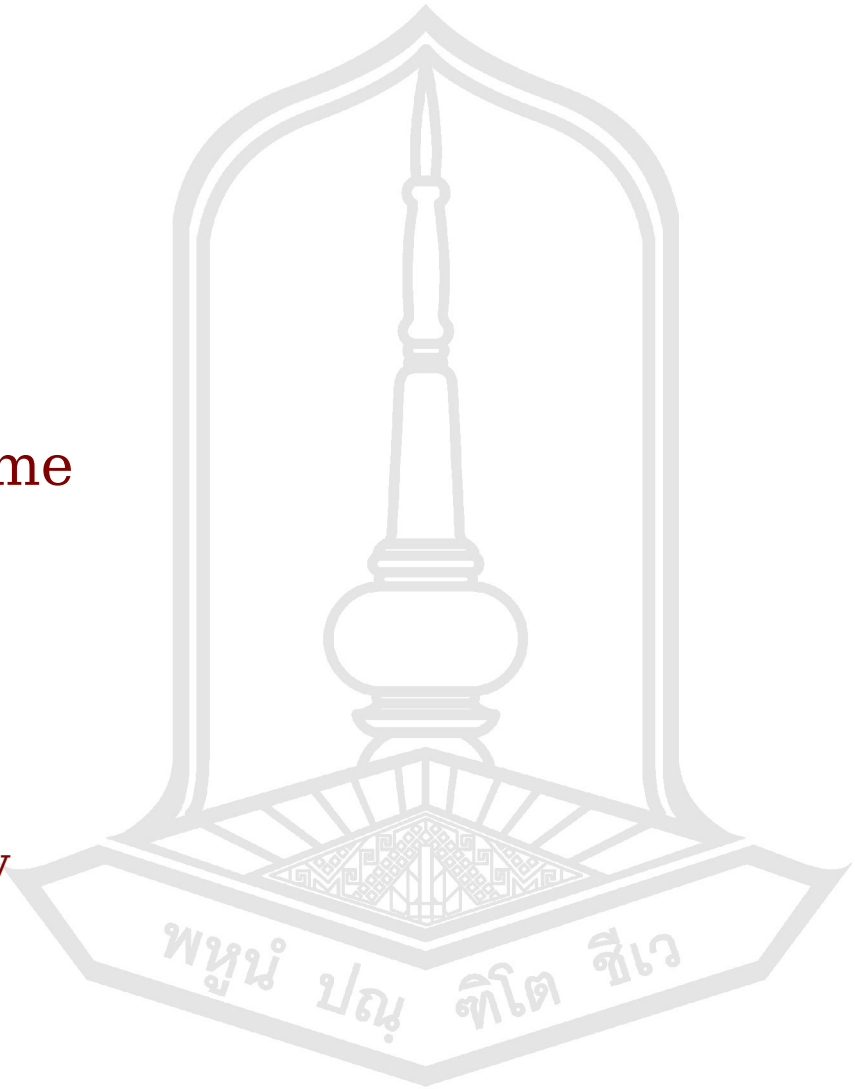
INTRODUCTION TO MACHINE LEARNING

For Computer Animation and Game

17 September 2019

INTRODUCTION TO MACHINE LEARNING

For Computer Animation and Game



Olarik Surinta, PhD.
Department of Information Technology
Faculty of Informatics
Mahasarakham University

- **โอฬาริก สุรินต๊ะ**

  ภาควิชาเทคโนโลยีสารสนเทศ

- Multi-agent Intelligent Simulation Laboratory (MISL)

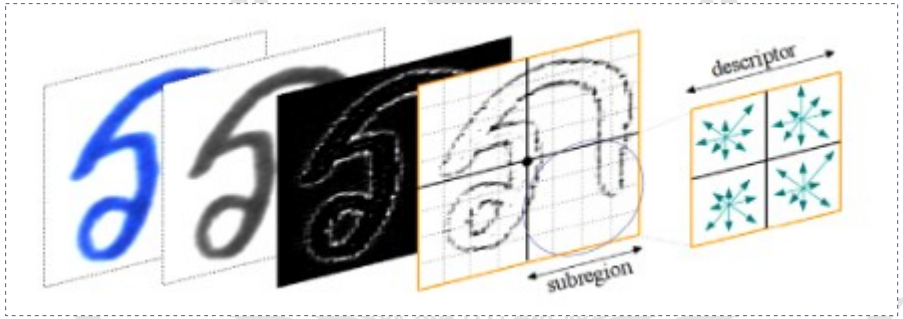
- **Research Area**

  Image Processing, Computer Vision, Machine Learning

  Pattern Recognition, Object Detection, Deep Learning

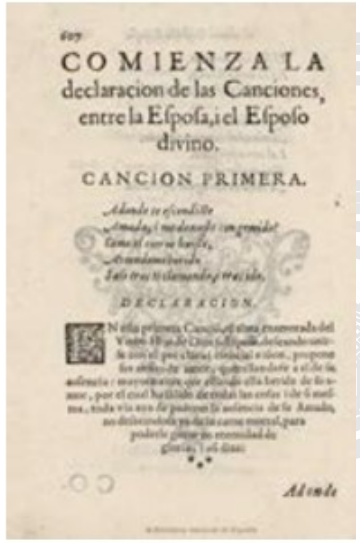
  Historical Document Analysis

Historical Document



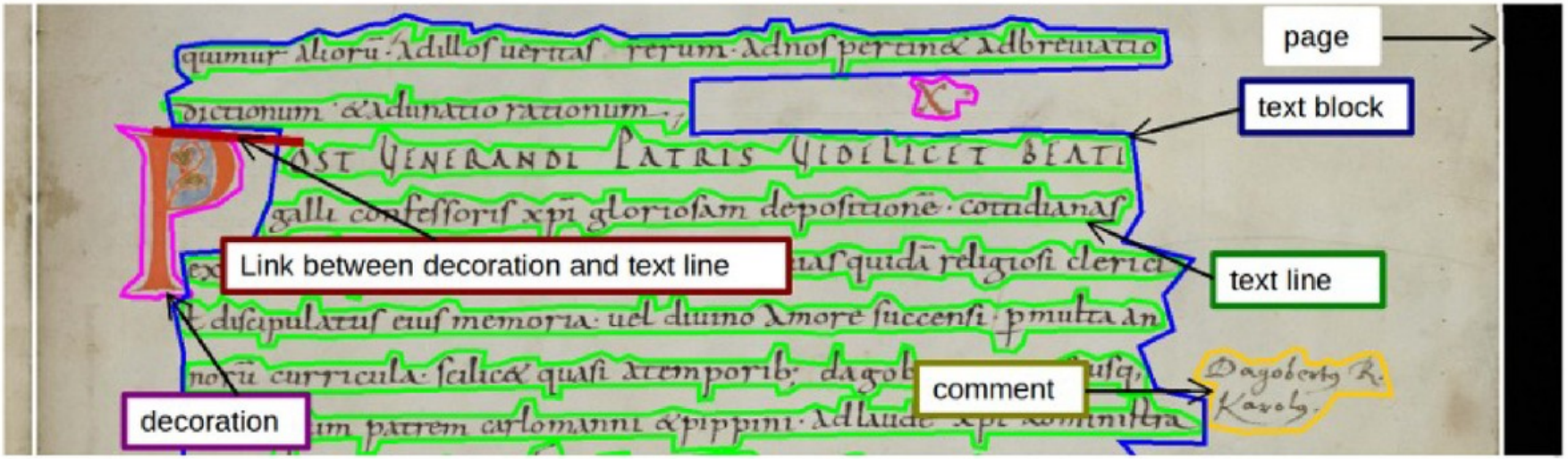
Local Gradient Feature Descriptor

Historical Document Analysis



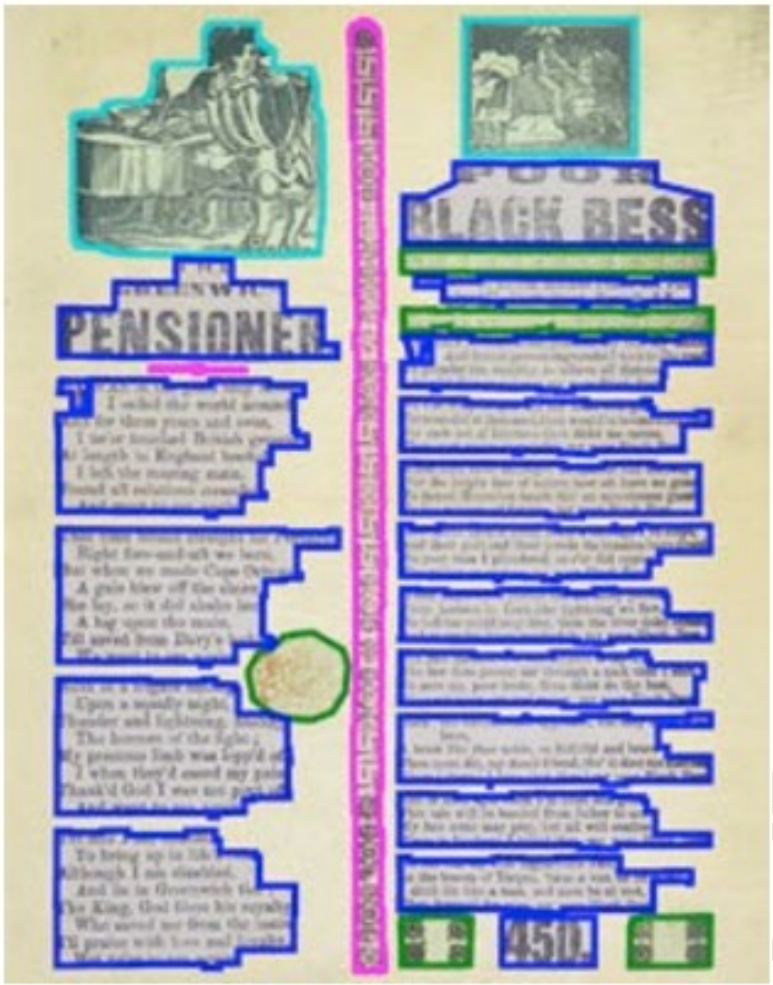
Historical Document Layout Analysis Competition

Historical Document Layout Analysis



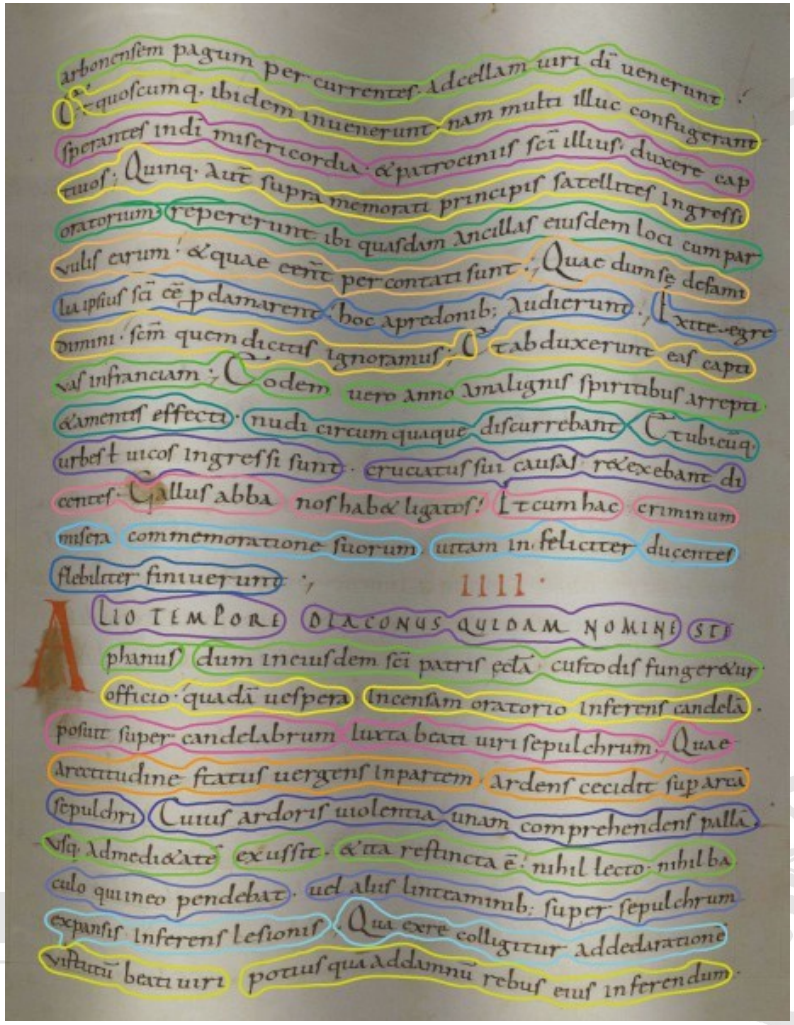
Ground truth model, tool, and dataset for layout analysis of historical documents

Historical Document Layout Analysis

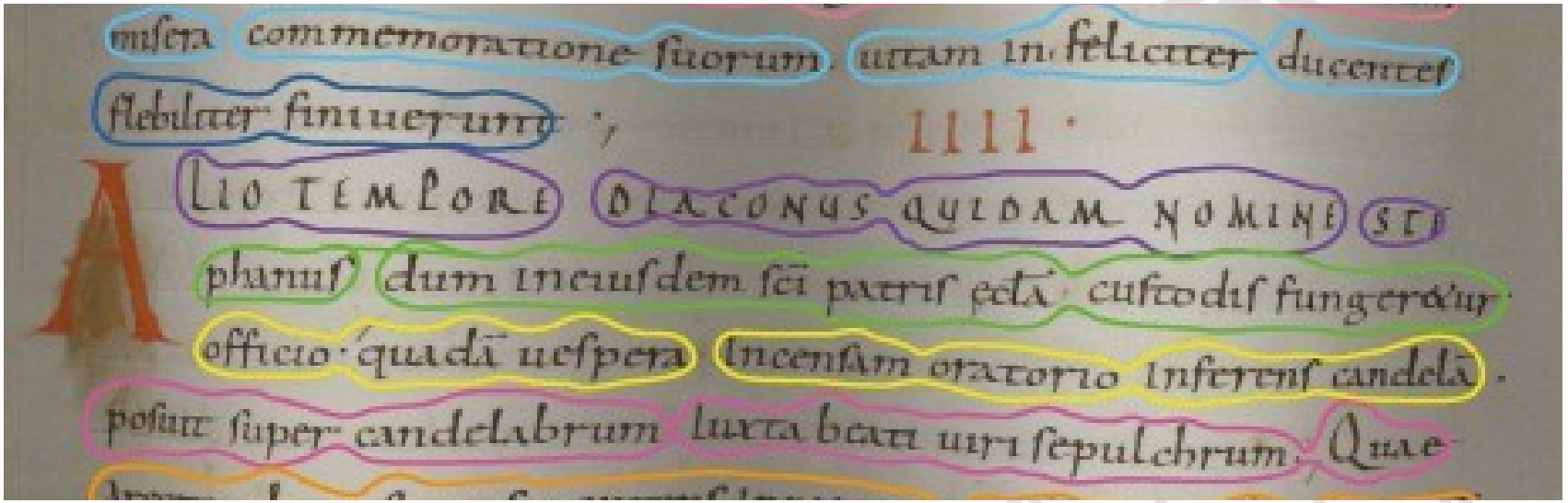


Historical Document Layout Analysis Competition

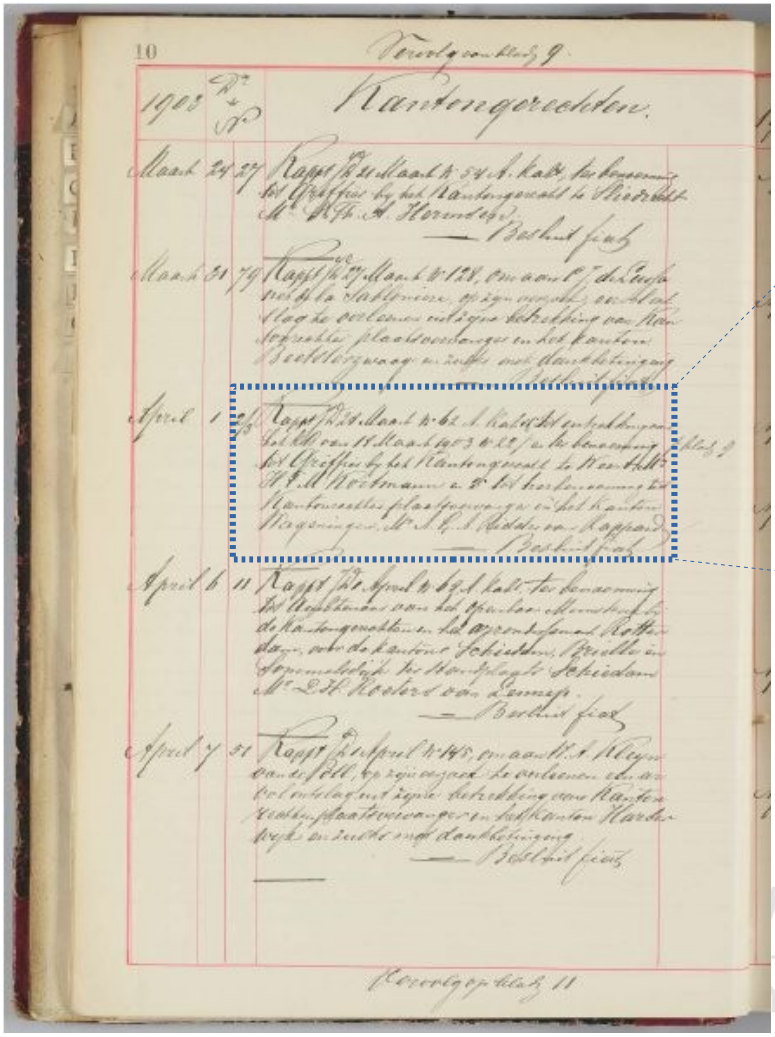
Line Segmentation



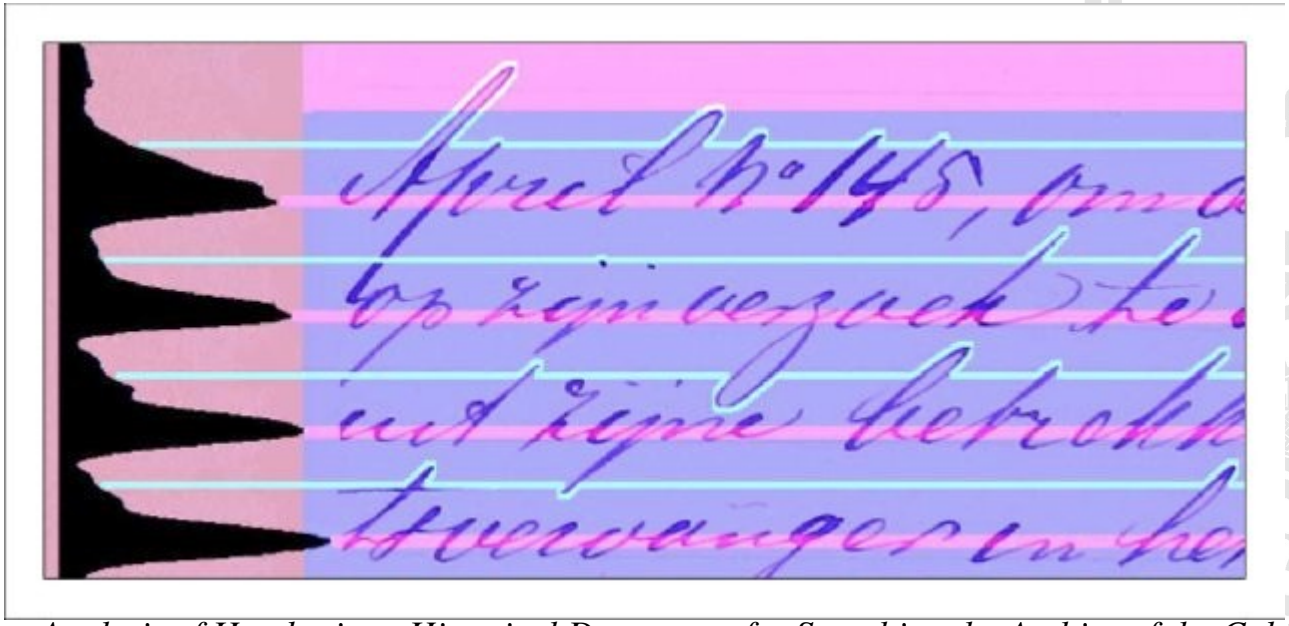
Line Segmentation



Line Segmentation

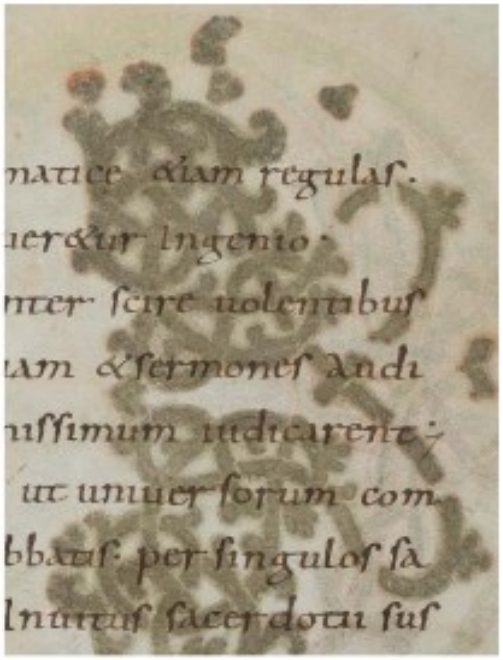


Line Segmentation



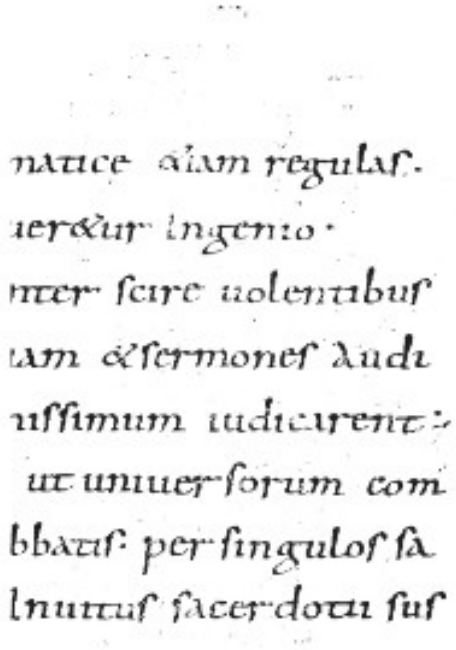
Line Segmentation

Binarization technique



Otsu's algorithm

Sauvola's algorithm

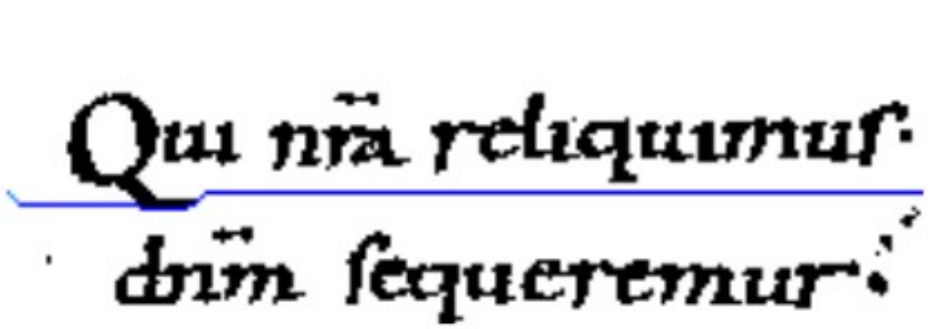


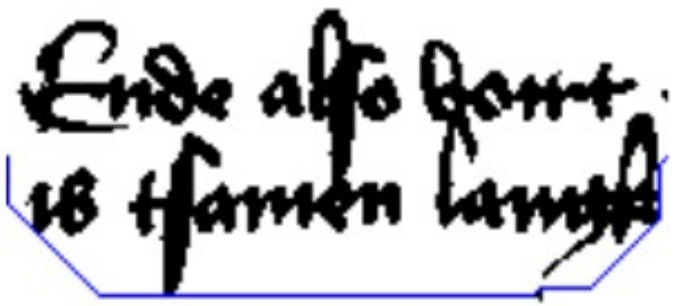
Line Segmentation

A* Path Planning Algorithm

$$p^* = \arg\min_{p^a} \sum_{i=1}^{n^a-1} C(s_i^a, s_{i+1}^a)$$

where $C(s_i, s_j)$ is the cost to go from state s_i to state s_j.

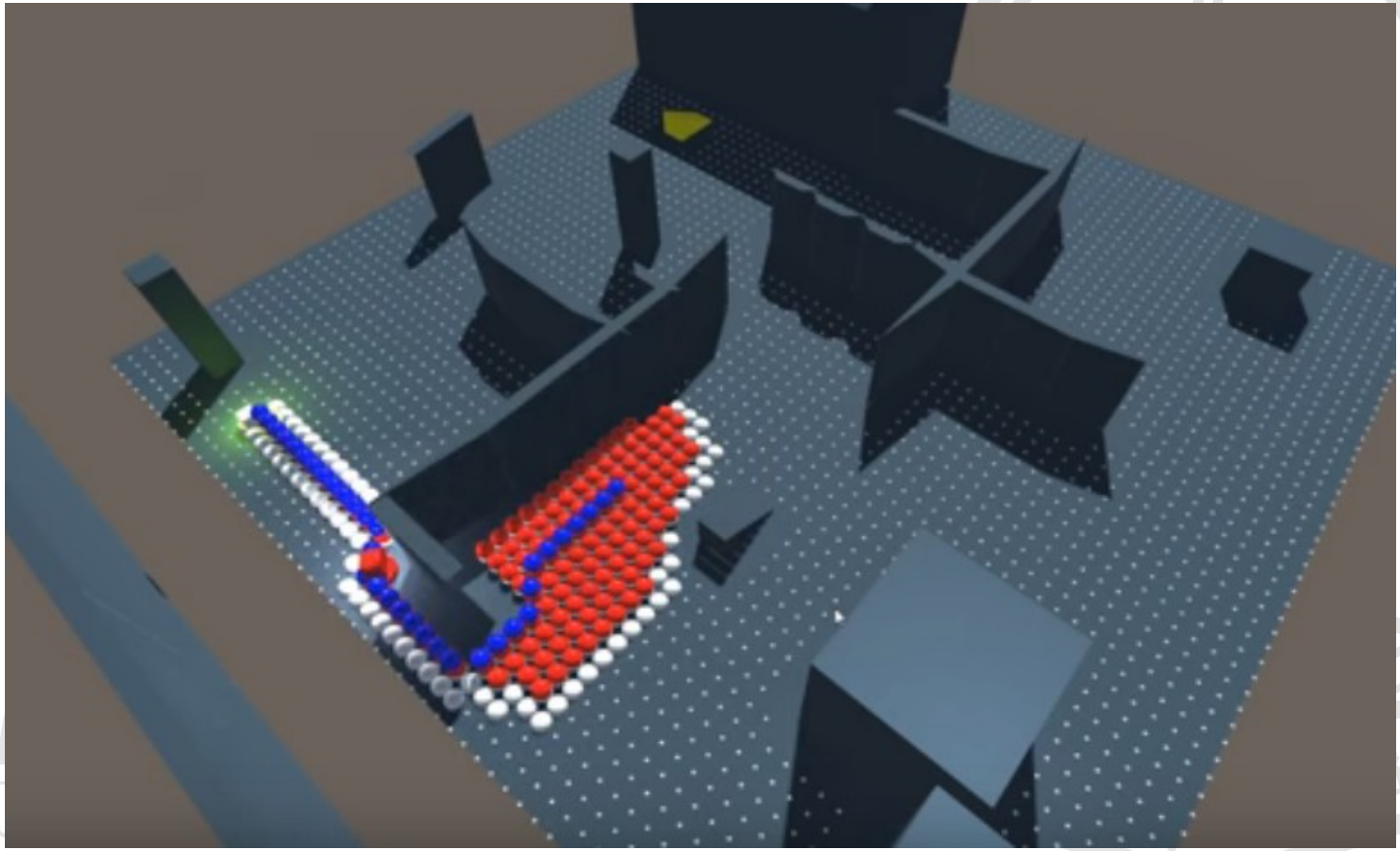




A Path Planning for Line Segmentation of Handwritten Documents*

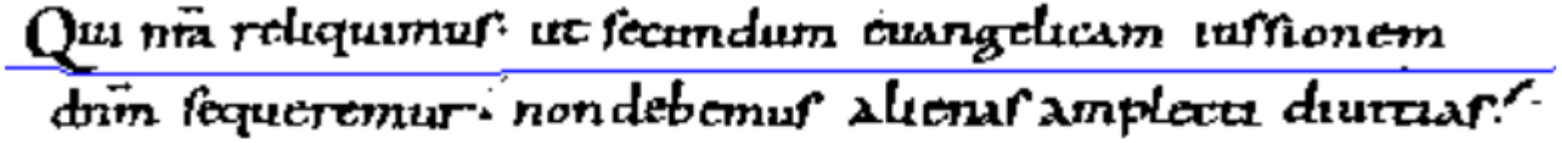
Unity3D – A* Pathfinding algorithm

https://www.youtube.com/watch?v=Ny63E6iLkpc



New A* Path Planning Algorithm

$$C(s_i, s_j) = c_d D(s_i) + c_{d2} D(s_i)^2 + c_m M(s_i) + c_v V(s_i) + c_n N(s_i, s_j)$$

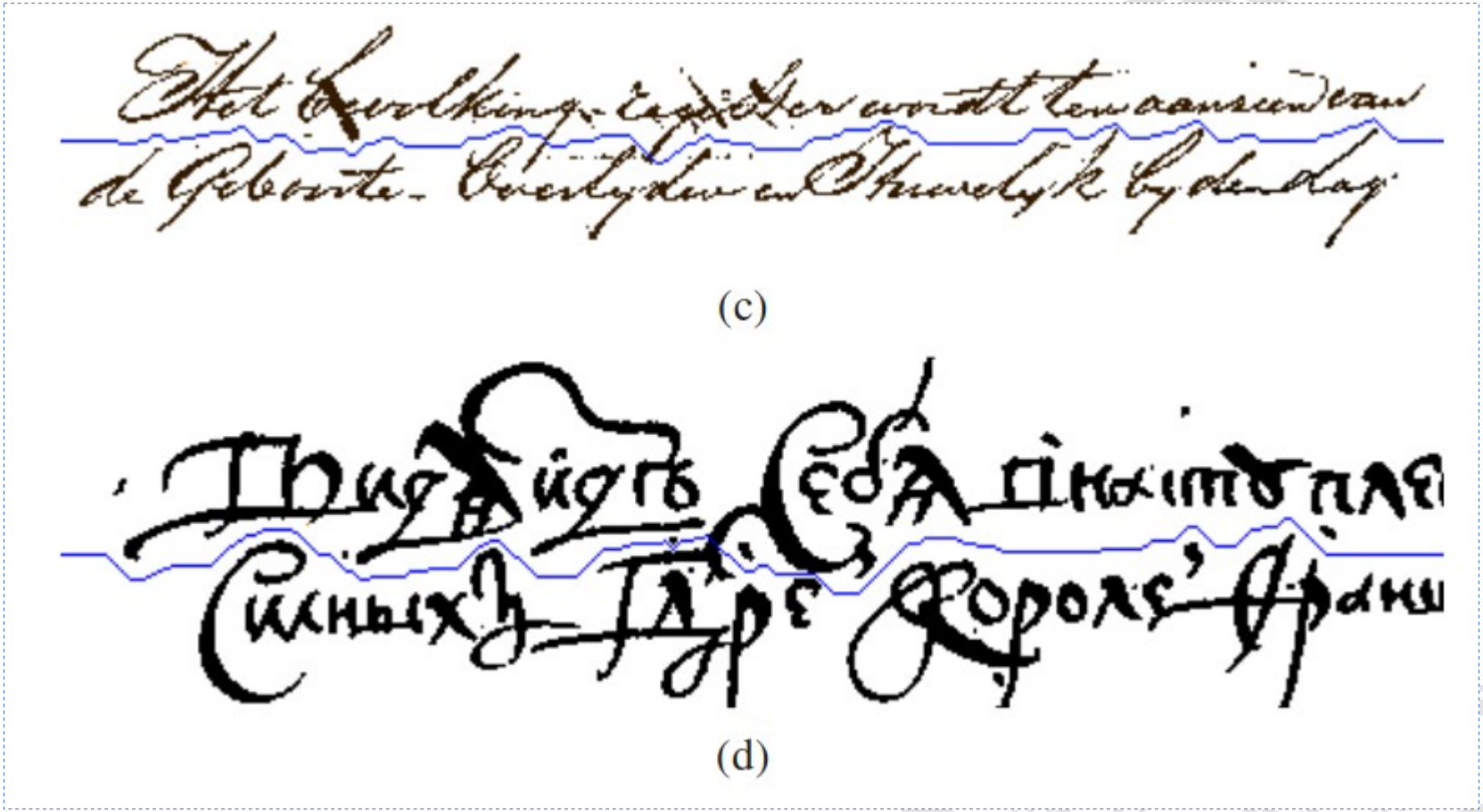


(a)

(b)

A Path Planning for Line Segmentation of Handwritten Documents*

New A* Path Planning Algorithm

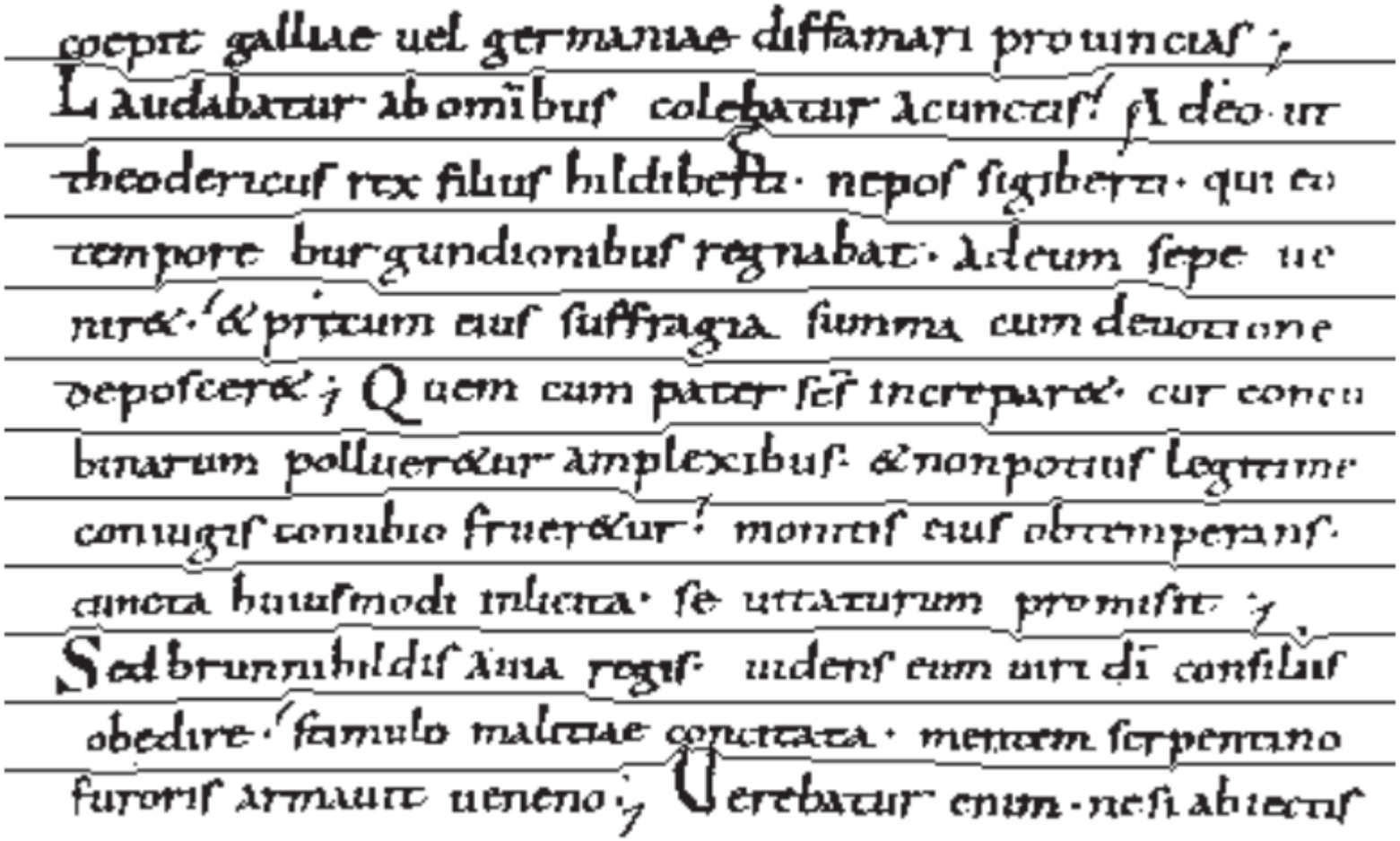


(c)

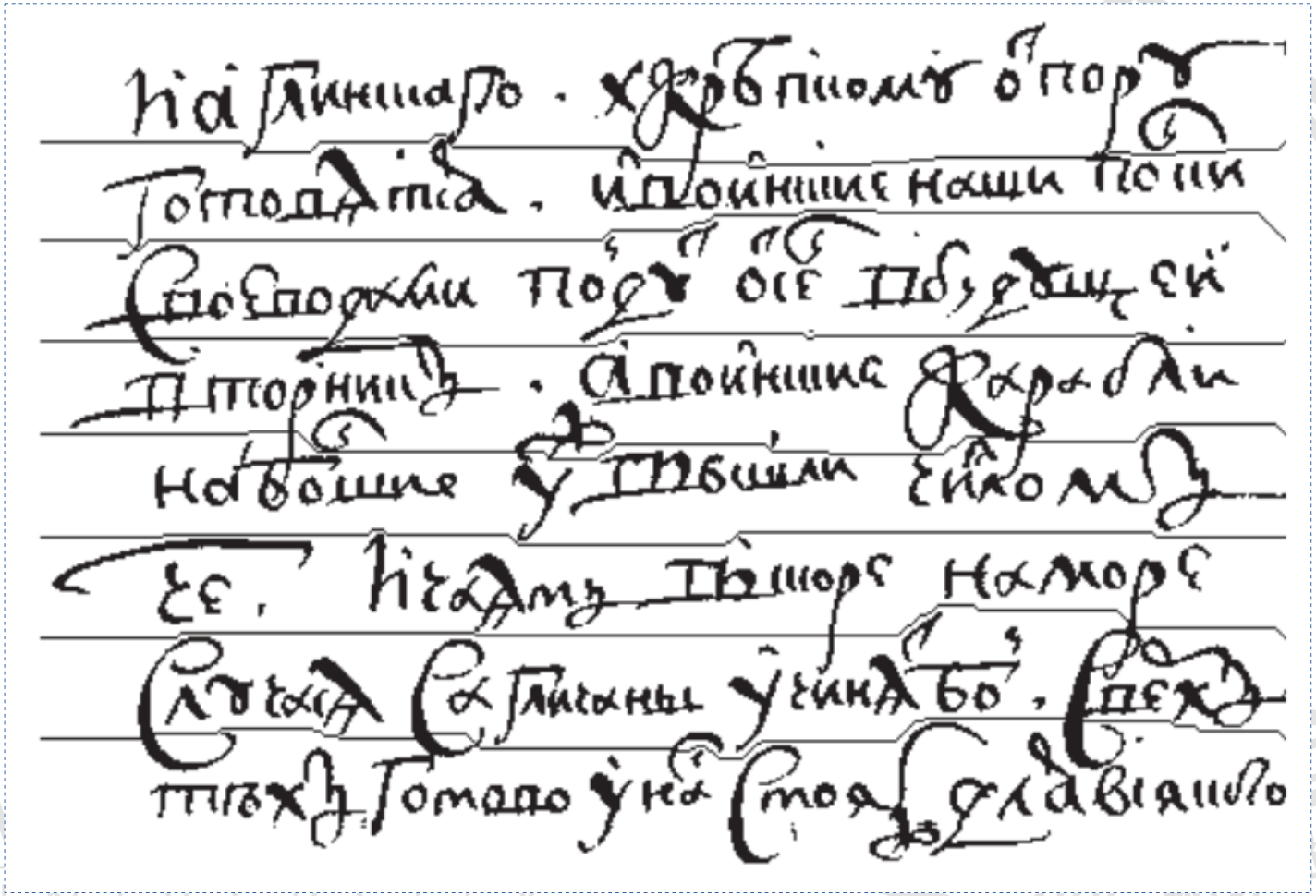
(d)

A Path Planning for Line Segmentation of Handwritten Documents*

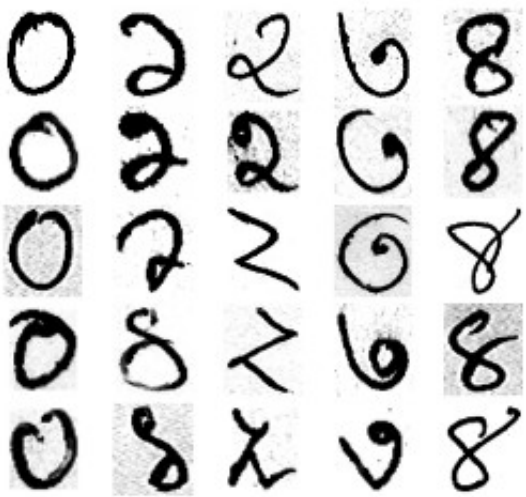
New A* Path Planning Algorithm


coepit gallias uel germanias diffamari prouincias ;
Laudabatur ab omnibus colebatur a cunctis si deo ut
theodericus rex filius hildibertæ · nepos sigiberti · qui eo
tempore burgundionibus regnabat · adeum sepe ue
niret · & pitcum eius suffragia summa cum deuotione
deposceret ; Quem cum pater sæpe increparet · cur conca
binarum polluerétur amplexibus · & non potius legitime
coniugis connubio frueretur ? monitis eius obtemperans ·
cuncta huiusmodi inlicita · se uitaturum promisit ;
Sed brunnihildis anus regis · uidens eum uiri dei consilius
obedire · famulo malitiæ conuitata · memorem serpentino
furoris animum ueneno ; Verebatur enim · ne si abiectis

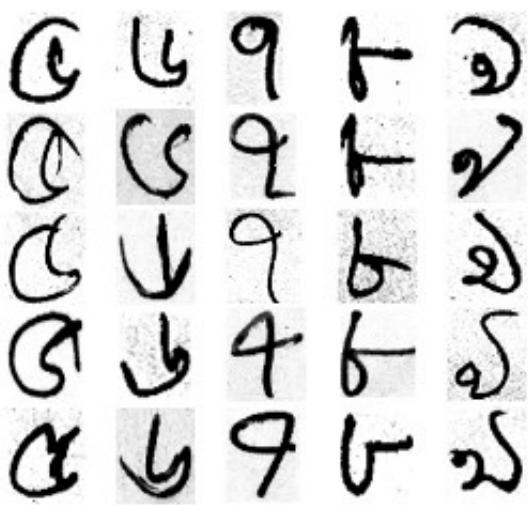
New A* Path Planning Algorithm



Handwritten Character Recognition



(a)



(b)

Fig. 1. A variety of handwritten Bangla digit samples. (a) Set of numbers from 0 to 4 and (b) from 5 to 9. Note the large differences between the examples on the first and last rows.

A Comparison of Feature and Pixel-based Methods for Recognizing Handwritten Bangla Digits

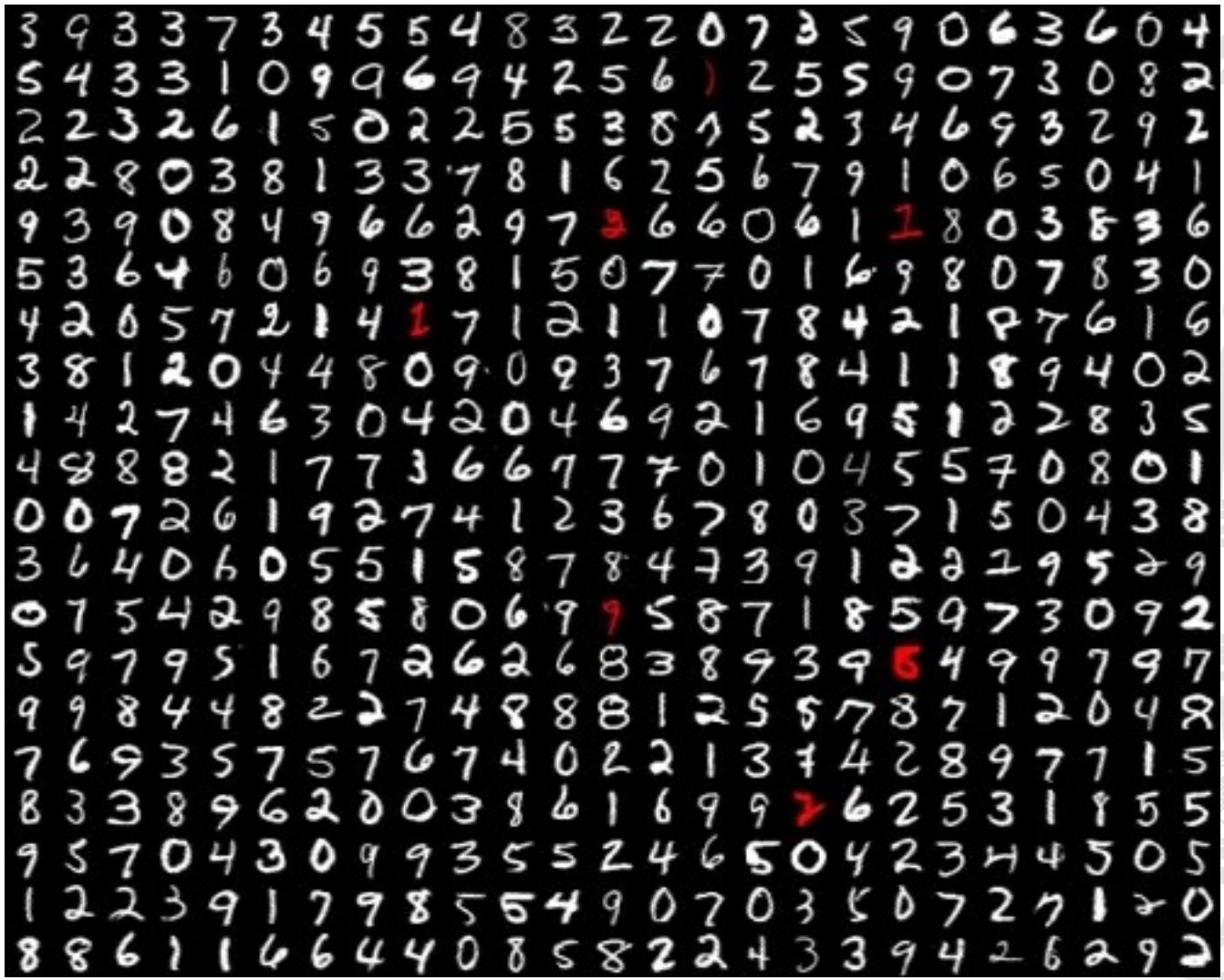
Handwritten Character Recognition

(a) (b)

Fig. 2. Similarities between different handwritten Bangla digits. (a) The images of number 1, and (b) number 2.

A Comparison of Feature and Pixel-based Methods for Recognizing Handwritten Bangla Digits

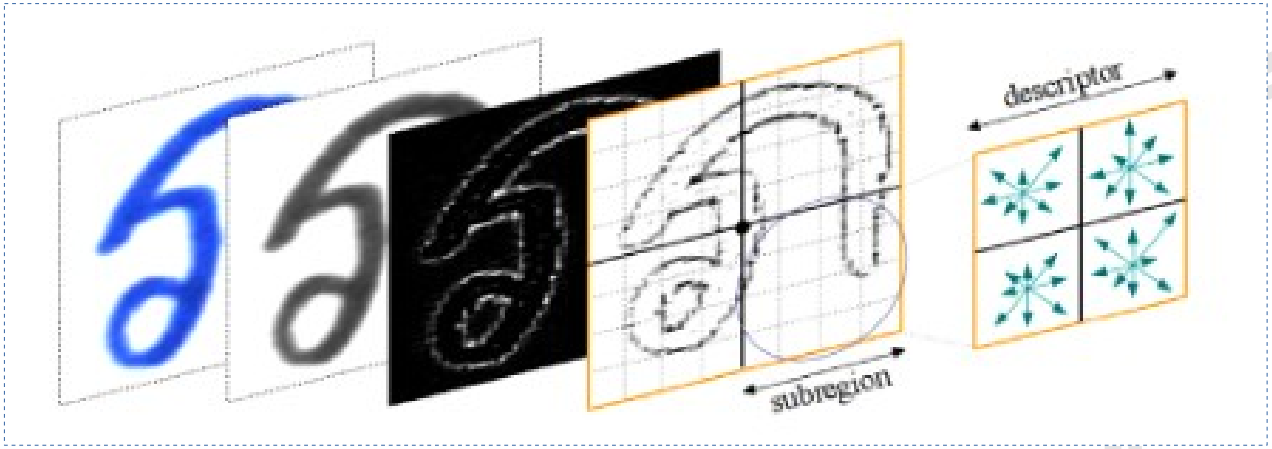
Handwritten Character Recognition



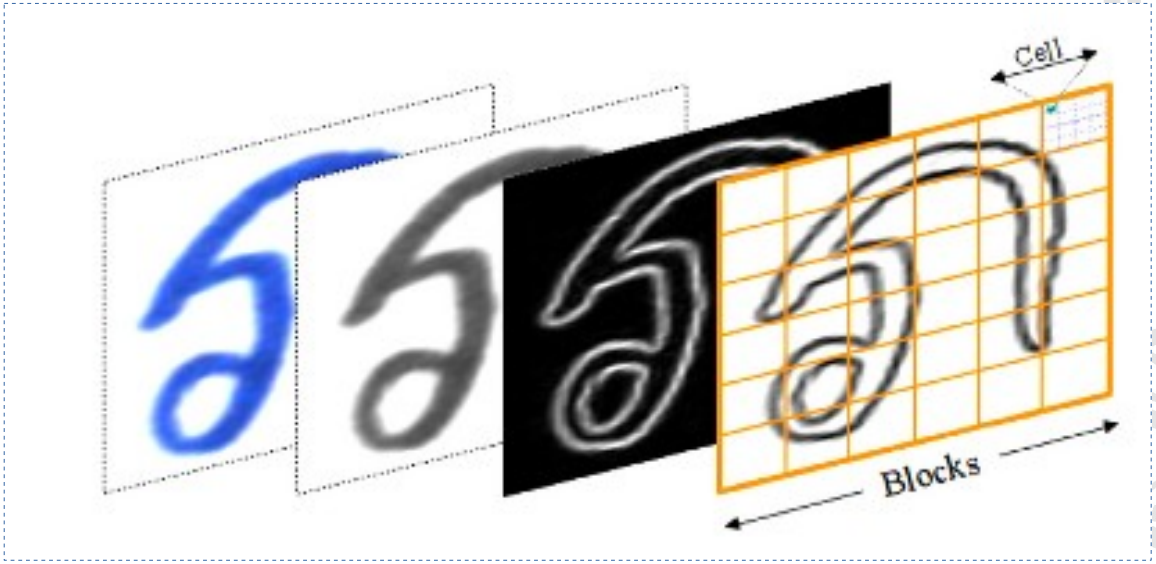
MNIST

https://www.learnopencv.com/handwritten-digits-classification-an-opencv-c-python-tutorial/

Feature Extraction Techniques



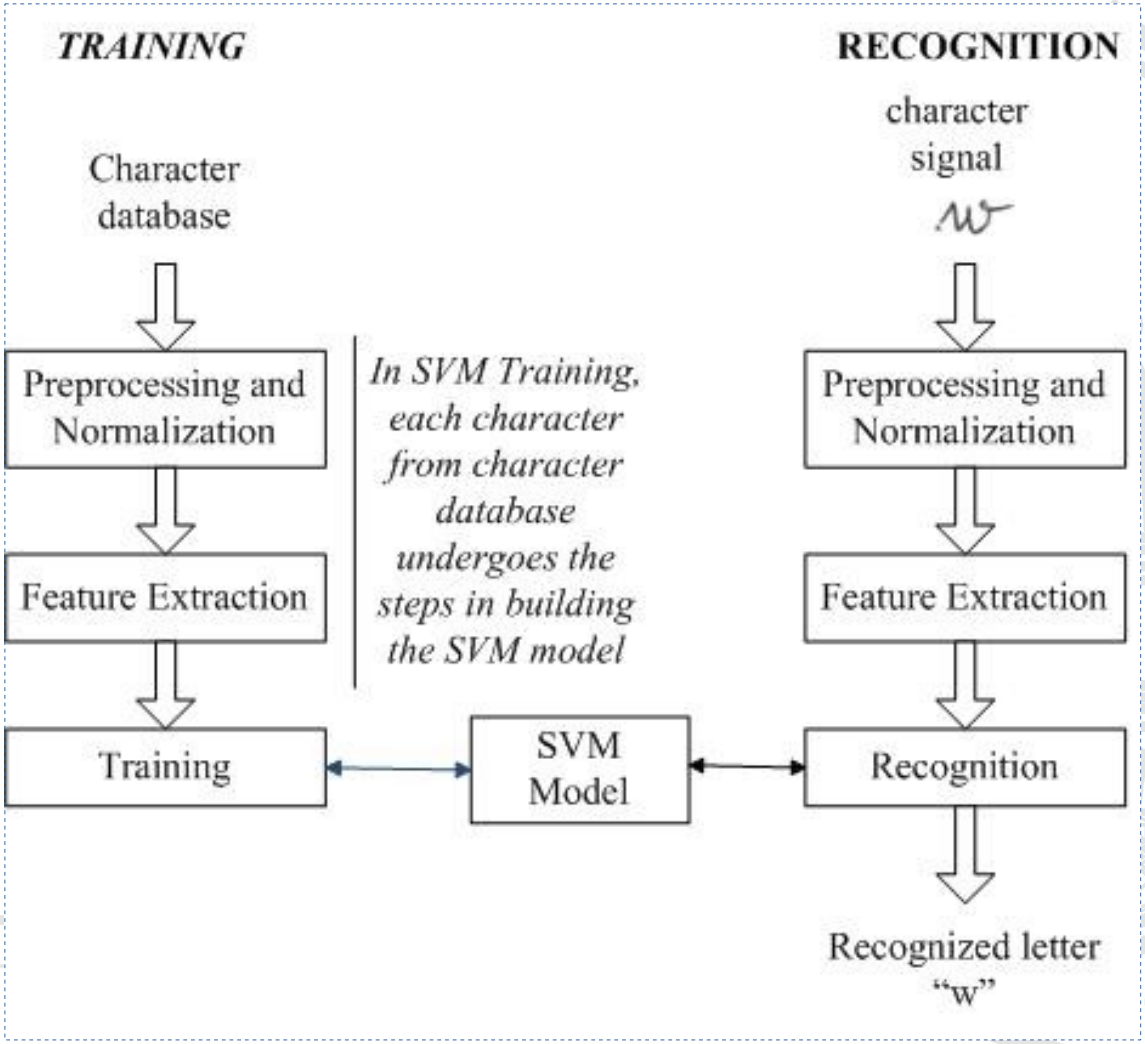
SIFT



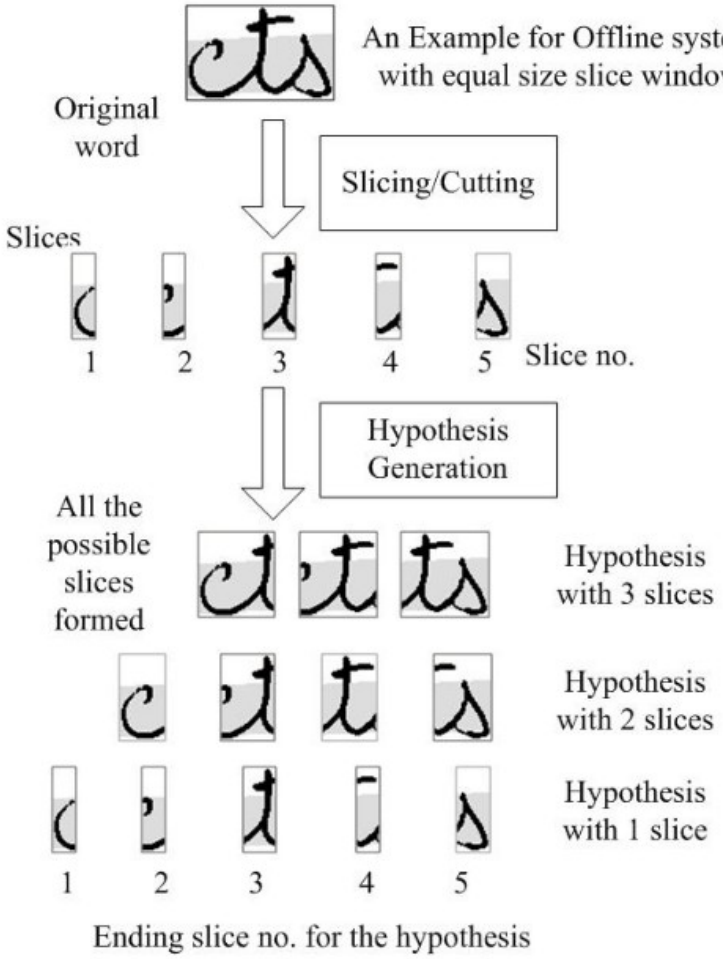
HOG

Recognition of Handwritten Characters using Local Gradient Feature Descriptors

Handwritten Character Recognition

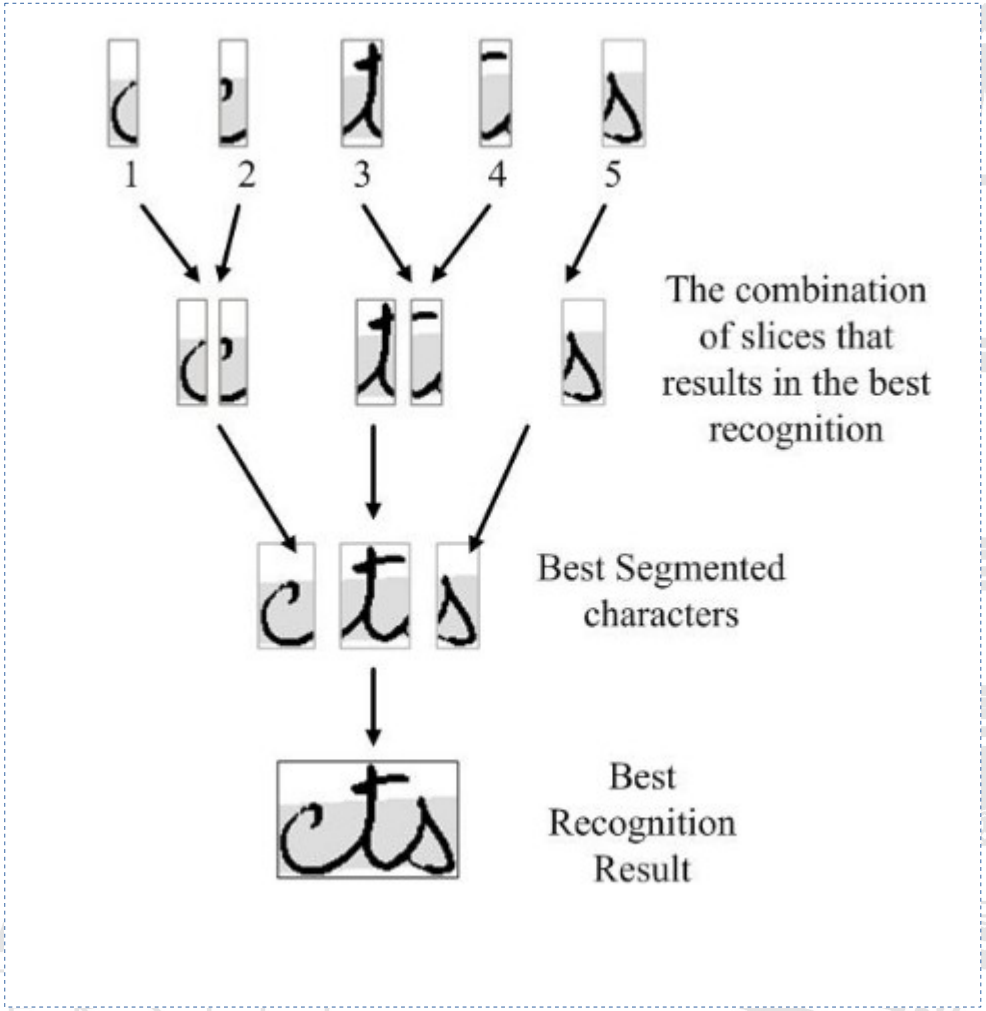


On-line Handwriting Recognition

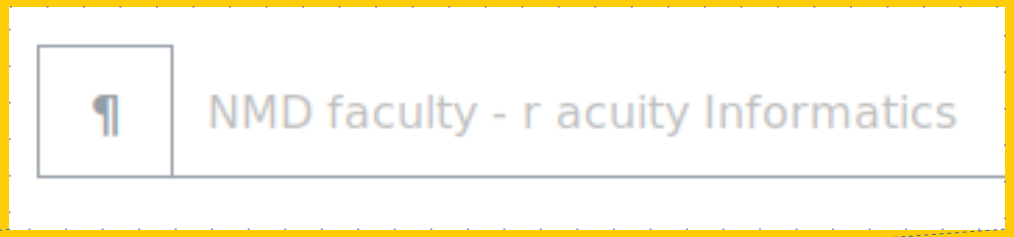


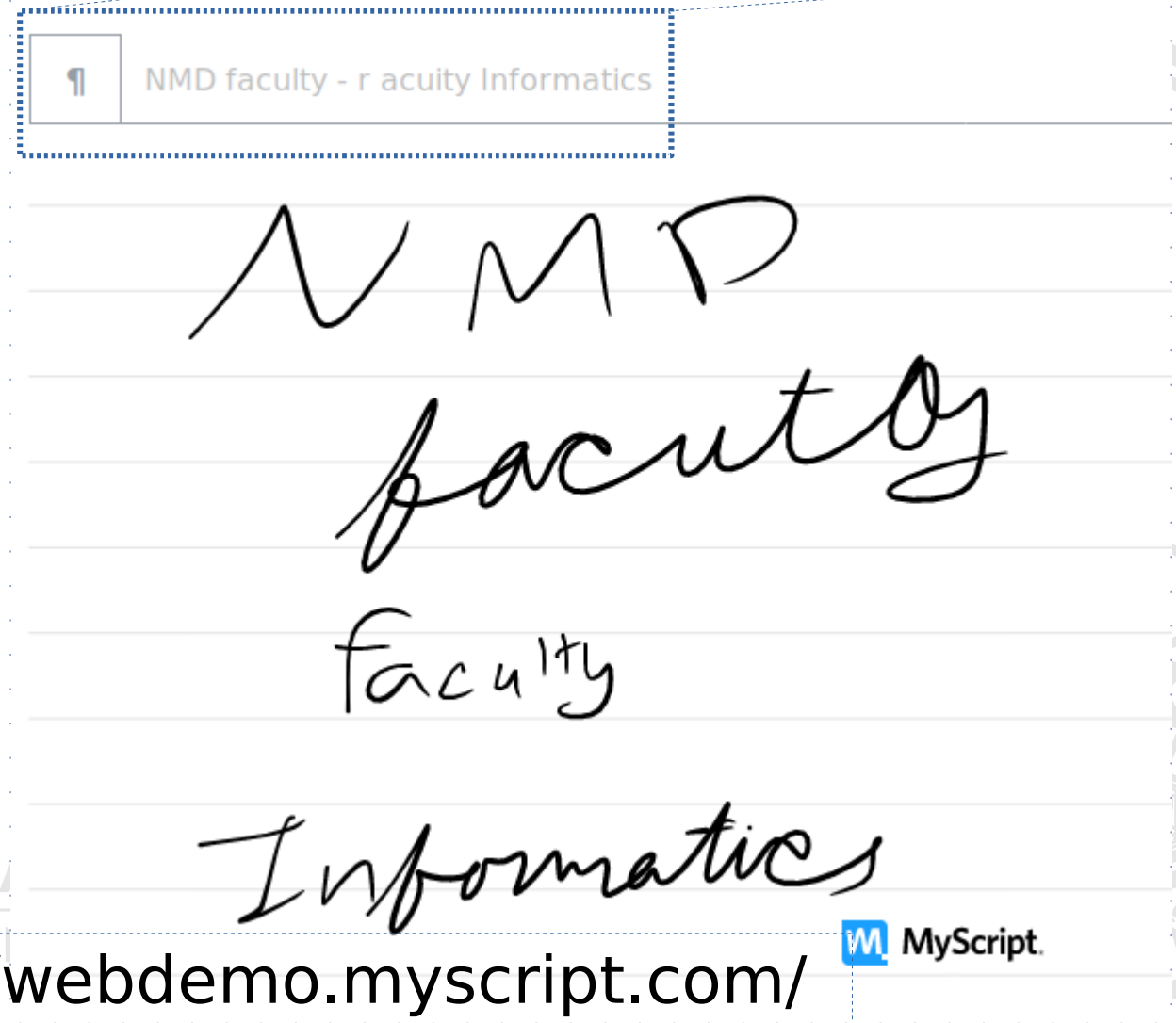
On-line Handwriting Recognition using Support Vector Machines and Hidden Markov Models Approaches

On-line Handwriting Recognition



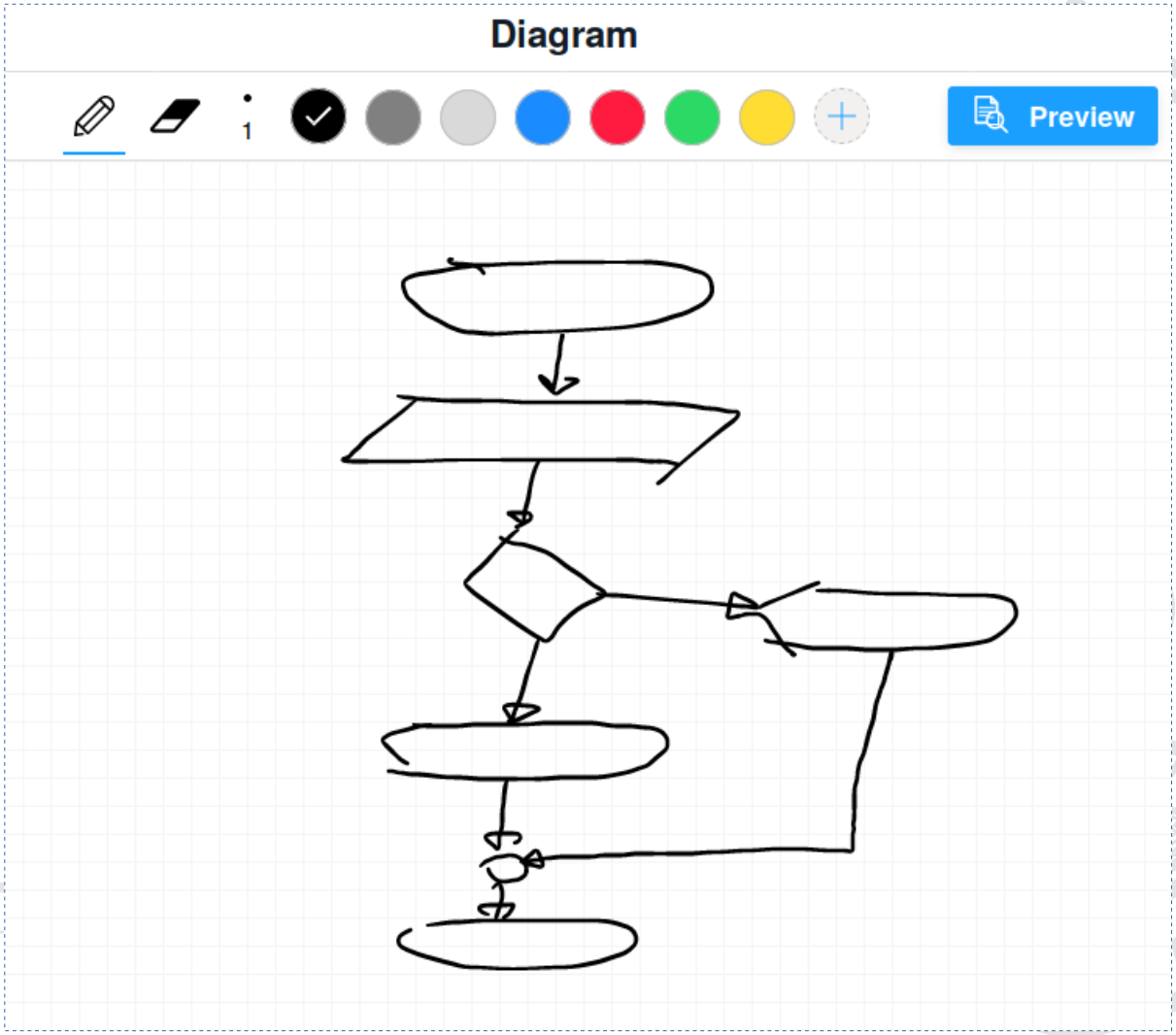
myscript.com



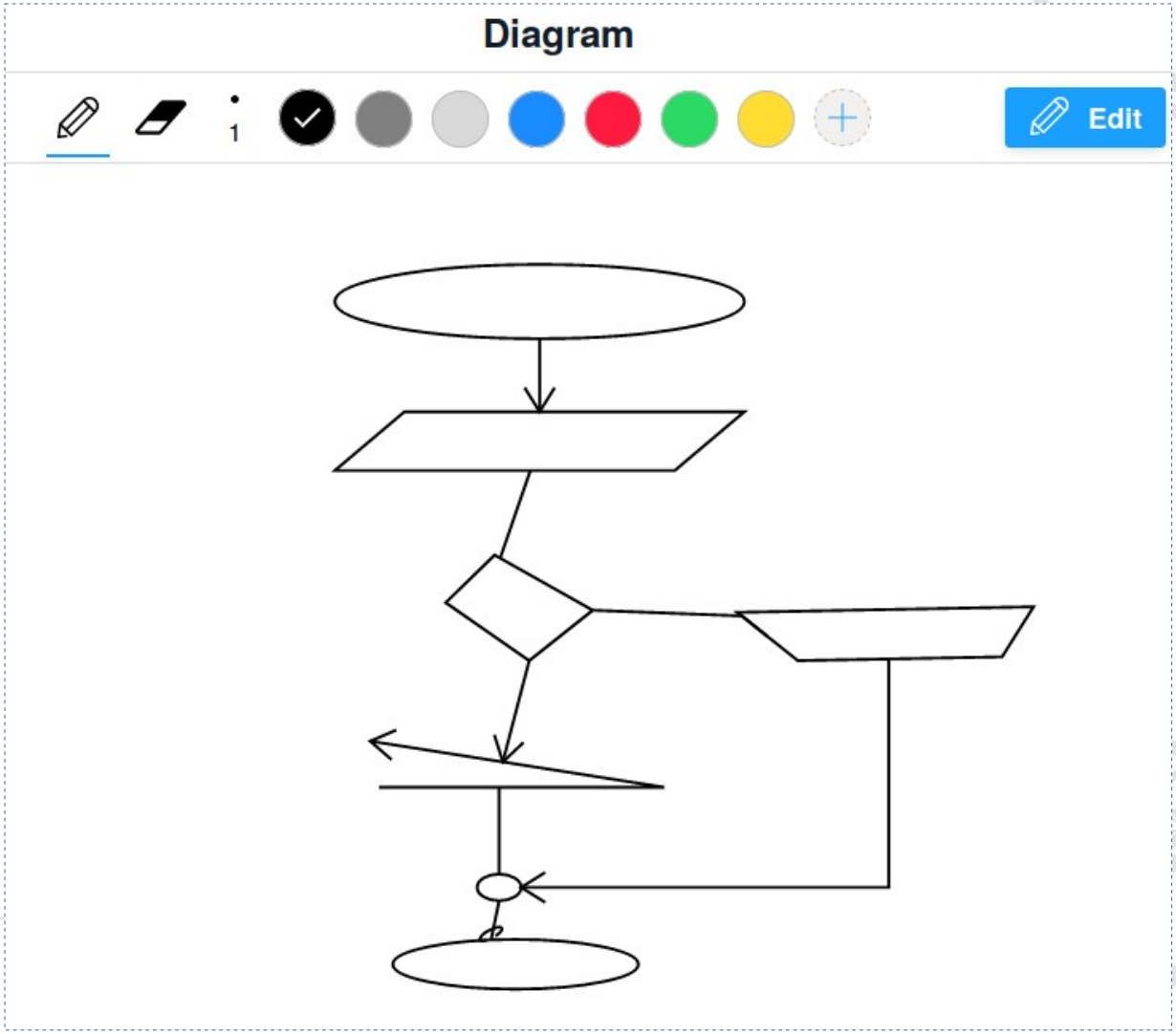


https://webdemo.myscript.com/

myscript.com - Demo



myscript.com - Demo



Demo

https://azure.microsoft.com/en-us/services/cognitive-services/computer-vision/

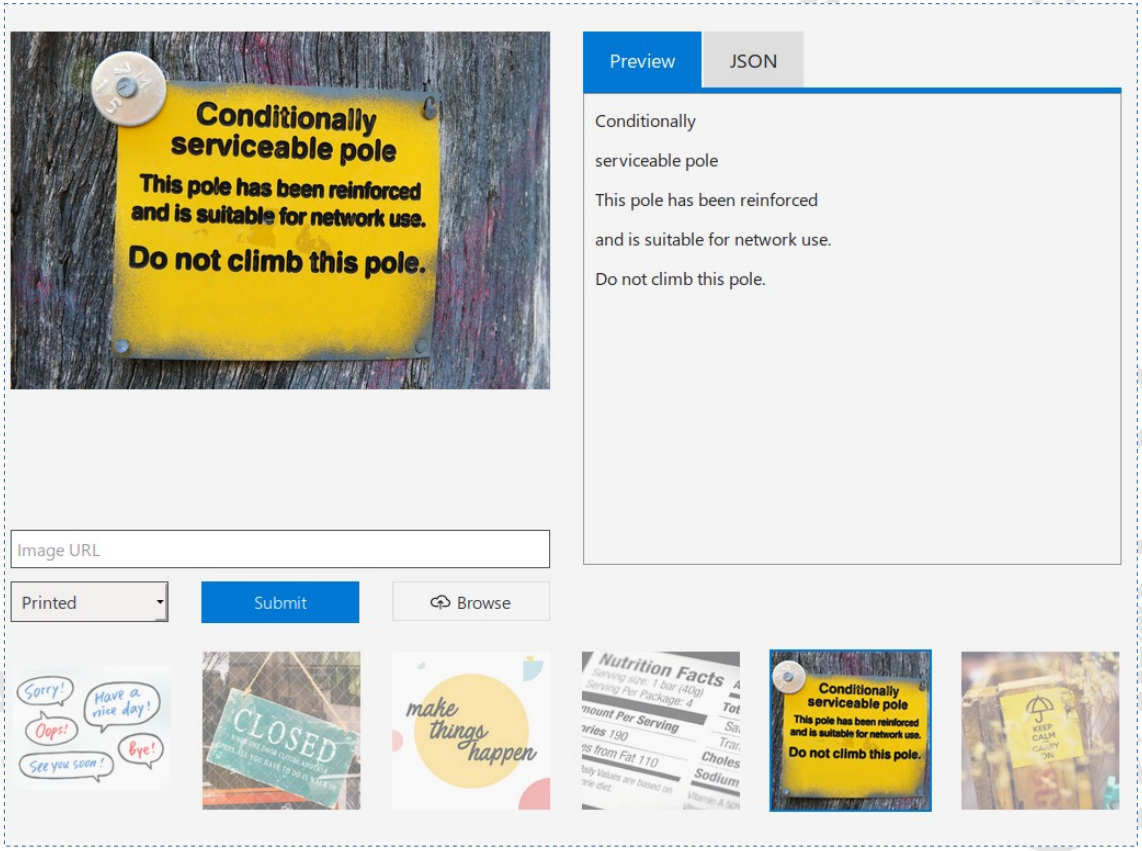


Image Recognition

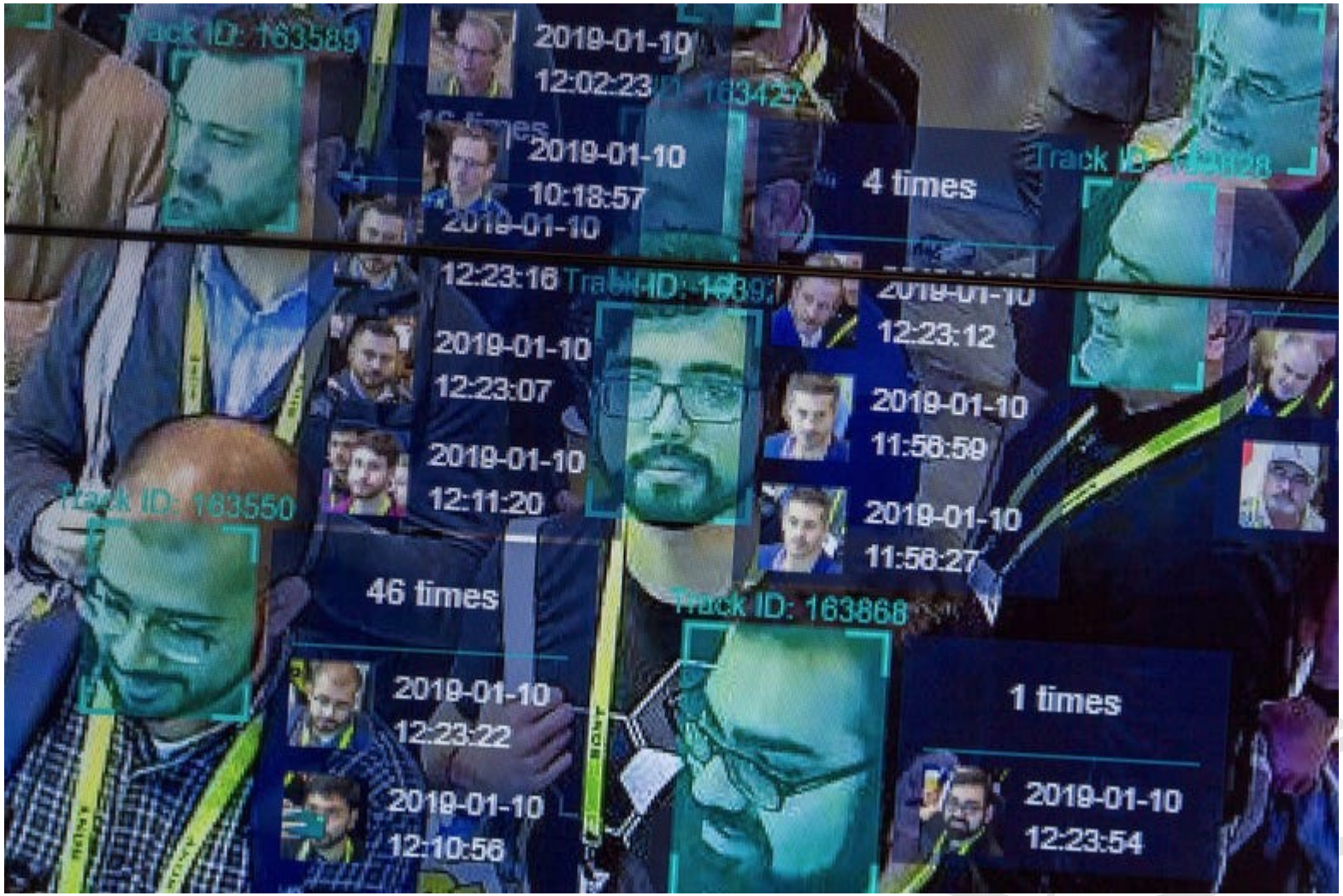
- **Image Recognition** is a term for computer technologies that can recognize certain people, animals, objects or other targeted subjects through the use of algorithms and machine learning concepts.
- The term "*image recognition*" is connected to "*computer vision*," which is an overarching label for the process of training computers to "see" like humans, and "image processing," which is a catch-all term for computers doing intensive work on image data.

Definition from technopedia.com

Image Recognition

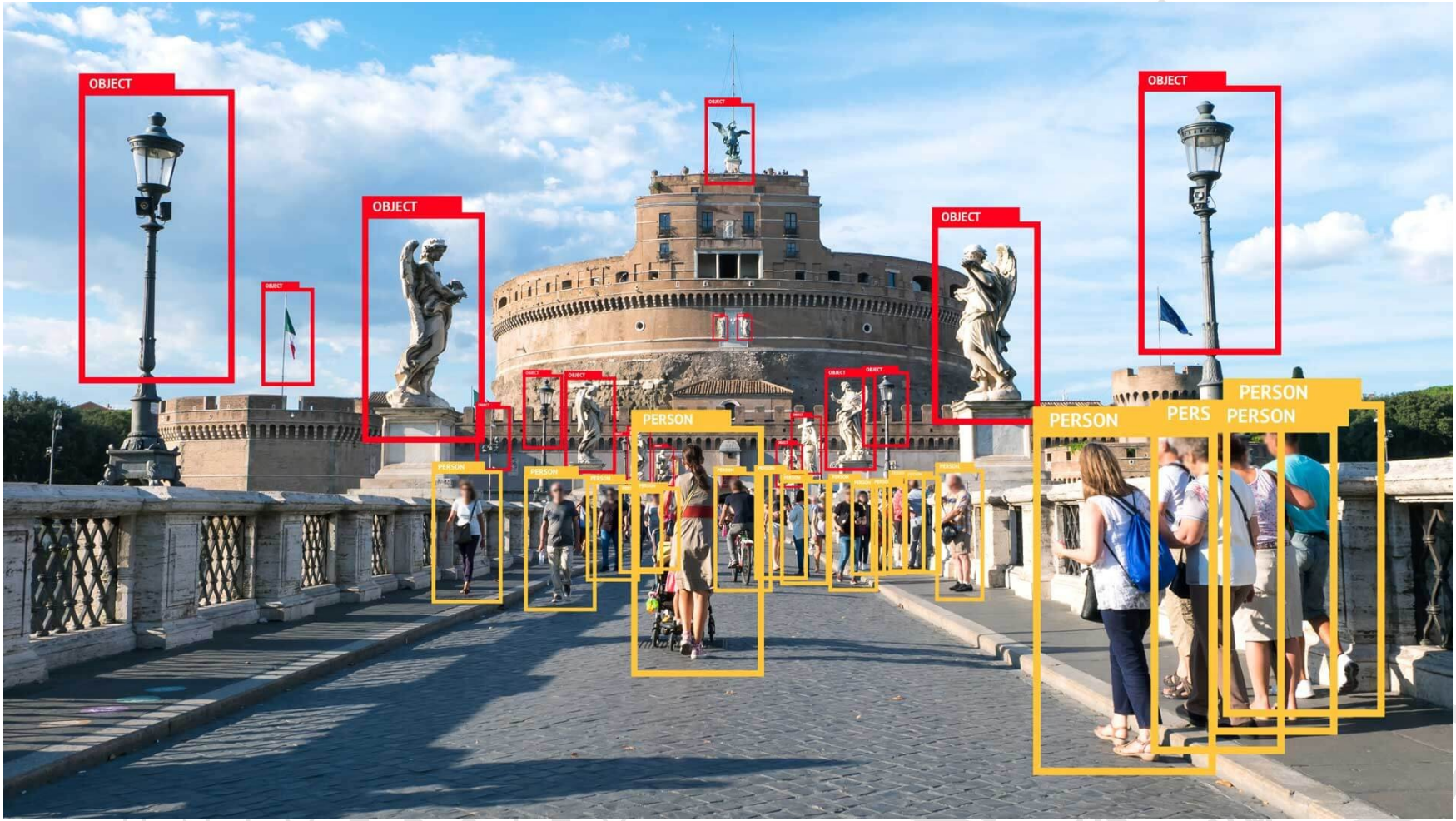
https://thenextweb.com/contributors/2018/10/29/heres-how-face-recognition-tech-can-be-gdpr-compliant/

Image Recognition



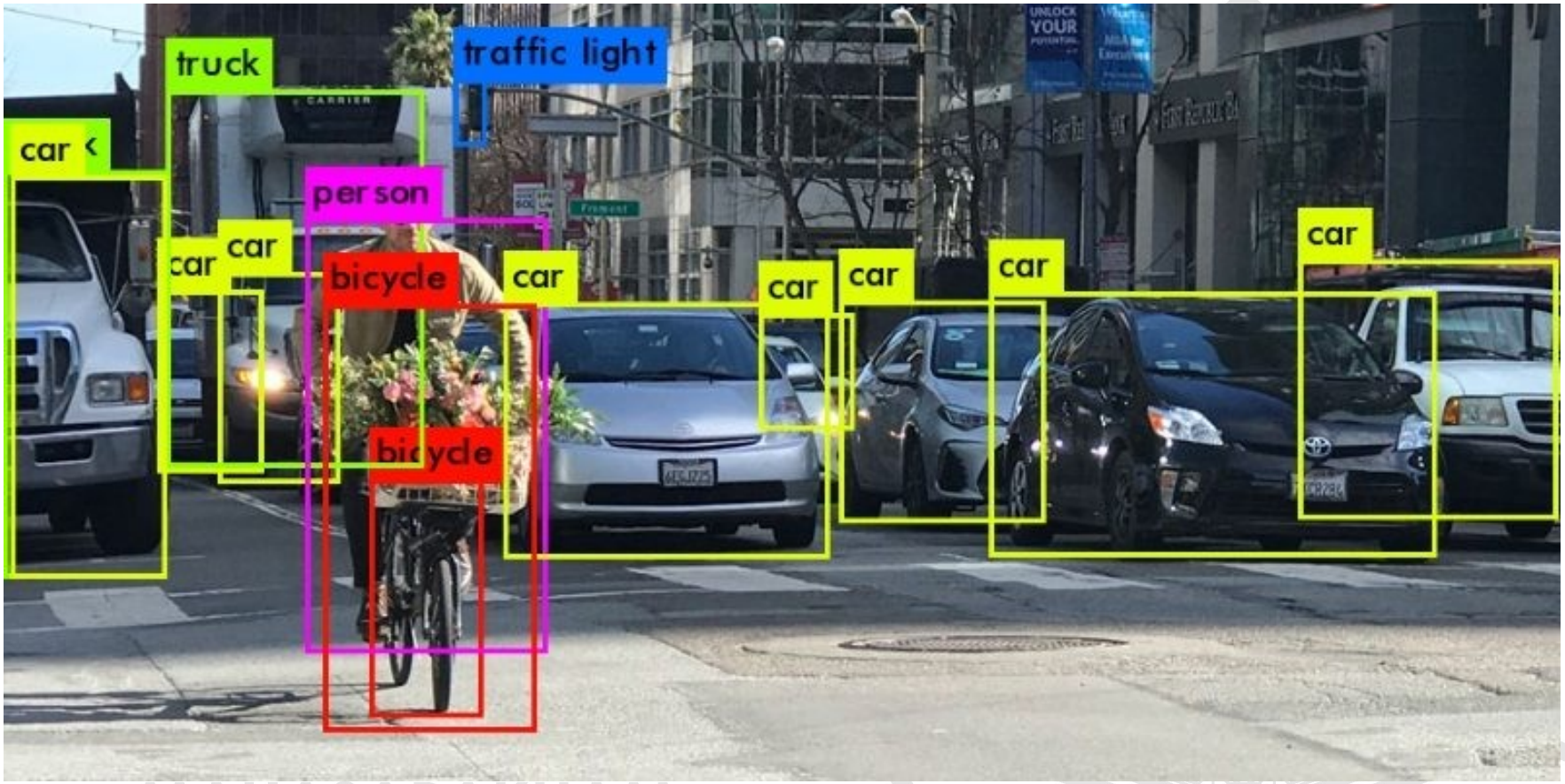
https://slate.com/technology/2019/01/10-year-challenge-facebook-facial-recognition.html

Image Recognition



https://martechtoday.com/how-visual-recognition-is-set-to-change-advertising-223719

Image Recognition

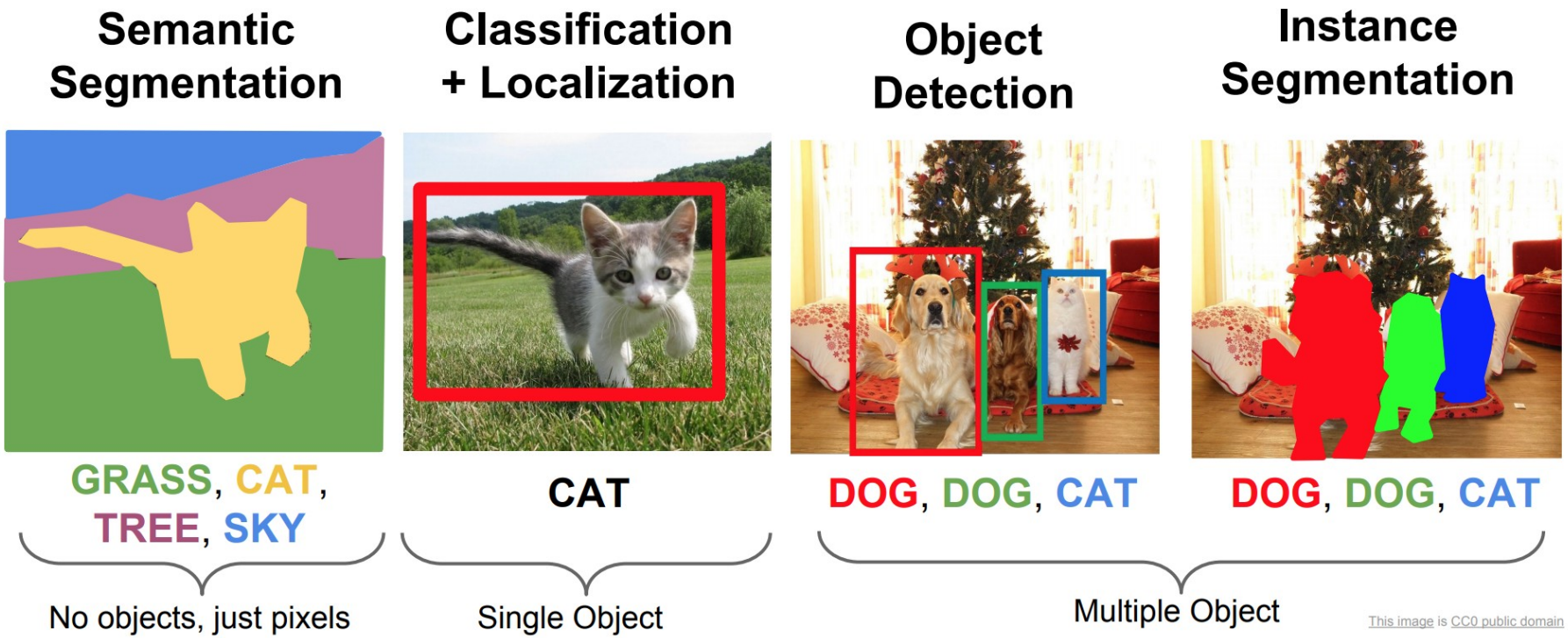


https://azati.ai/image-detection-recognition-and-classification-with-machine-learning/

Image Segmentation

https://www.vox.com/future-perfect/2019/4/19/18412674/ai-bias-facial-recognition-black-gay-transgender

Image Segmentation

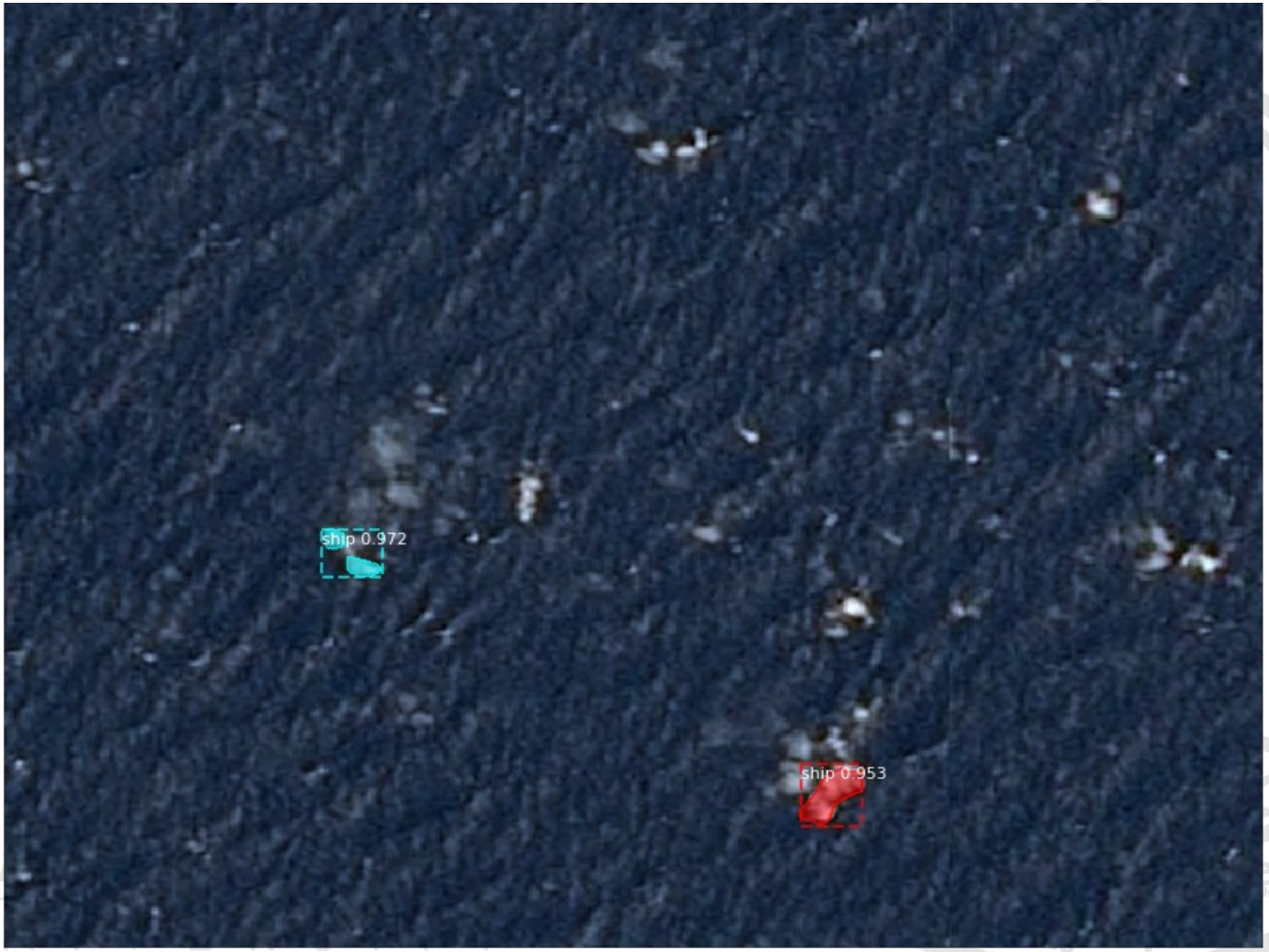


https://towardsdatascience.com/mask-r-cnn-for-ship-detection-segmentation-a1108b5a083

Ship Detection & Segmentation

https://towardsdatascience.com/mask-r-cnn-for-ship-detection-segmentation-a1108b5a083

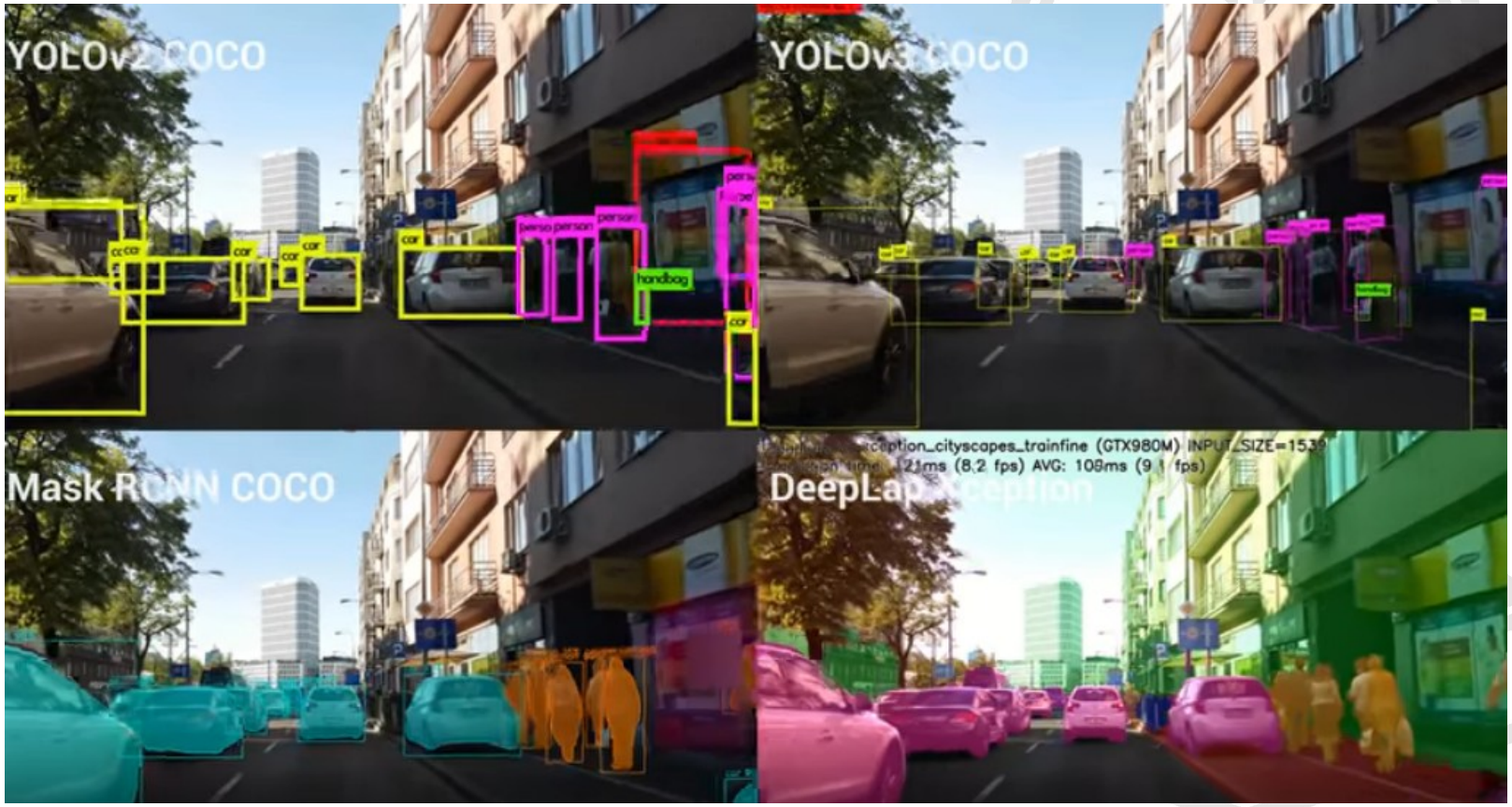
Ship Detection & Segmentation



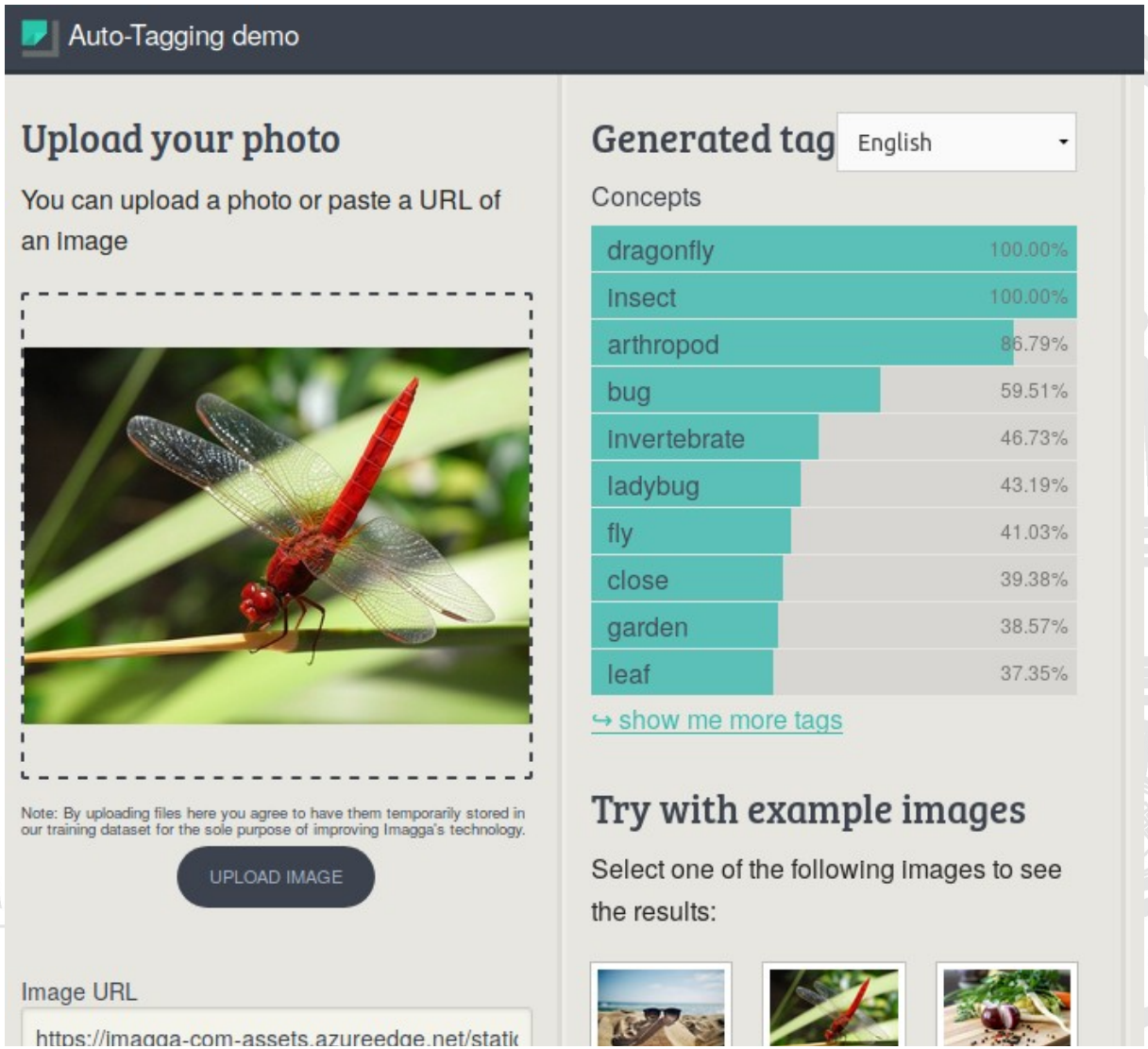
https://towardsdatascience.com/mask-r-cnn-for-ship-detection-segmentation-a1108b5a083

Image Detection & Segmentation

https://www.youtube.com/watch?v=s8Ui_kV9dhw



Auto-Tagging | https://imagga.com/auto-tagging-demo



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Auto-Tagging demo

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sport	59.44%
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sea	46.19%
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active	38.89%
sand	38.68%
jumping	37.75%
sky	35.89%
summer	35.41%

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  --header 'accept: application/json'
  --header 'authorization: Basic YWNj
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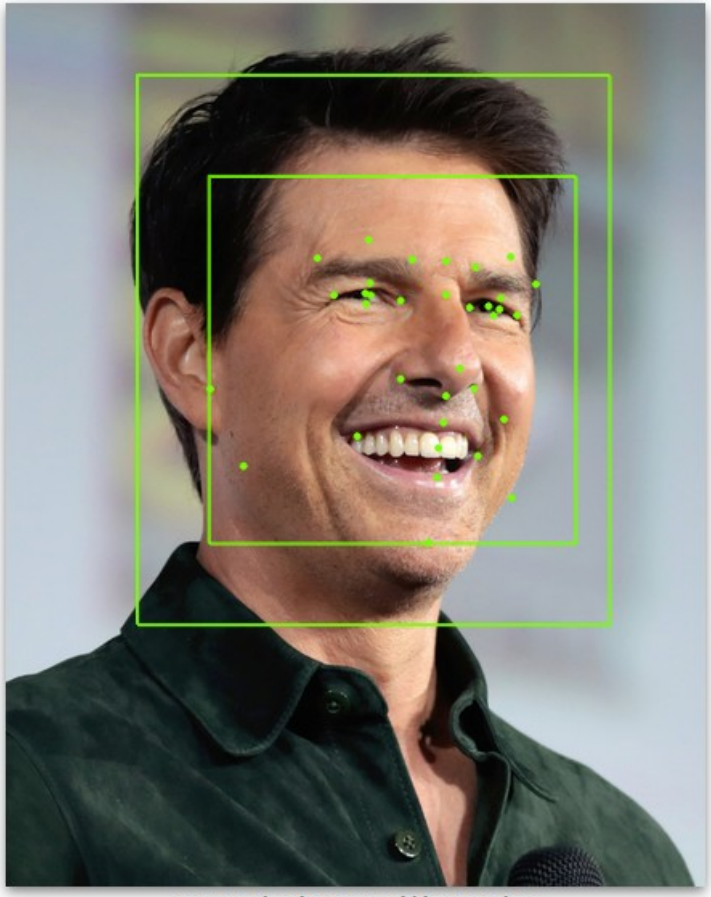

Tom_Cruise_by_Gage_Skidmore_2.jpg

Joy	Very Likely
Sorrow	Very Unlikely
Anger	Very Unlikely
Surprise	Very Unlikely
Exposed	Very Unlikely
Blurred	Very Unlikely
Headwear	Very Unlikely

Roll: 2° Tilt: 12° Pan: 24°

Confidence 100%

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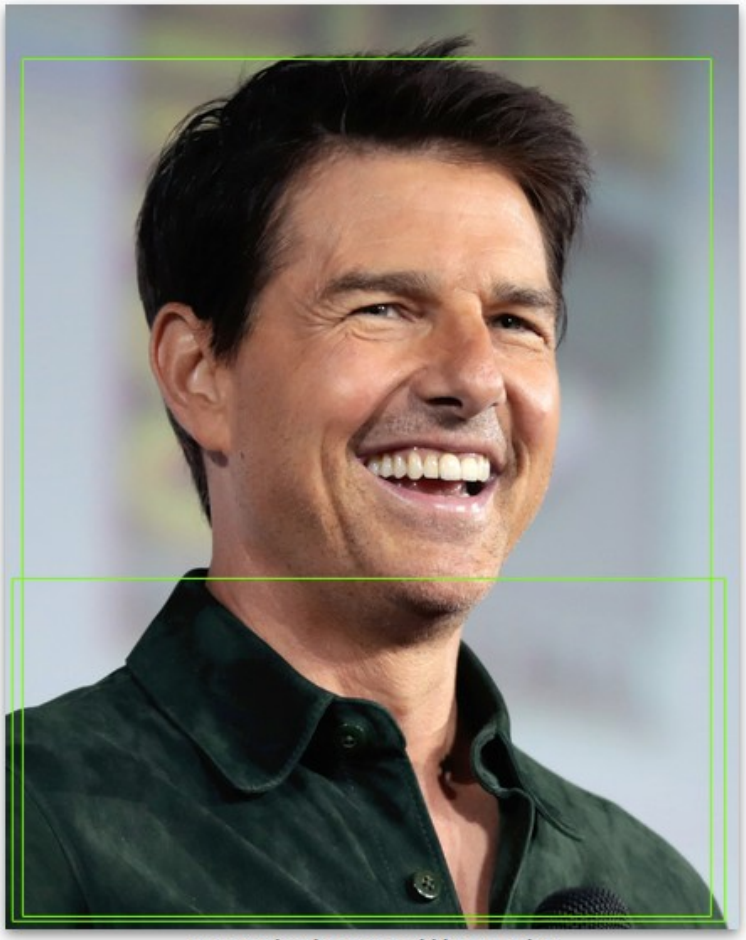

Tom_Cruise_by_Gage_Skidmore_2.jpg

Man	81%
Clothing	76%

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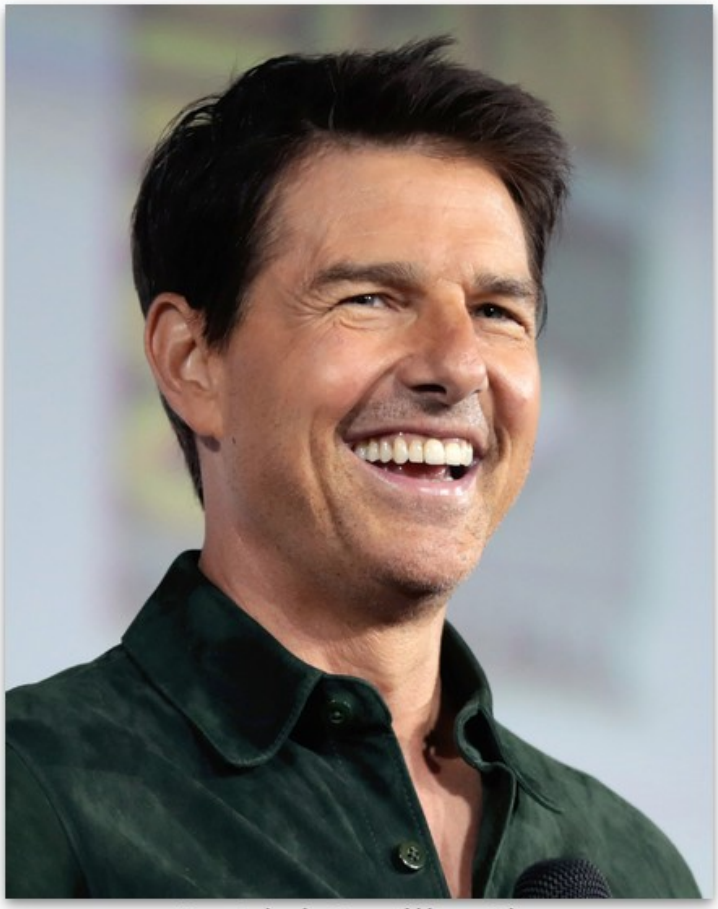

Tom_Cruise_by_Gage_Skidmore_2.jpg

Facial Expression	94%
Chin	92%
Forehead	89%
Smile	85%
White-collar Worker	63%
Actor	63%
Laugh	59%
Jaw	57%
Pleased	53%
Gesture	52%

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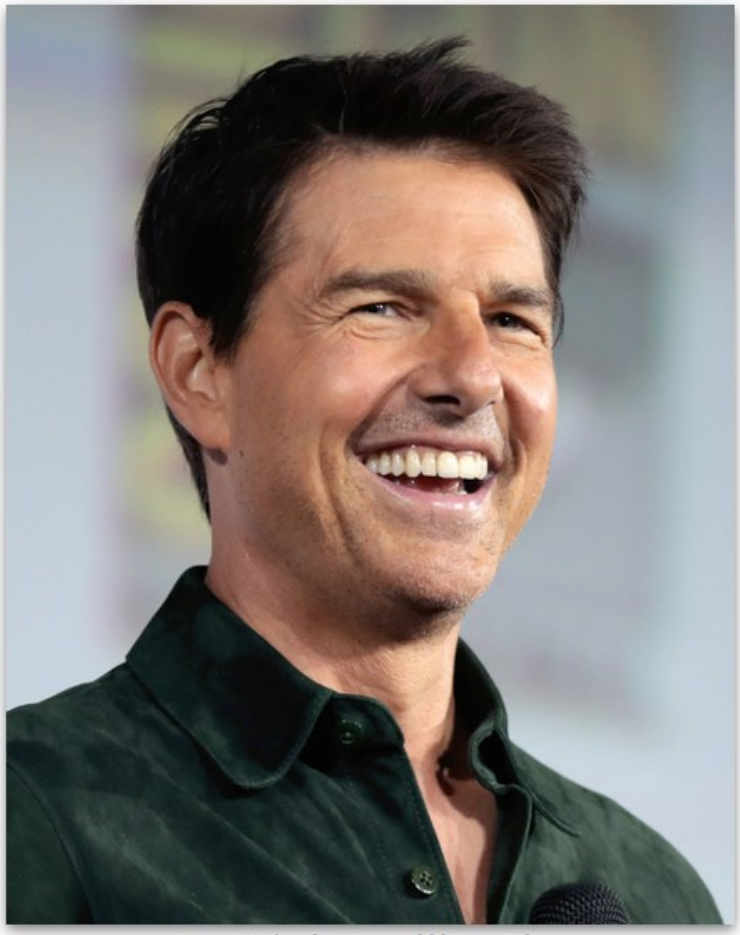

Tom_Cruise_by_Gage_Skidmore_2.jpg

Web Entities

Tom Cruise	13.347
Top Gun: Maverick	0.795
Film	0.6141
Film Producer	0.5868
Actor	0.5741
Golden Globe Awards	0.4003
Top Gun	0.3956
Tom Cruise filmography	0.3751
Nicole Kidman	0.067
Justin Bieber	0.06631
Being Tom Cruise	0.0642
Kelly McGillis	0.05893
Endless Love	0.04892
Magnolia	0.04495

Pages with Matched Images

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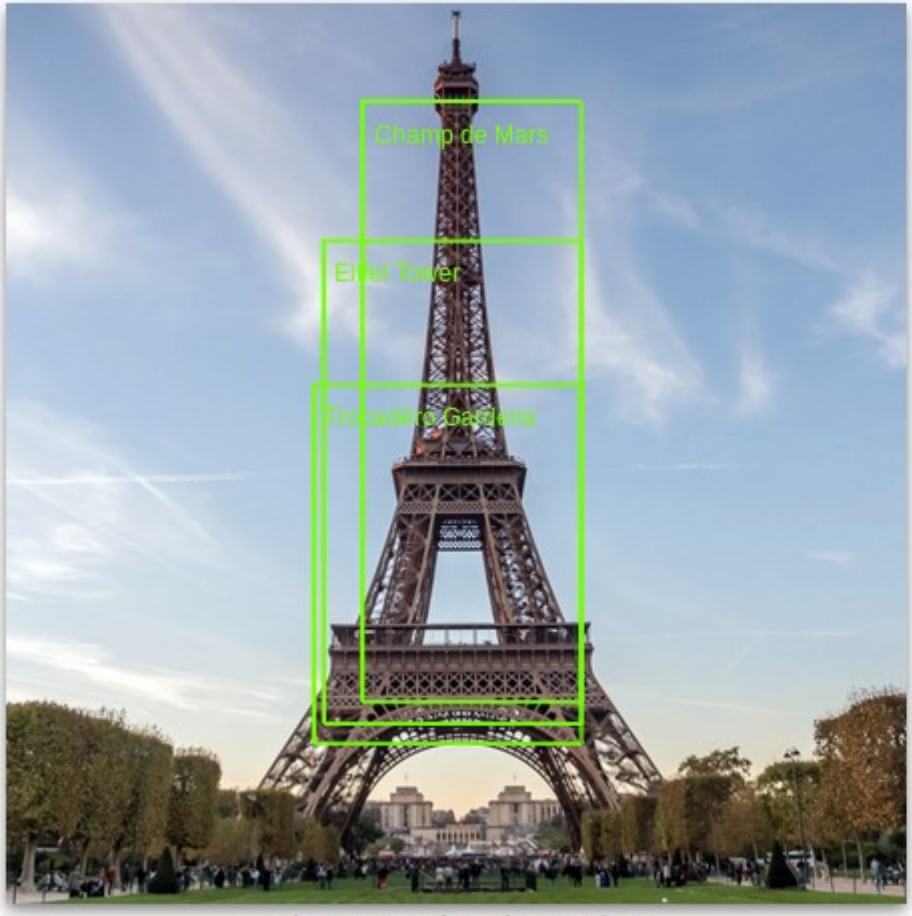
Landmarks | Objects | Labels | Web | Properties | Safe Search



picto_myGoogleBusiness_1.jpg

Eiffel Tower 89%

Location: 48.858461, 2.294351

Champ de Mars 87%

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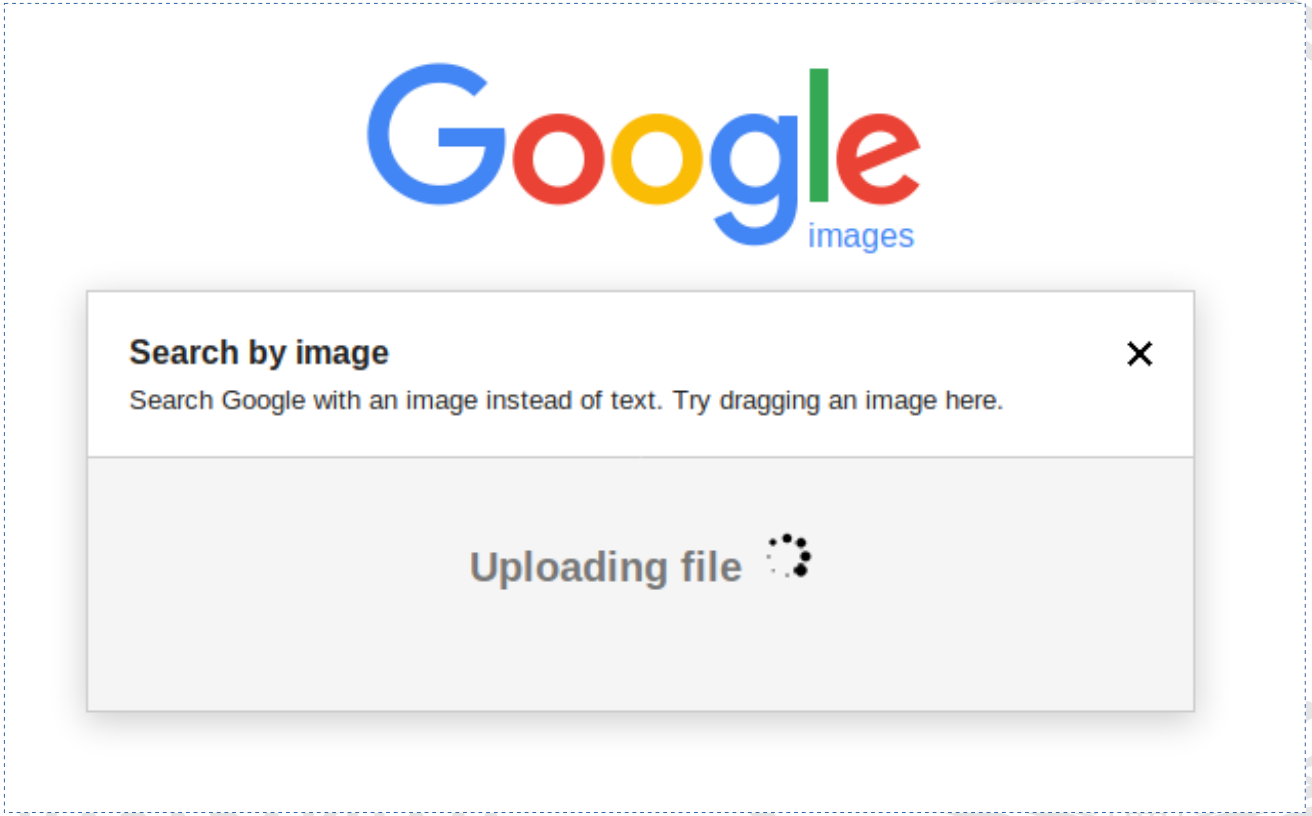
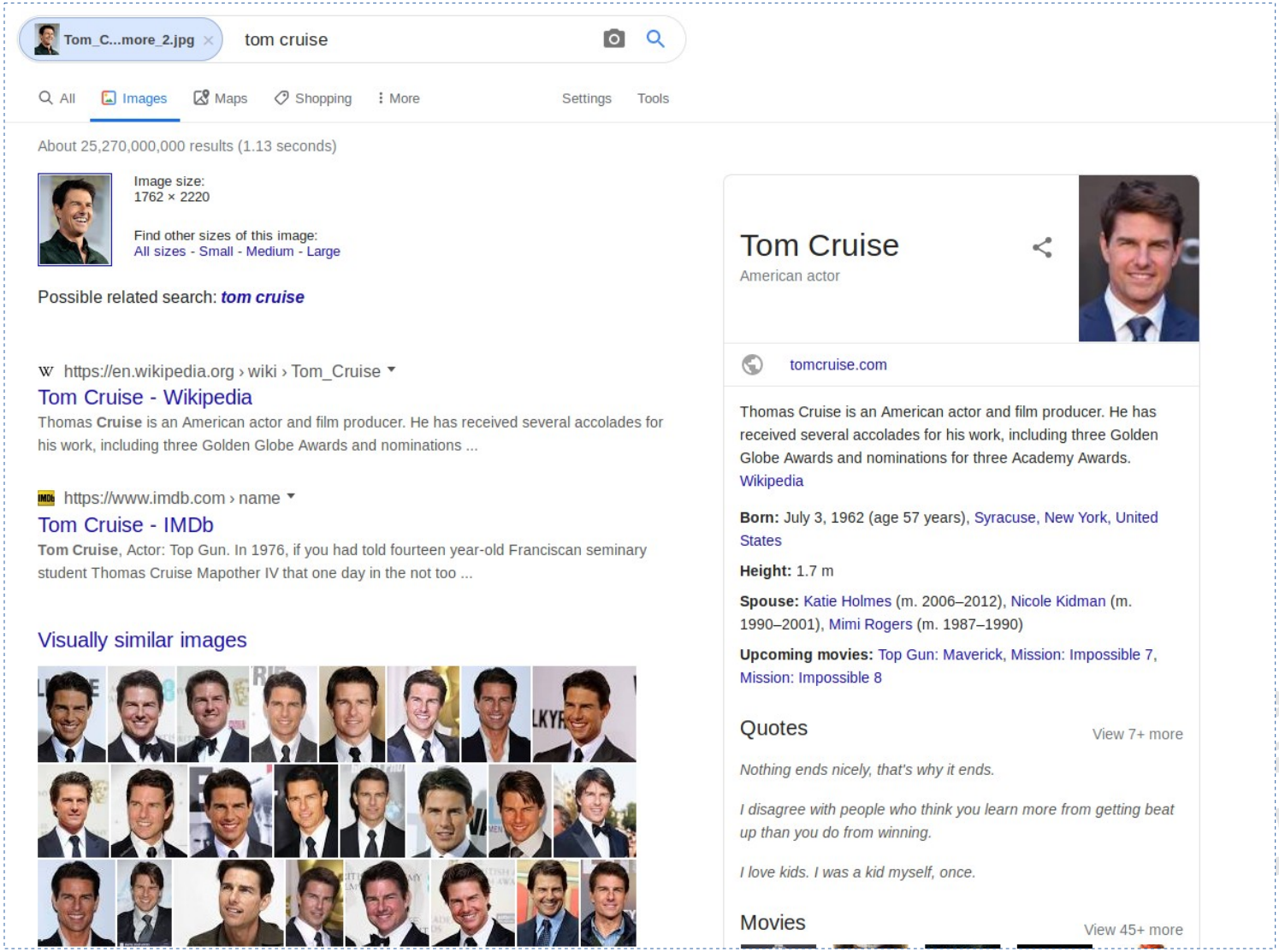
Web Entities

Eiffel Tower	2.1933
Tower	0.7109
Seine	0.58679
Louvre Museum	0.49172
The construction of the E...	0.3889
Event Tickets	0.328
Image	0.2901
Monument	0.2734
Coloring book	0.2539
1889	0.2164
Electronic ticket	0.2065
Color	0.1997
Paris	0.00193
France	0

Google search



Google search



Eye and Eye-pair Detection

Figure 1: Sample eye-pair regions for training the eye-pair detector.

In-plane Rotational Alignment of Faces by Eye and Eye-pair Detection

Eye and Eye-pair Detection

(a) (b)

Figure 2: Sample eye (a) and non-eye (b) regions cropped from eye-pair image patches. Note that the non-eye regions may still contain eyes, but they are not very precisely located in the center.

In-plane Rotational Alignment of Faces by Eye and Eye-pair Detection

Eye and Eye-pair Detection

Figure 1: Sample eye-pair regions for training the eye-pair detector.

In-plane Rotational Alignment of Faces by Eye and Eye-pair Detection

Eye and Eye-pair Detection

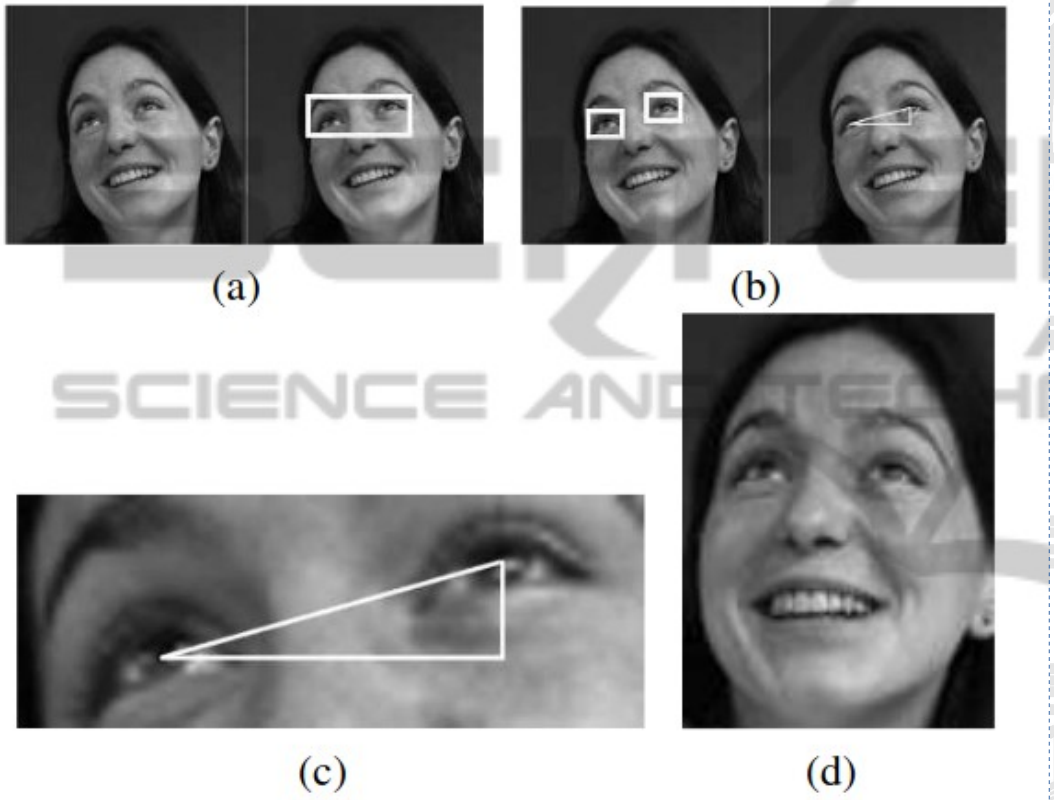
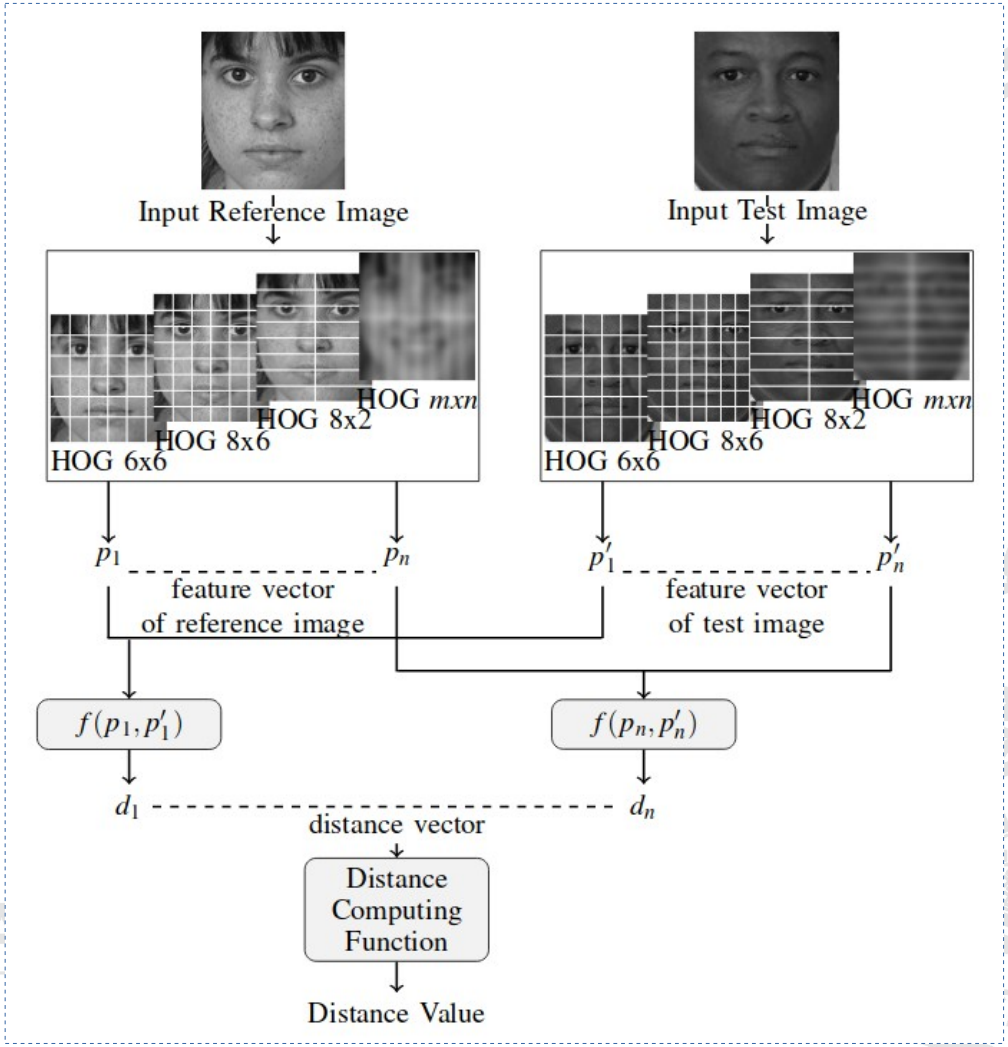


Figure 3: Rotation angle estimation stages: (a) finding eye-pair, (b) finding eyes from eye-pair, (c) computing the angle from central coordinates of eyes (17.5° in this example), (d) rotationally aligned face.

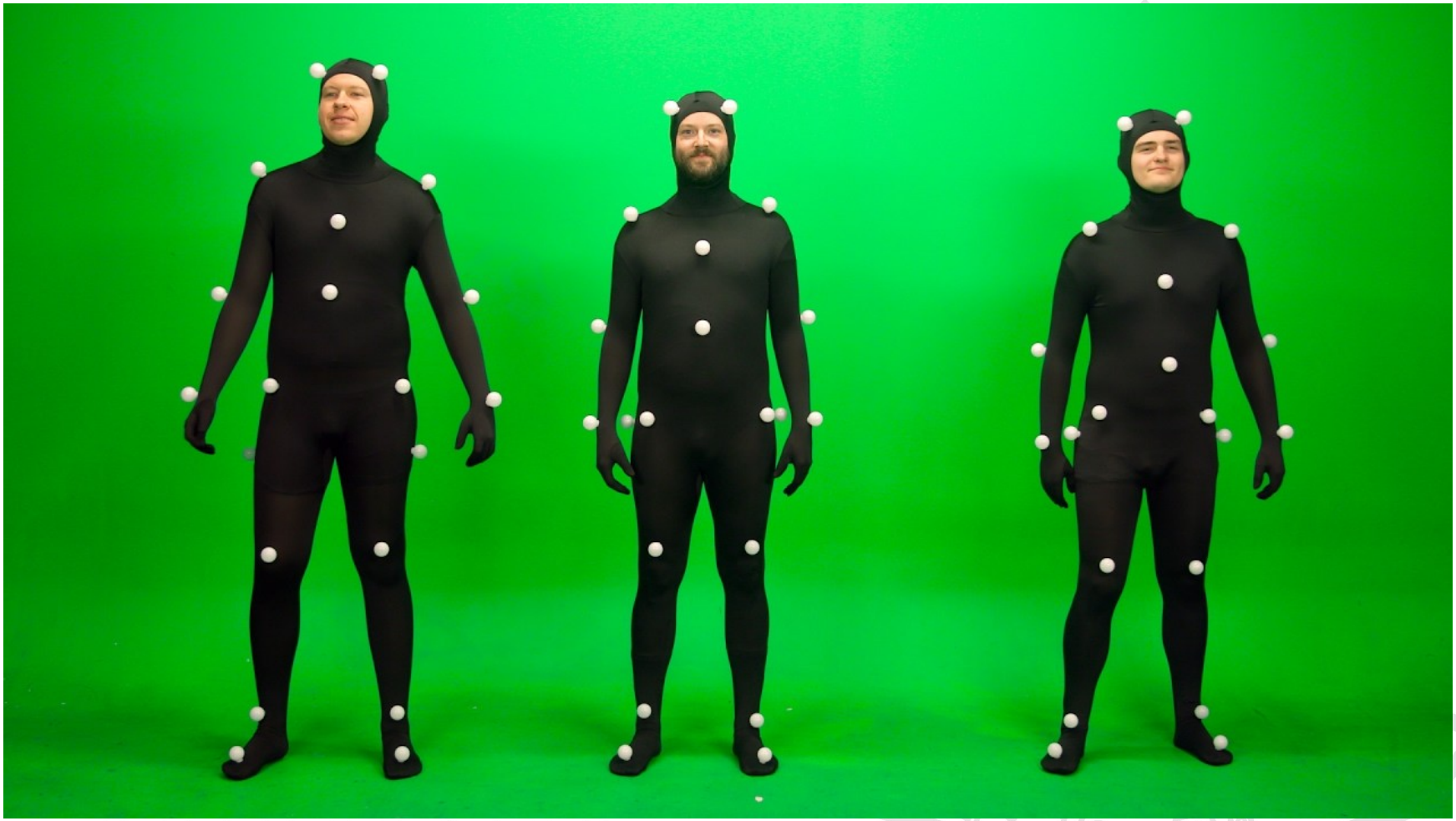
In-plane Rotational Alignment of Faces by Eye and Eye-pair Detection

Robust Face Recognition



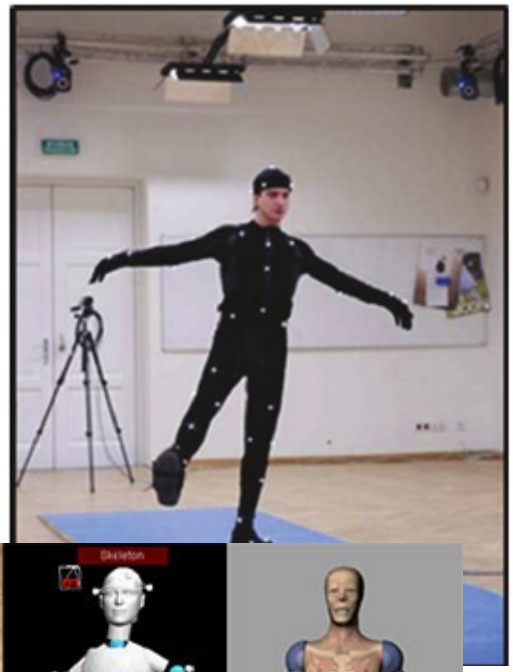
Robust Face Recognition by Computing Distances from Multiple Histograms of Oriented Gradients

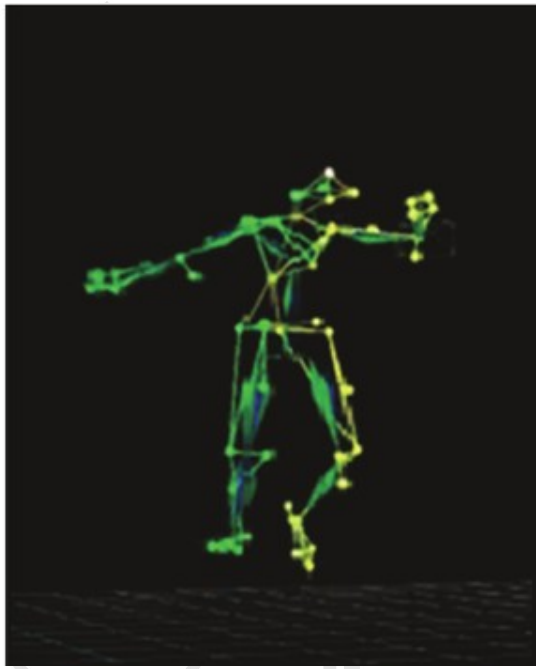
Motion capture

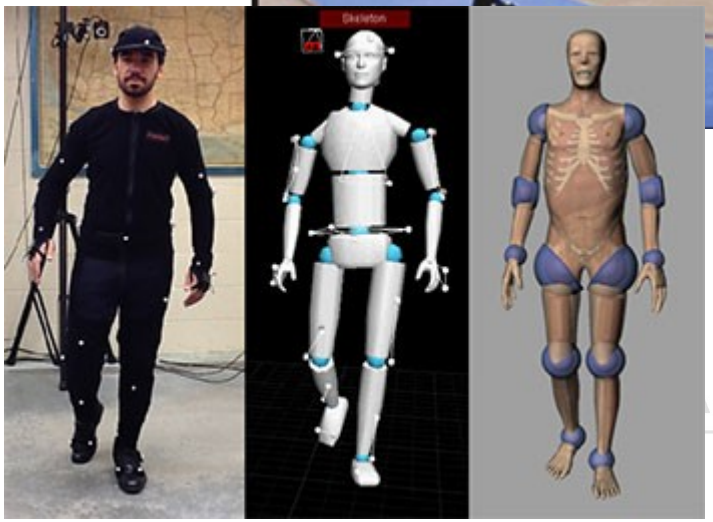


https://www.youtube.com/watch?v=kH7msPLVW_k

Motion capture





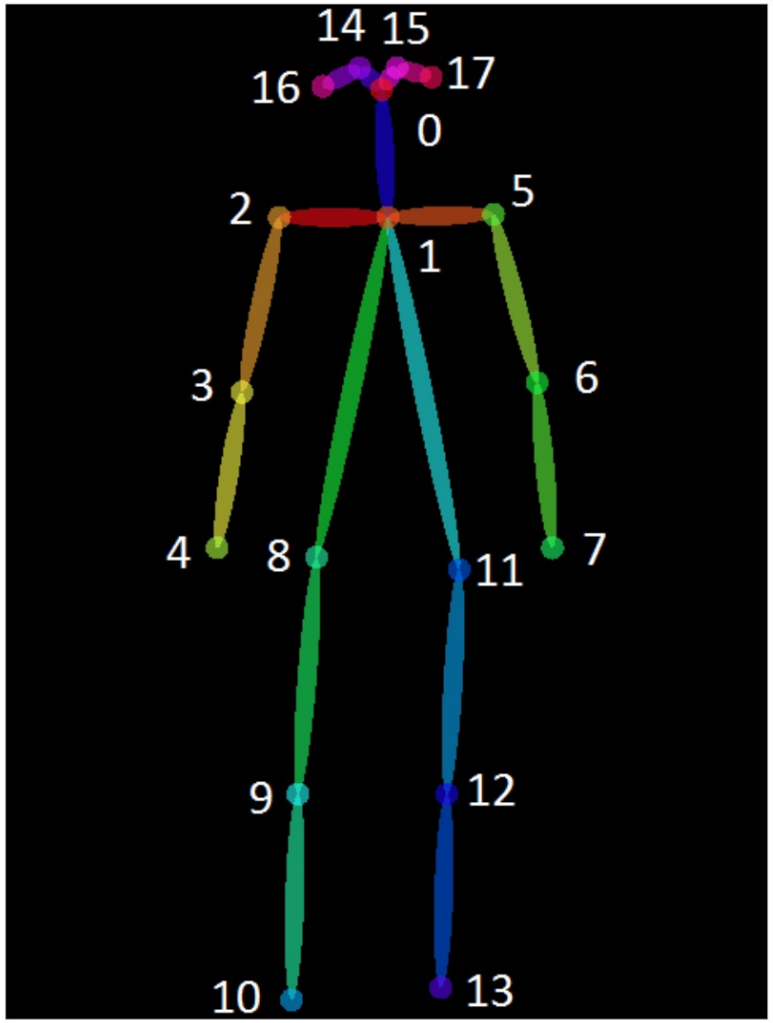


The Expanded Invasive Weed Optimization Metaheristic for Solving Continuous and Discrete Optimization Problems

https://neuronmocap.com/content/mocap-101

Pose Estimation

https://www.youtube.com/watch?v=KYNDzlcQMWA



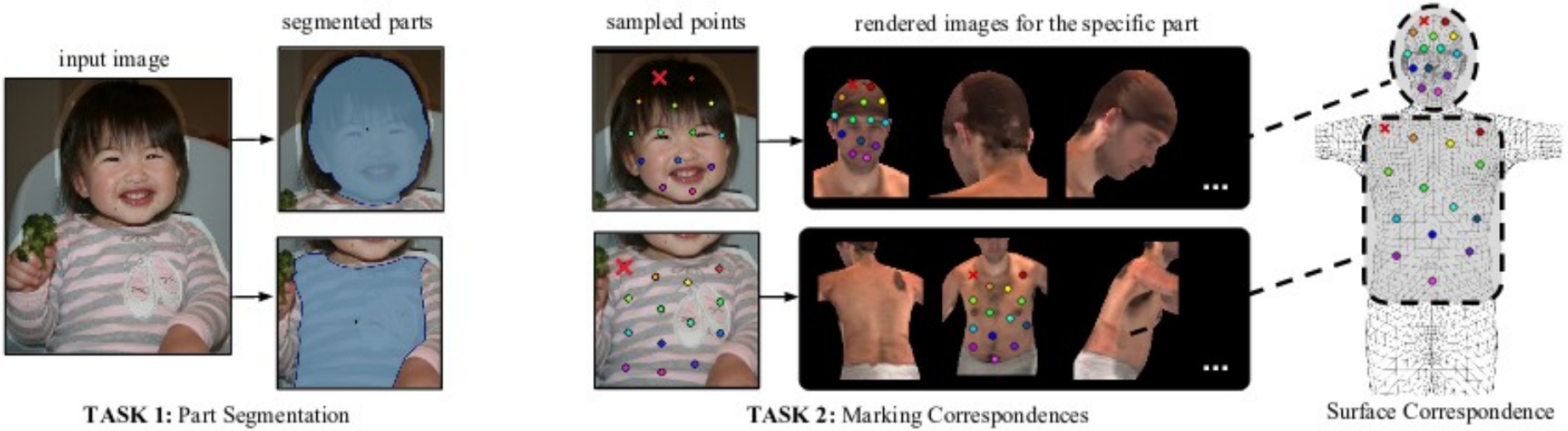
Pose Estimation

https://www.youtube.com/watch?v=pW6nZXeWlGM

Pose Estimation

https://www.youtube.com/watch?v=vTC0QKR_uM0

Dense Human Pose Estimation



DensePose: Dense Human Pose Estimation in The Wild

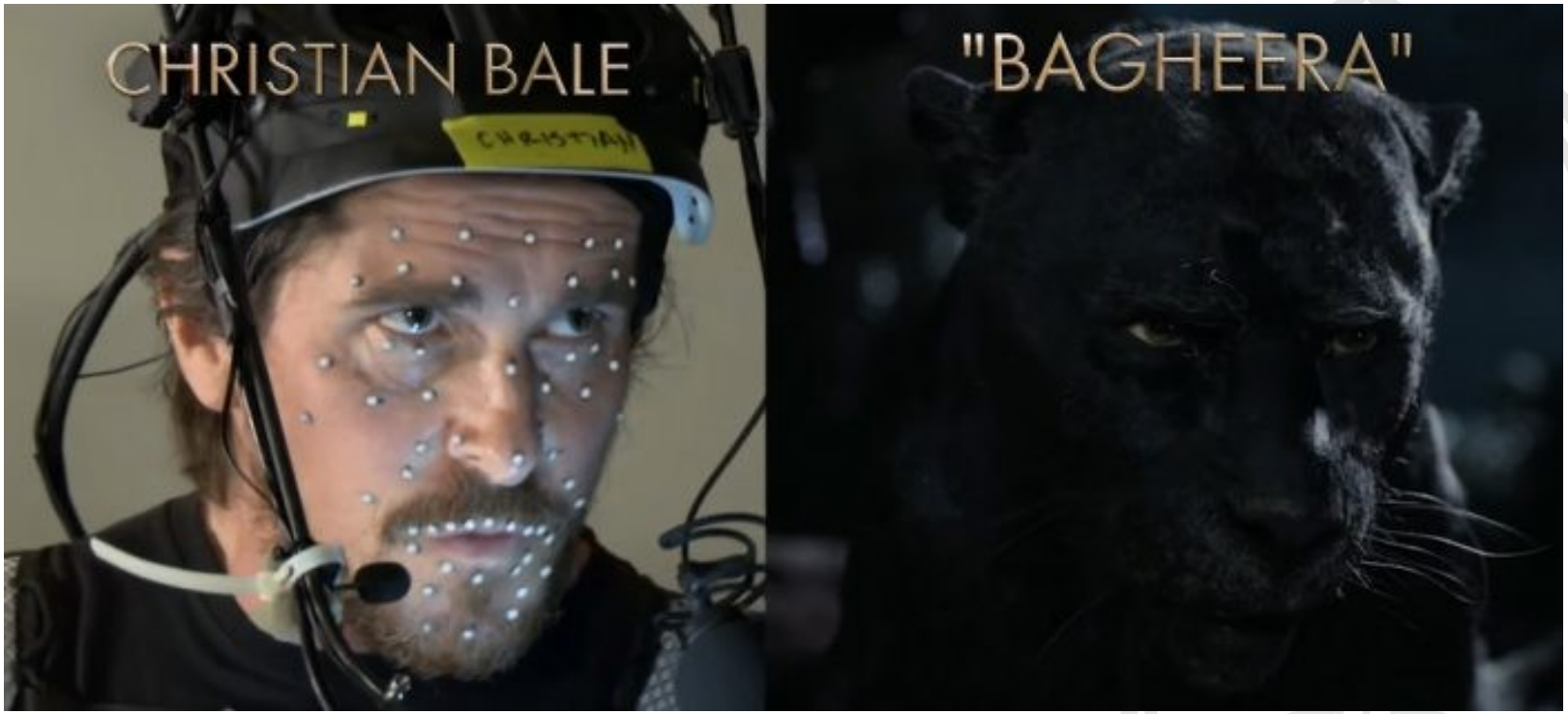
Dense Human Pose Estimation

DensePose-RCNN Results

DensePose COCO Dataset

DensePose: Dense Human Pose Estimation in The Wild

Motion capture



https://www.slashfilm.com/the-morning-watch-the-motion-capture-of-mowgli-why-disney-killed-roger-rabbit-2-more/

Motion capture

https://srushtivfx.com/how-digital-characters-replicate-human-action-and-emotions-motion-capture/

Face Segmentation

Deep face segmentation in extremely hard conditions

Deep Fake

https://www.youtube.com/watch?v=knRGxj37AjM

Deep Fake

https://medium.com/datadriveninvestor/facts-in-a-world-of-artificial-intelligence-deepfakes-c073f8791cb6

Deep Fake

https://www.youtube.com/watch?time_continue=79&v=qc5P2bvfl44

Results

Full Head Reenactment

Remove Background using Photoshop

https://www.wikihow.com/Remove-Background-With-Photoshop-Elements

Remove Background using AI

https://www.remove.bg/

Remove Background using AI

Original image

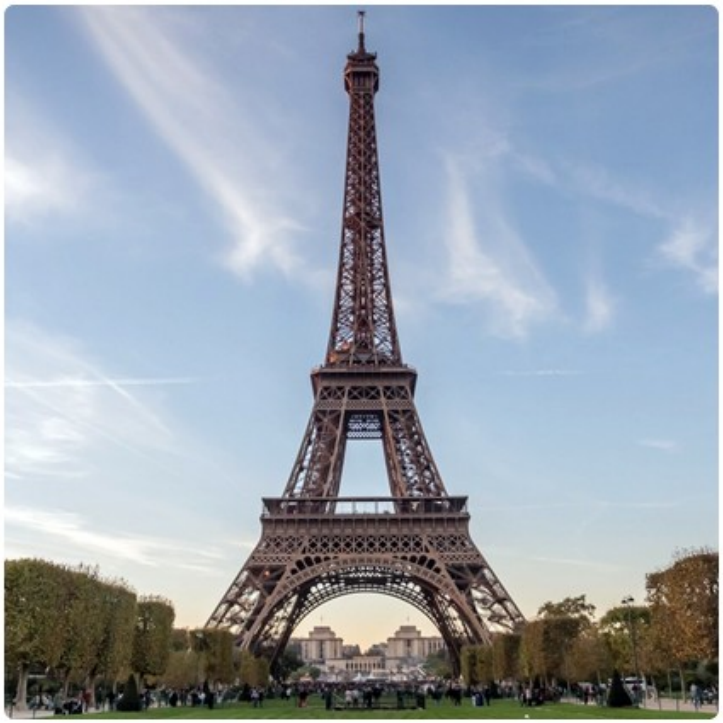
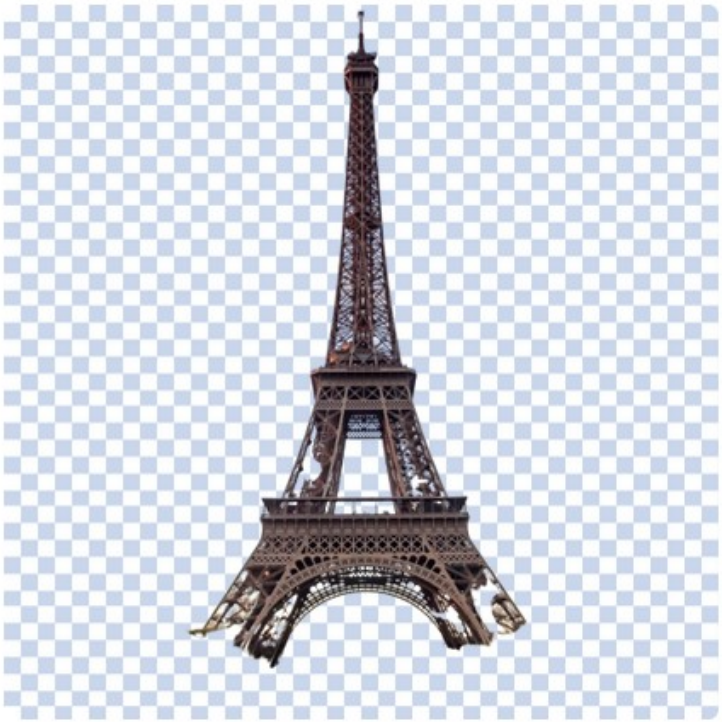


Image without background



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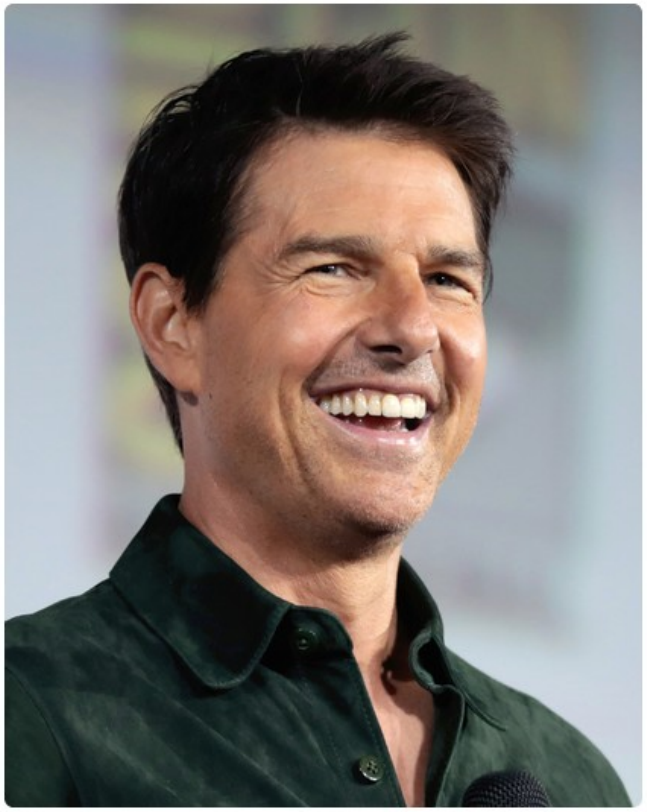

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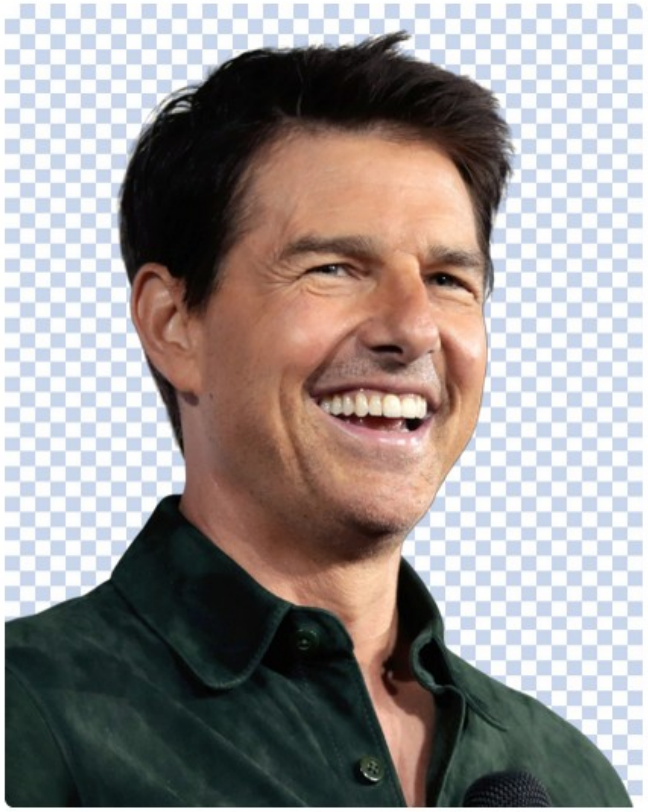

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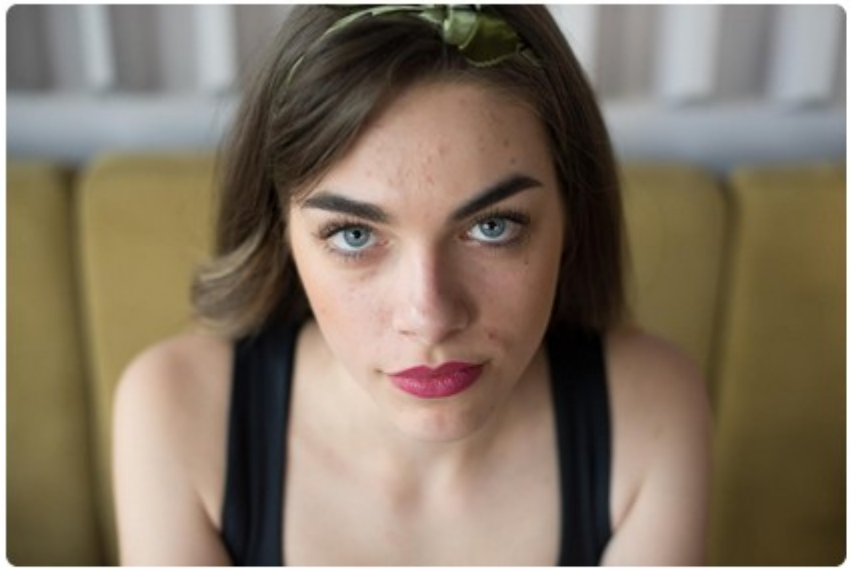

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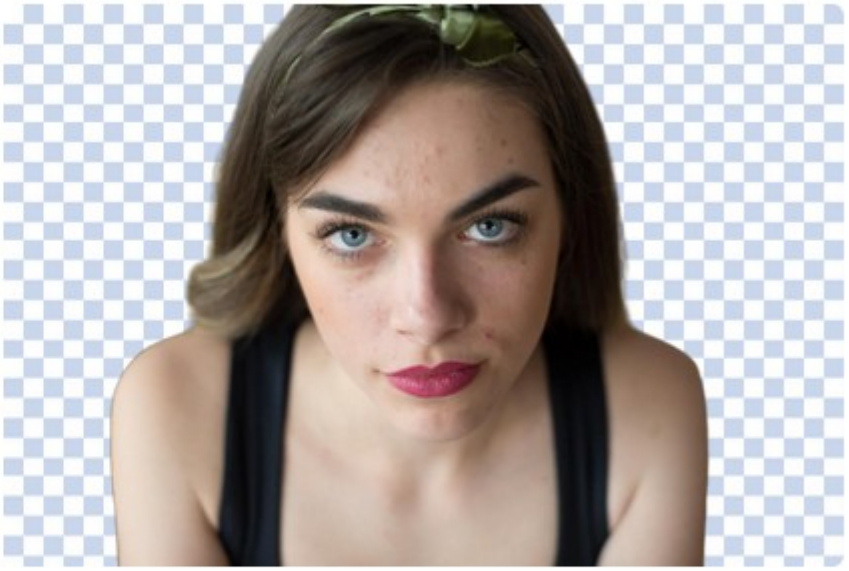

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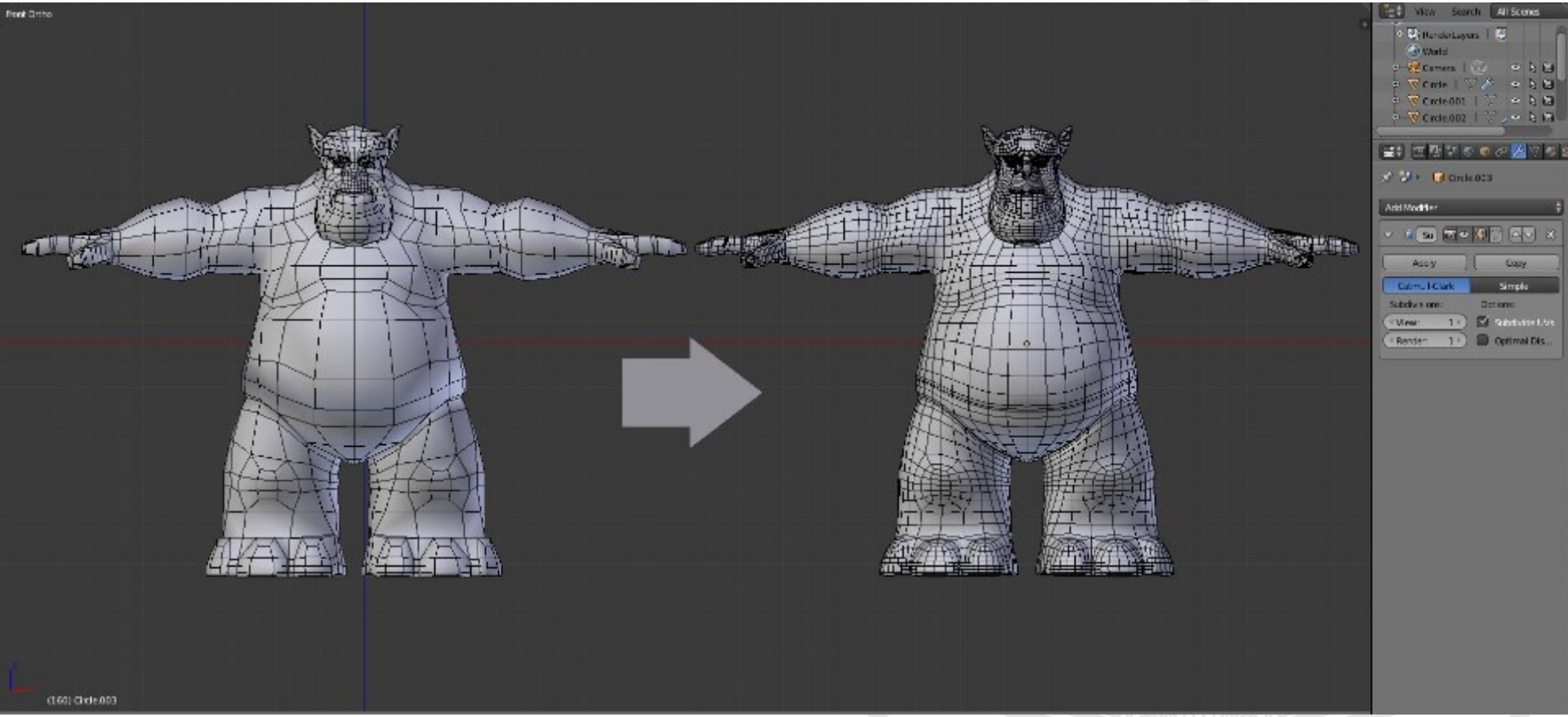
3D Model



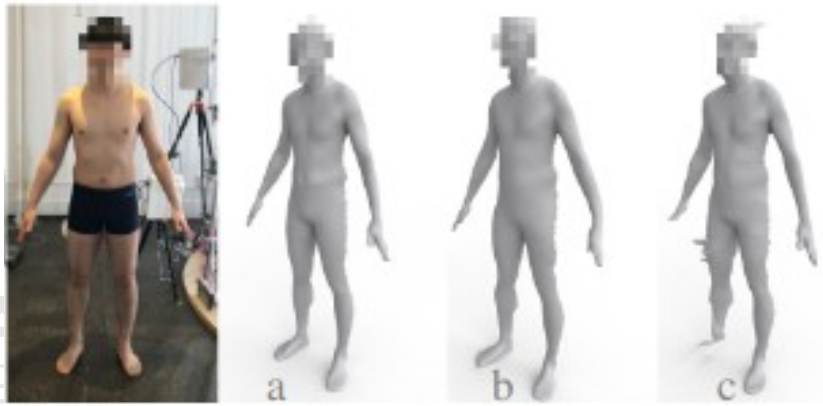
https://www.sculpteo.com/en/glossary/3d-modeling-software-definition/

Estimate a detailed body from a single photo

Figure 1: FAX converts a single RGB image (a) into a scan (b, d) with albedo texture (c, e)

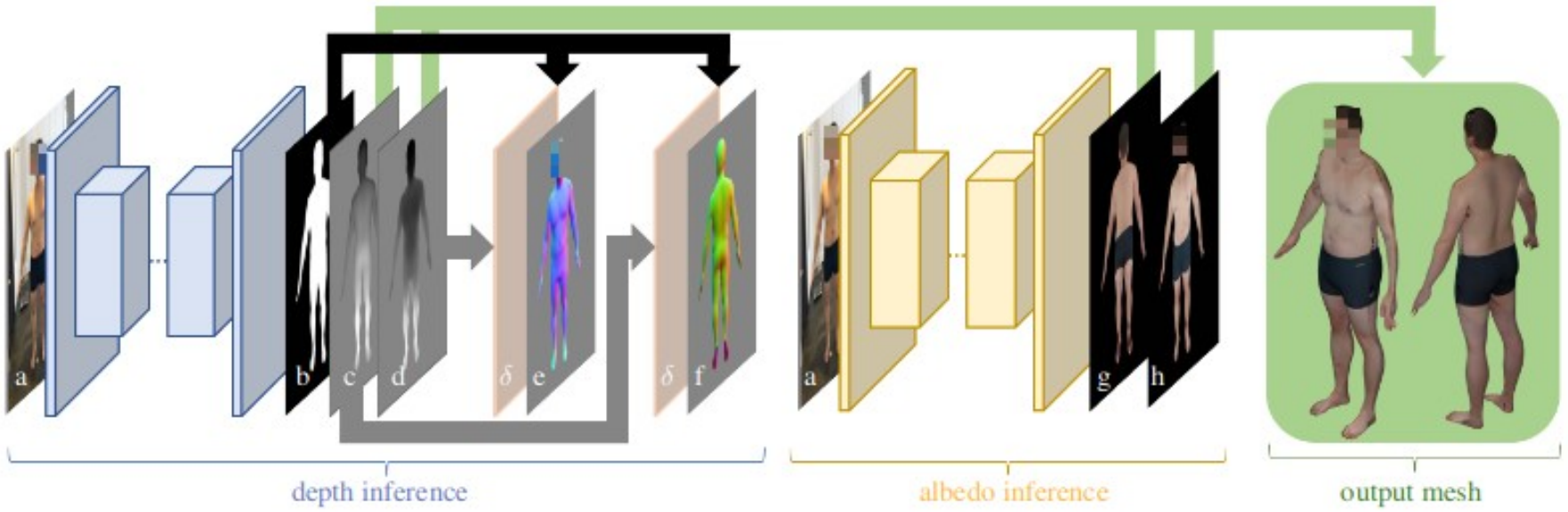
FACSIMILE: Fast and Accurate Scans From an Image in Less Than a Second

Estimate a detailed body from a single photo



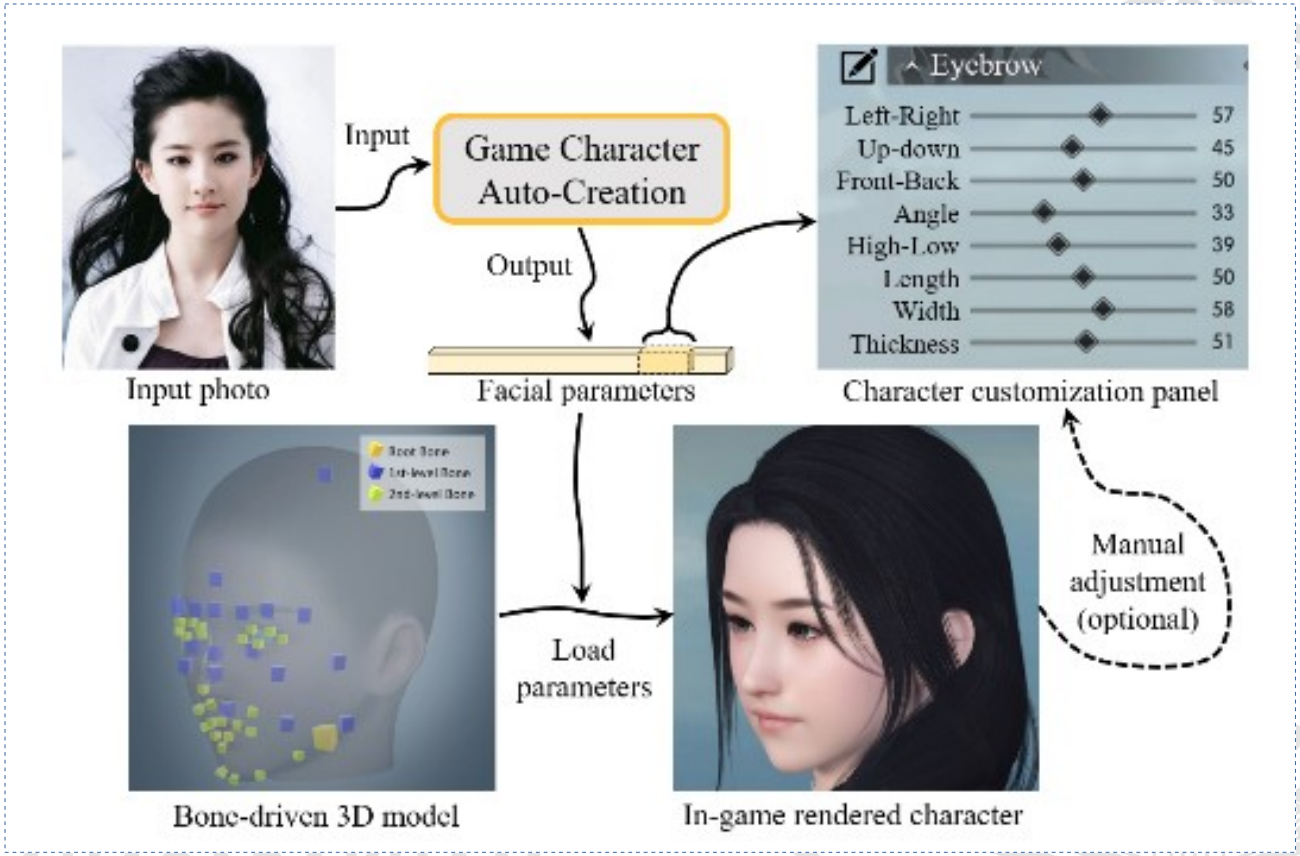
FACSIMILE: Fast and Accurate Scans From an Image in Less Than a Second

Estimate a detailed body from a single photo



FACSIMILE: Fast and Accurate Scans From an Image in Less Than a Second

Game Character Auto-Creation



Face-to-Parameter Translation for Game Character Auto-Creation

Game Character Auto-Creation

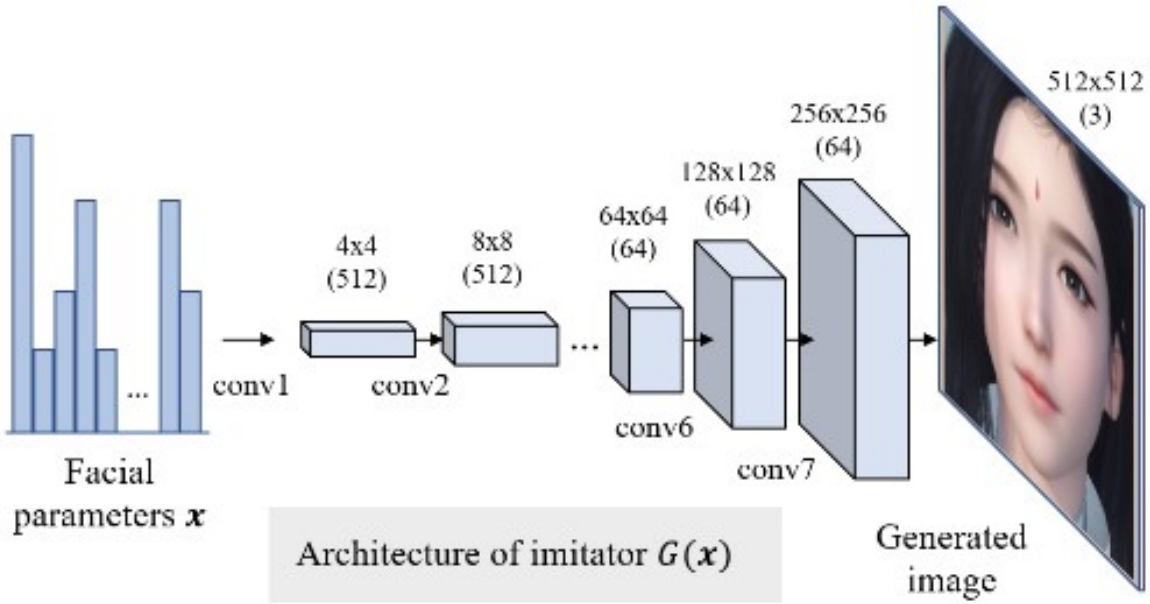


Figure 3. The architecture of our imitator $G(\boldsymbol{x})$. We train the imitator to learn a mapping from the input facial customization parameters $\boldsymbol{x}$ to the rendered facial image $\hat{\boldsymbol{y}}$ produced by the game engine.

Game Character Auto-Creation

Input photo | Aligned input | Generated character | Generated in-game character (front-view) | Generated in-game character (side-view)

Face-to-Parameter Translation for Game Character Auto-Creation

Game Character Auto-Creation

Face-to-Parameter Translation for Game Character Auto-Creation

Style Transfer GANs

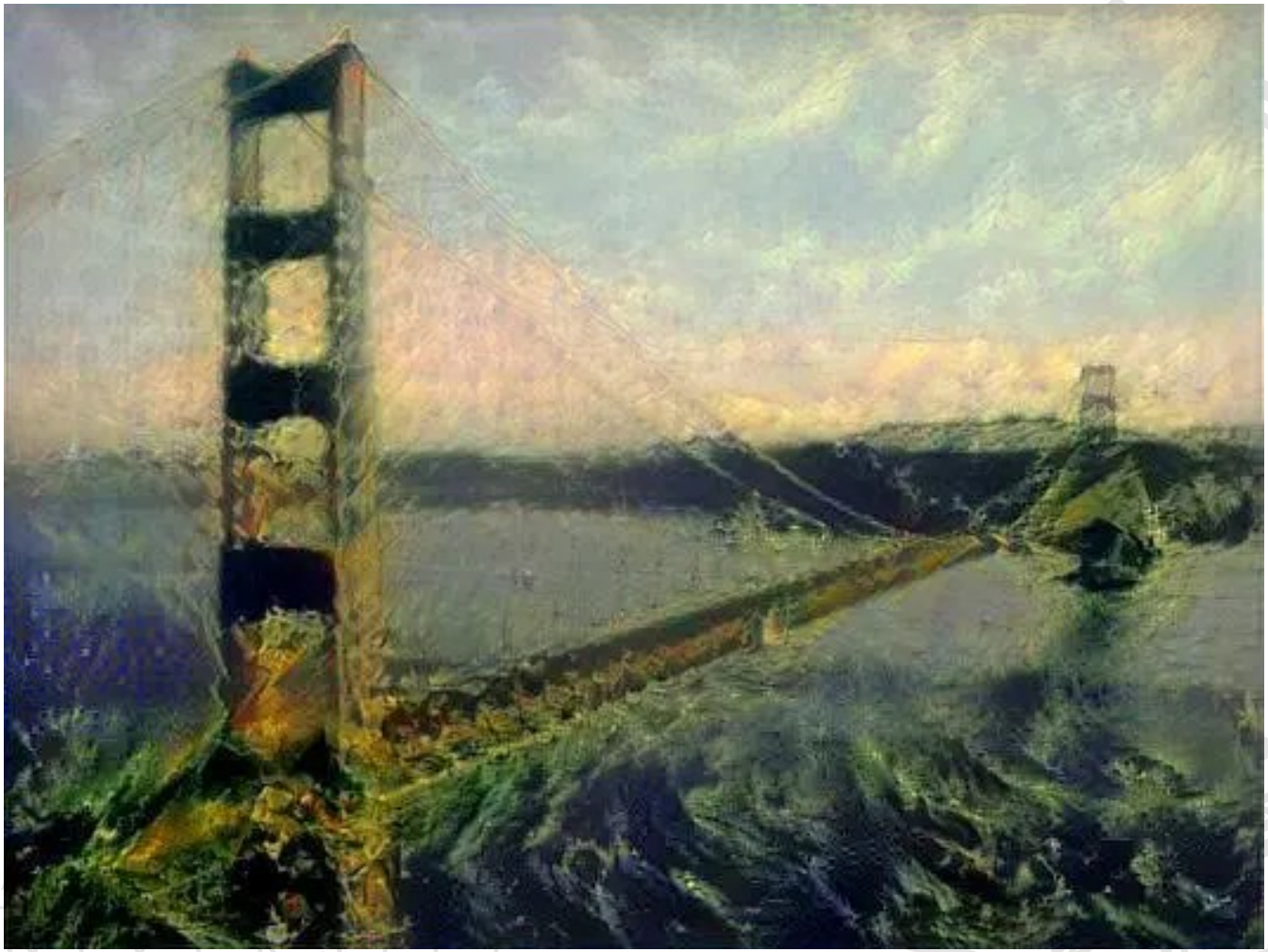
Generative Adversarial Networks: GANs

https://softologyblog.wordpress.com/2019/03/31/style-transfer-gans-generative-adversarial-networks/

Style Transfer

https://markojerkic.com/style-transfer-keras/

Style Transfer GANs



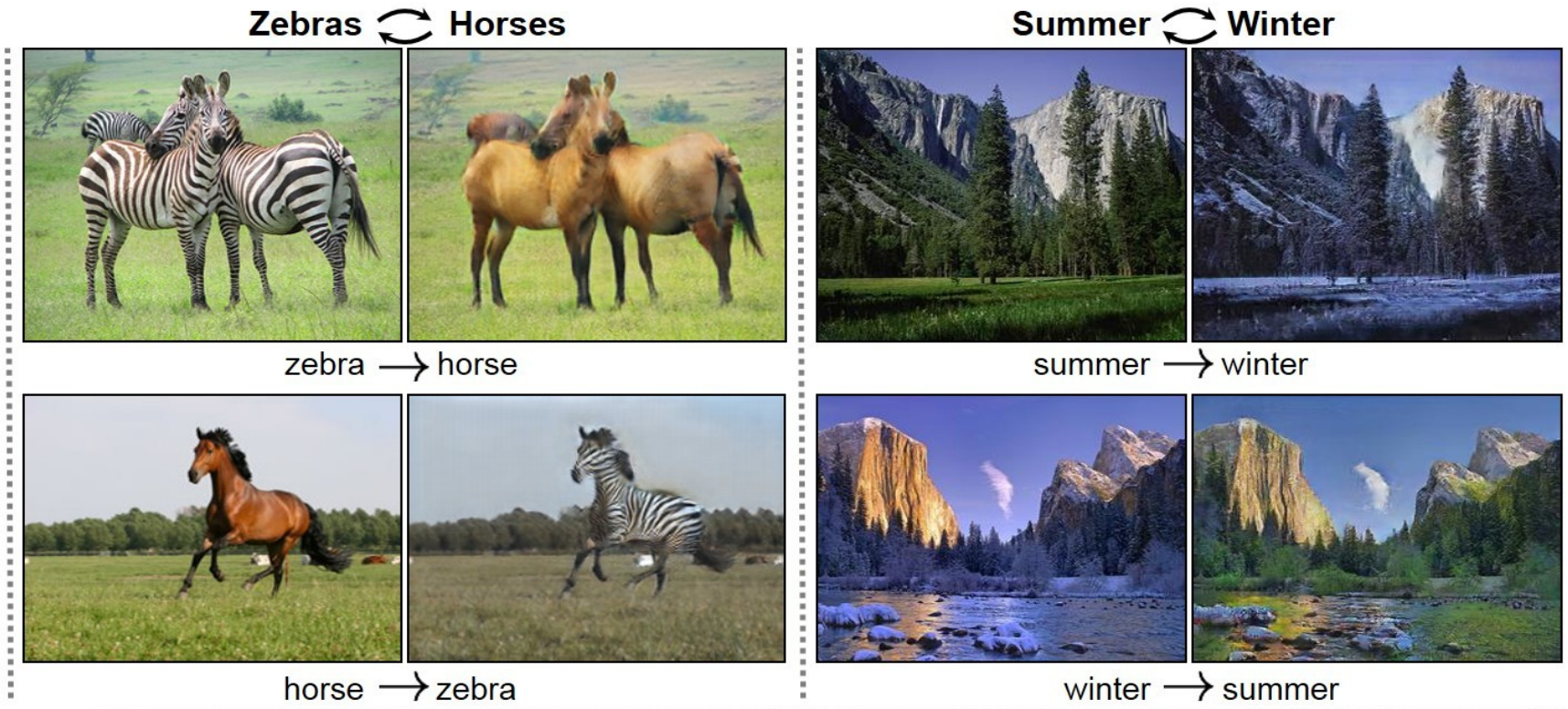
https://markojerkic.com/style-transfer-keras/

Style Transfer GANs

https://markojerkic.com/style-transfer-keras/

Style Transfer GANs

Image-to-Image Translation



https://github.com/junyanz/CycleGAN

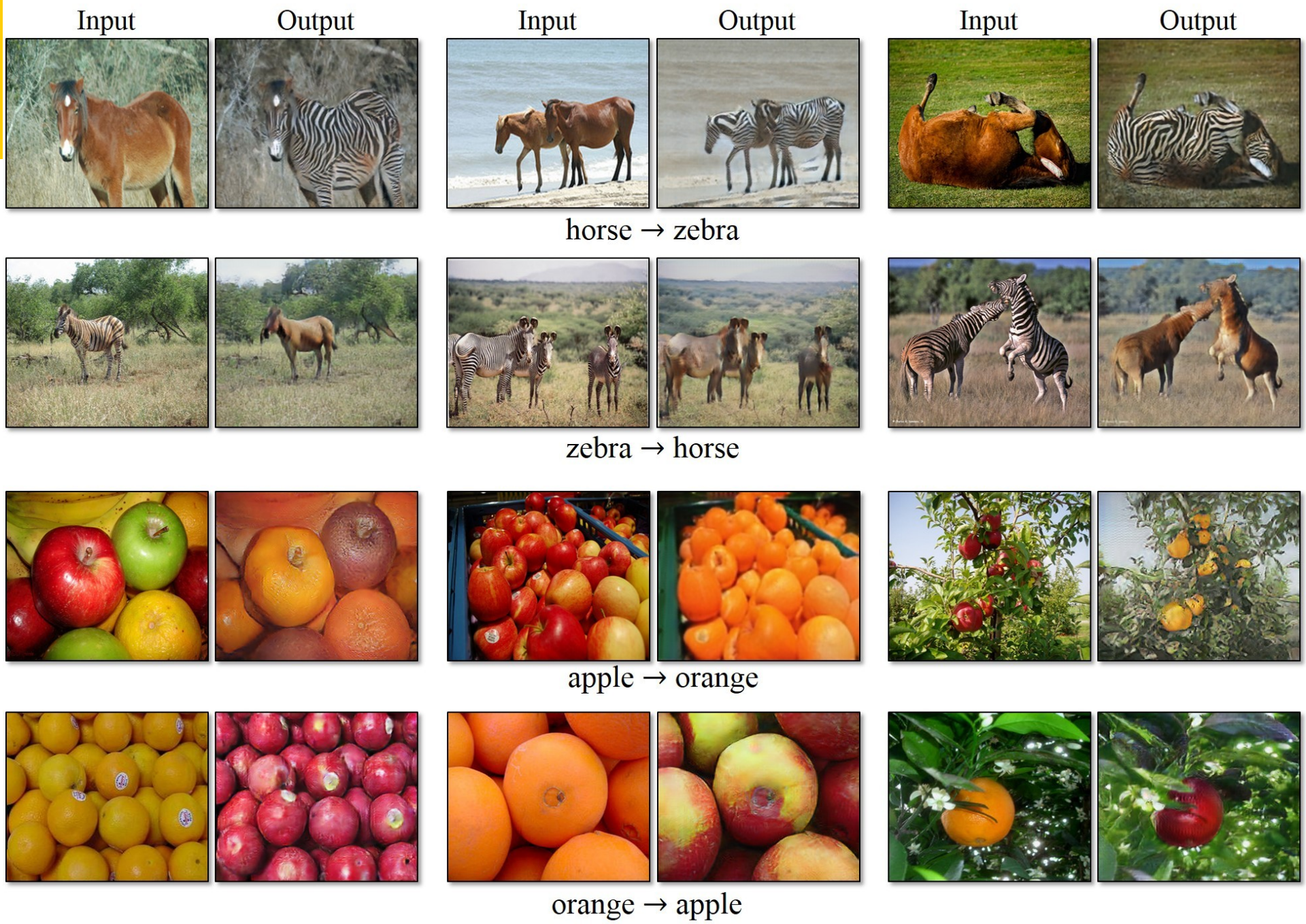

Input
Output
Input
Output
Input
Output
horse → zebra
zebra → horse
apple → orange
orange → apple

Image-to-Image Translation

Failure case

https://github.com/junyanz/CycleGAN