitive result and save resources
Possibility	• Face detector has been quantized for faster inference time • Pipeline can run on CPU in less than 1s/frame

V. Limitations

- Challenge in imbalanced data
- Having difficulty in challenging attributes such as age, emotion, especially skintone.
- Face Attributes Classifier is not designed to automatically augment data.
- Face Attributes Classifier has not been quantized.
- Faces with mask are still impossible to predict emotion (bias to neutral)

=> Addressed in the future

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VI. Product & Demo

Quantization step: reduce **about 74.07%** inference time of YOLO (jetson Xavier)

Achieve > 30 FPS for Face detection only

```
root@tronganh-jetsonxavier:/home/tronganh/AIChallenge# yolo detect val model=/home/tronganh/AIChallenge/log/checkpoint_yolov8m/
best.pt data=/home/tronganh/AIChallenge/datasets/mydataset.yaml batch=1 imgsz=640
Ultralytics YOLOv8.0.200 🚀 Python-3.8.10 torch-2.0.0a0+ec3941ad.nv23.02 CUDA:0 (Xavier, 6857MiB)
Model summary (fused): 218 layers, 25840339 parameters, 0 gradients, 78.7 GFLOPs
val: Scanning /home/tronganh/AIChallenge/datasets/data_yolo/dev/labels.cache... 703 images, 0 backgrounds, 0 corrupt: 100%|
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|| 703/703 [03:47<00:00
                   all        703        703          1          1      0.995      0.987
Speed: 1.4ms preprocess, 121.5ms inference, 0.1ms loss, 4.4ms postprocess per image
Results saved to runs/detect/val5
 Learn more at https://docs.ultralytics.com/modes/val
root@tronganh-jetsonxavier:/home/tronganh/AIChallenge# yolo detect val model=/home/tronganh/AIChallenge/log/checkpoint_yolov8m/
bestt.pt data=/home/tronganh/AIChallenge/datasets/mydataset.yaml batch=1 imgsz=640
best.onnx         best.pt           best_fp16.engine
root@tronganh-jetsonxavier:/home/tronganh/AIChallenge# yolo detect val model=/home/tronganh/AIChallenge/log/checkpoint_yolov8m/
best_fp16.engine data=/home/tronganh/AIChallenge/datasets/mydataset.yaml batch=1 imgsz=640
Ultralytics YOLOv8.0.200 🚀 Python-3.8.10 torch-2.0.0a0+ec3941ad.nv23.02 CUDA:0 (Xavier, 6857MiB)
Loading /home/tronganh/AIChallenge/log/checkpoint_yolov8m/best_fp16.engine for TensorRT inference...
[01/23/2024-10:50:19] [TRT] [I] Loaded engine size: 51 MiB
[01/23/2024-10:50:22] [TRT] [I] [MemUsageChange] Init cuDNN: CPU +343, GPU +325, now: CPU 741, GPU 3360 (MiB)
[01/23/2024-10:50:22] [TRT] [I] [MemUsageChange] TensorRT-managed allocation in engine deserialization: CPU +0, GPU +49, now: C
PU 0, GPU 49 (MiB)
[01/23/2024-10:50:23] [TRT] [I] [MemUsageChange] Init cuDNN: CPU +0, GPU +0, now: CPU 690, GPU 3312 (MiB)
[01/23/2024-10:50:23] [TRT] [I] [MemUsageChange] TensorRT-managed allocation in IExecutionContext creation: CPU +0, GPU +32, no
w: CPU 0, GPU 81 (MiB)
val: Scanning /home/tronganh/AIChallenge/datasets/data_yolo/dev/labels.cache... 703 images, 0 backgrounds, 0 corrupt: 100%|
                 Class     Images  Instances      Box(P          R      mAP50  mAP50-95): 100%|| 703/703 [01:22<00:00
                   all        703        703          1          1      0.995      0.988
Speed: 1.2ms preprocess, 31.4ms inference, 0.1ms loss, 4.2ms postprocess per image
Results saved to runs/detect/val6
 Learn more at https://docs.ultralytics.com/modes/val
```

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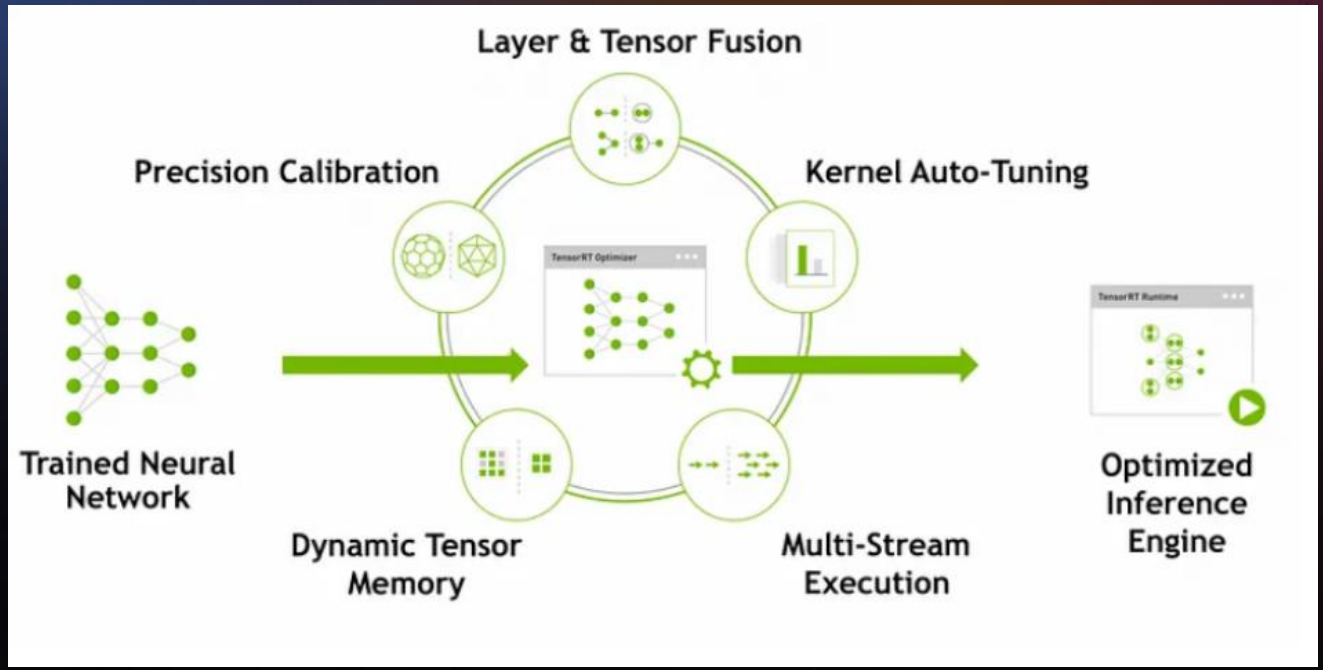
VI. Product & Demo



Quantization and optimization using TensorRT

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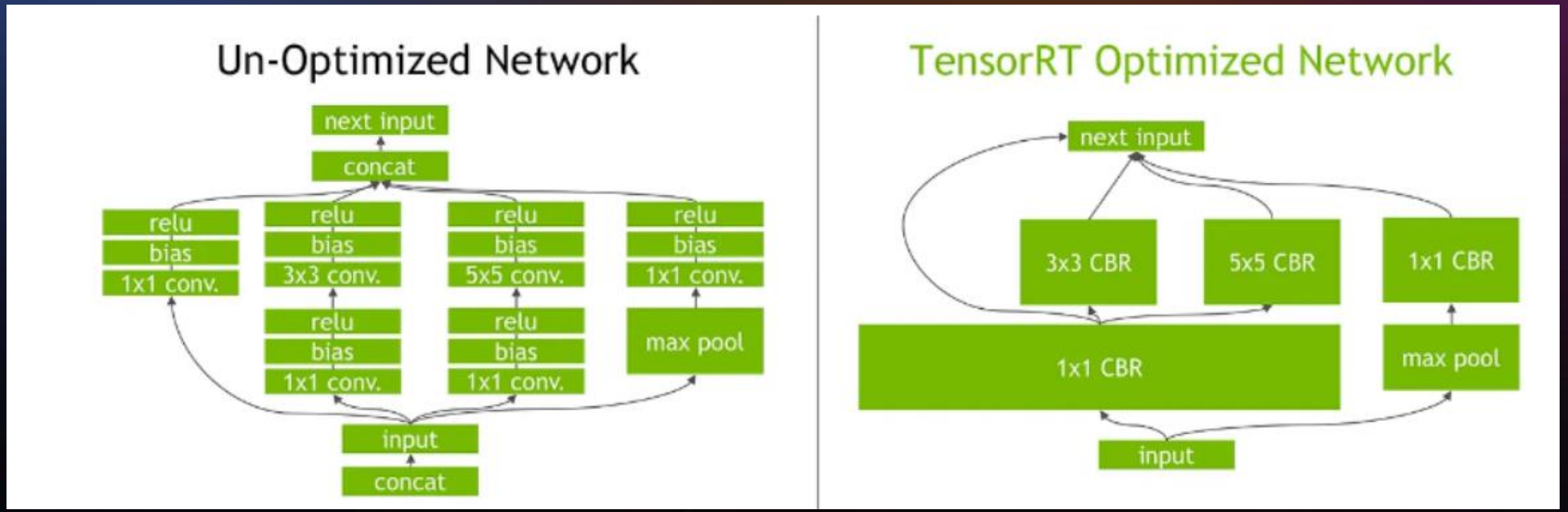

Layer fusion method optimization

VI. Product & Demo

Quantization step: reduce **about 74.07%** inference time of YOLO (jetson Xavier)
Face classifier model has not been quantized yet
Achieve 17 FPS (including pre-processing and post-processing steps)
GPU cost: 2.2 GB
RAM cost: 4.8GB

```
Thời gian yolov8 thực hiện: 0.019832611083984375 s
Thời gian face analysis model thực hiện: 0.038395404815673828 s
Tổng thời gian thực hiện: 0.059618473052978516 s
```

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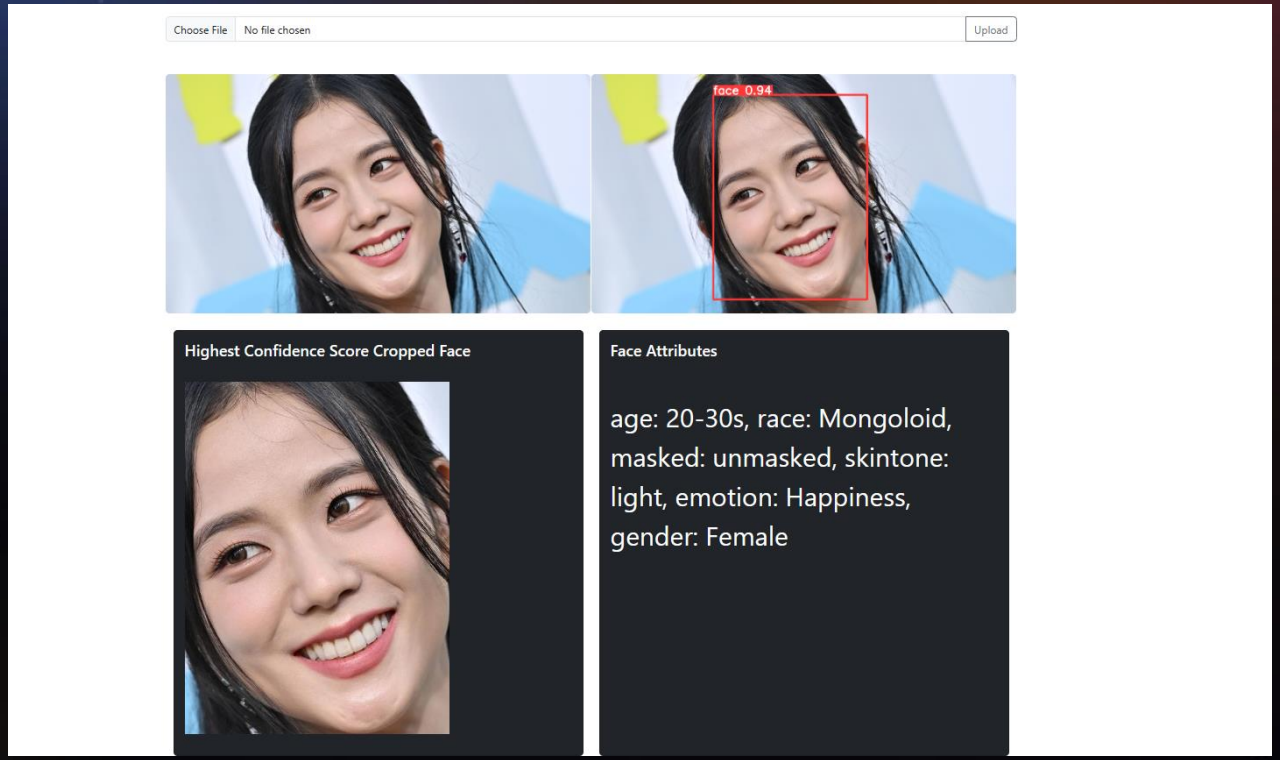
VI. Product & Demo

Make a simple website that can detect faces in image and analyze face attributes (age, race, masked, skintone, emotion, gender)



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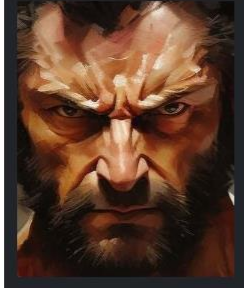
VI. Product & Demo

⚠ Note:
To get the best result, please upload a vertical photo, without tilt or angle, and with good lighting conditions

Choose File | No file chosen | Upload

Highest Confidence Score Cropped Face



Face Attributes

age: 20-30s, race: Caucasian, masked: unmasked, skintone: mid-dark, emotion: Anger, gender: Male

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Thank you for listening !

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