Facial Recognition

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https://goo.gl/IQagi3

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Introduction to Facial Recognition

Similar to thumbprint recognition

Unique to you

Landmarking is x & y points on face

Emerging technology

Security and Hospitality

Landmarks:

- 1 Glabella (g)
- 2 Nasion (n)
- 3 Endocanthion (en) L/R
- 4 Exocanthion (ex) L/R
- 5 Palpebrale superius (ps) L/R
- 6 Palpebrale inferius (pi) L/R
- 7 Pronasale (prn)
- 8 Subnasale (sn)
- 9 Alare (al) L/R
- 10 Labiale superius (ls)
- 11 Labiale inferius (li)
- 12 Crista philtri (cph) L/R
- 13 Cheilion (ch) L/R
- 14 Pogonion (pg)

Total = 21 Landmarks

Introduction to Facial Recognition

Primary landmarks		Secondary landmarks	
Number	Definition	Number	Definition
16	Left eyebrow outer corner	1	Left temple
19	Left eyebrow inner corner	8	Chin tip
22	Right eyebrow inner corner	2-7, 9-14	Cheek contours
25	Right eyebrow outer corner	15	Right temple
28	Left eye outer corner	16-19	Left eyebrow contours
30	Left eye inner corner	22-25	Right eyebrow contours
32	Right eye inner corner	29, 33	Upper eyelid centers
34	Right eye outer corner	31, 35	Lower eyelid centers
41	Nose tip	36, 37	Nose saddles
46	Left mouth corner	40, 42	Nose peaks (Nostrils)
52	Right mouth corner	38-40, 42-45	Nose contours
63,64	Eye centers	47 51,53-62	Mouth contours

Figure 2 *m*17 landmark set includes squares representing the primary (first order) landmarks. *m*7 landmark set consists of the most fiducial points represented by red squares. Green dots the secondary (second order) landmarks, totally 64 landmark points.

Table 1 An overview of the texture-based face landmarking algorithms

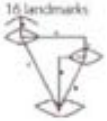
Work	Highlights of the method	Domain knowledge used	Landmark types
Yuille et al. [72], 1989	Using image saliencies of the face components, geometrical templates are developed consisting of arcs and circles. Eye template consists of a circle for iris, two parabola sections for eye contours, two center points for the white sclera.	Descriptive information of the eye and mouth geometries.	Eye, iris and mouth contours. 
Pentland et al. [18], 1994	Extension of the eigenface approach to eigenmouth, eigeneye and eigennose. Multiple eigenspaces mitigate variations due to pose. Face-ness, mouth-ness etc. are assessed based on the concept of distance from corresponding (eye, mouth, nose etc.) eigenspace.	None.	Mouth, nose and individual eye components. 
Vukadinovic & Pantic [44], 2005	GentleBoost templates built from both gray level intensities and Gabor wavelet features. A sliding search is run with templates over twenty face regions.	Face initially divided into search regions on the basis of IOD vis-à-vis the detected eyes. In addition horizontal and vertical projection histograms and symmetry of the frontal face are used.	20 landmarks. 
Arca et al. [41], 2006	Face is detected with skin features, and eyes are located using SVM. Facial components are extracted using parametric curves specific to each component as in [72], and facial landmarks are traced on these curves.	Various facial component heuristics such as the vertically alignment of the eyes, the mouth is centered with respect to the eye positions etc.	16 landmarks. 
Zhang & Ruan [73], 2006	Rectangular eyes, mouth and nose templates resulting from averaging several instances used for detection. Geometrical templates consisting of arcs and circles are fitted to components for detailed modeling.	Eye and mouth geometry.	Eye, iris and mouth contours. 
Akakin & Sankur [16,27], 2007	Templates based on 50% of block DCT features (block size 0.4 × IOD) scan the image and SVM score map is obtained. Initial combinatorial search decides for 7 fiducial landmark, and the rest of the landmarks are predicted and locally tested with their DCT features.	Landmark distances and angles are learned, modeled as Gaussians and the information embedded in a graph.	17 landmarks. 
Ding & Martinez [68], 2010	Face components are found via Subclass Determinant Analysis, where multiple models for the target component, eyes and mouth are developed; the context is the subspace representation of the regions surrounding the components.	Estimated positions of the face components within detected face boxes.	Eyes and mouth components. 
Valstar et al. [70], 2010	SVRs are trained to predict the landmark locations using RoI samples. The search is regularized via a Markov network to exploit the learned spatial relationships between landmarks.	A priori probability map of the likely locations of seven fiducial landmarks and the locations of 15 less fiducial landmarks vis-à-vis the first seven.	20 landmarks as in [44]. 

Table 2 An overview of the model-based face landmarking algorithms

Work	Highlights of the method	Domain knowledge used	Landmark types
Leung et al. [76], 1995	Face image is Gaussian filtered at multiple orientations and scales. This process provides a set of candidate landmarks. Each possible configuration of candidates is validated through random graph matching.	The geometrical relationship between landmarks is expressed with a probabilistic model, which reduces the matching complexity and eliminates irrelevant points.	Eye centers and nose. 
Wiskot et al. [9], 1997	A labeled graph is constructed where links are the average distances between landmarks and where nodes represent 40-dimensional Gabor jets at candidate locations. The face graph is elastically deformed toward the query face.	Multiple face graphs capture head rotations and bunch graphs capture the various appearances.	An example graph: 
Cootes et al. [79], 1998	AAM, a generalization of ASM, jointly models the shape and texture variation of the fiducial points. The main goal is to find the appropriate model parameters that minimize the difference between the query and the model face.	PCA models of both texture and shape.	An example of fitting: 
Cristinacce et al. [80,81], 2003	Multiple landmark detectors are run on the face and locate the initial landmarks. Then, two steps are repeated until convergence: First, estimated locations are improved by boosted regression; second, shape model is fitted to the updated landmark locations.	Configurational constraints are applied to eliminate false positives as well as to recover missing landmarks.	17 landmarks: eye, eyebrow, nose, mouth and chin. 
Cristinacce et al. [83], 2008	Local templates per each landmark type are combined into a geometrical configuration. The estimated locations are updated by a shape-driven search.	Learned global shape model to avoid non-plausible face shapes.	22 landmarks. 
Milborrow and Nicolls [31], 2008	Enhancements on ASM such as stacking of two ASMs for better initialization, 2D profile search for individual landmarks etc.	Learned profile models for the individual landmarks and learned global shape model via PCA	76 landmarks. 
Belhumeur et al. [106], 2011	A local detector collects SIFT features and landmark-specific SVMs output landmark likelihoods. A Bayesian framework unifies the local evidences into a global shape.	Anatomical and geometrical constraints on facial landmarks derived implicitly from the exemplars.	29 features. 
Zhu & Ramanan [99], 2012	Local and global information merged from beginning via tree-connected patches covering the landmarkable zones of the face. Patches represent HOG features while global shape is imposed via quadratic springs between them. The maximum likelihood setting of the tree is searched.	Linearly-parameterized, tree-structured pictorial structure of the landmark rich parts of the face.	68 landmarks for frontal and 39 landmarks for profile faces. 

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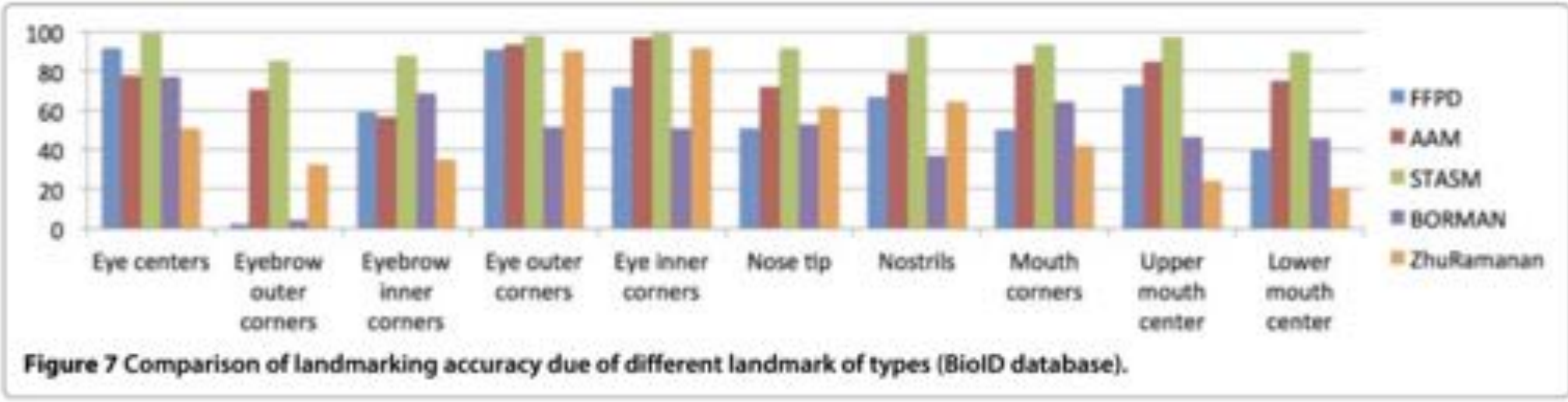

Figure 7 Comparison of landmarking accuracy due of different landmark of types (BioID database).

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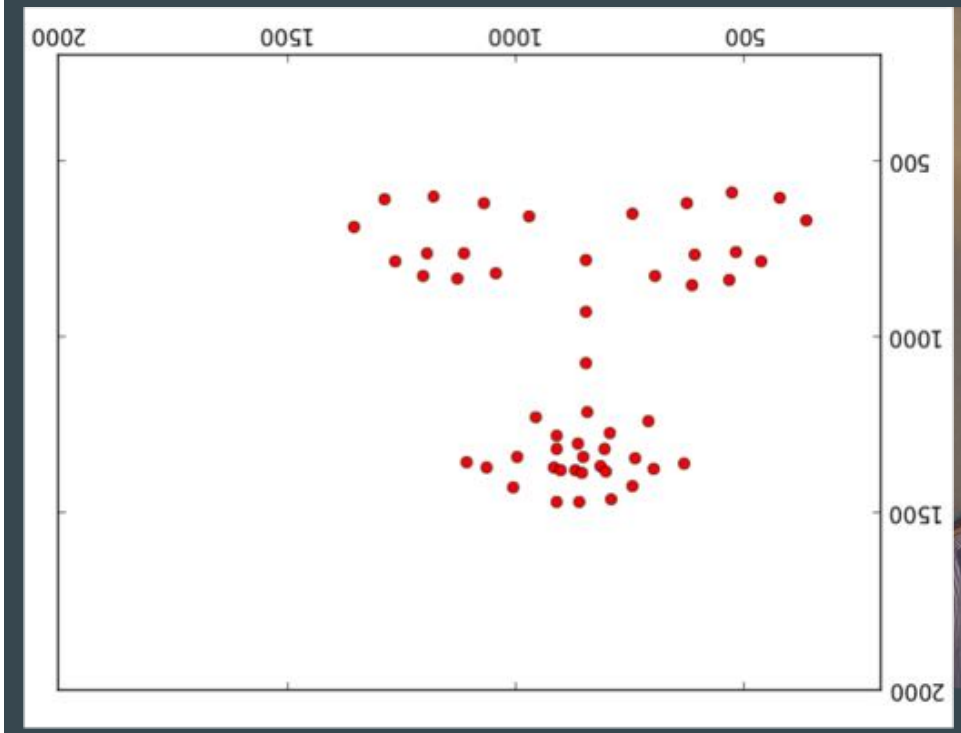

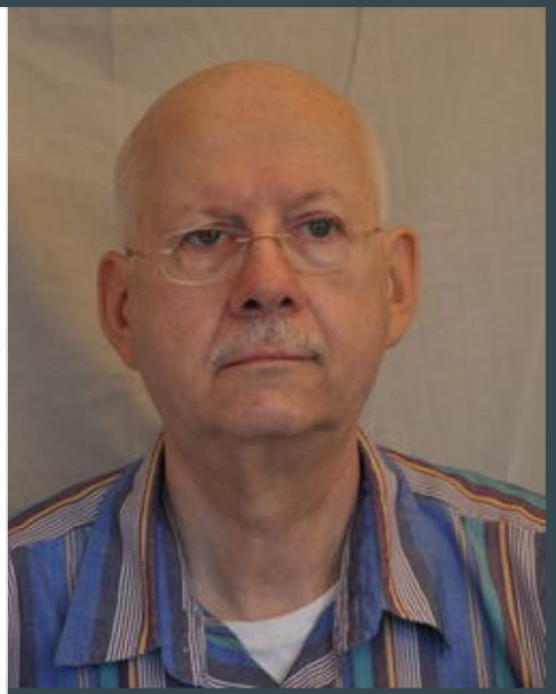

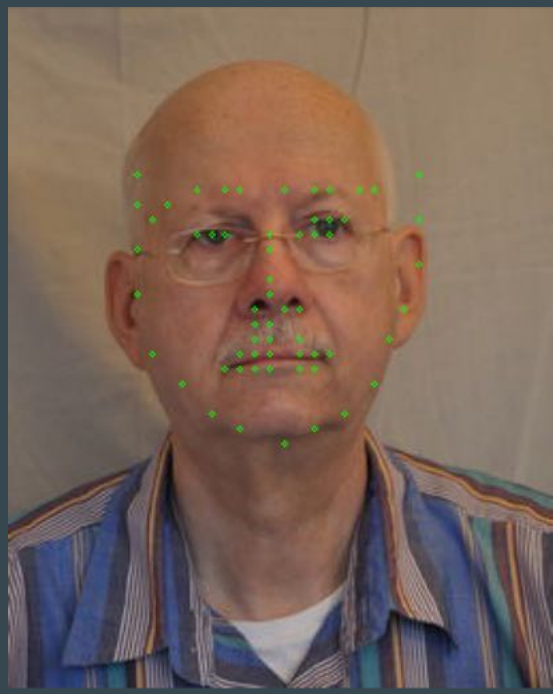

ZhuRamana Algorithm

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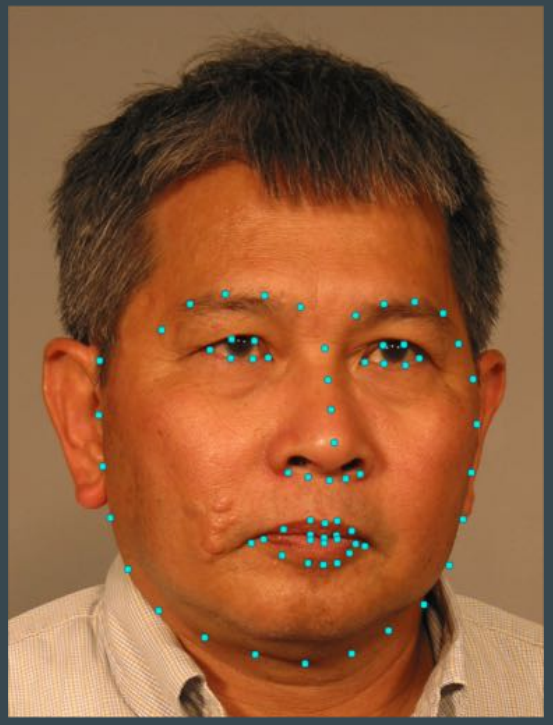
DLIB Algorithm

Facex Algorithm



Vito Algorithm

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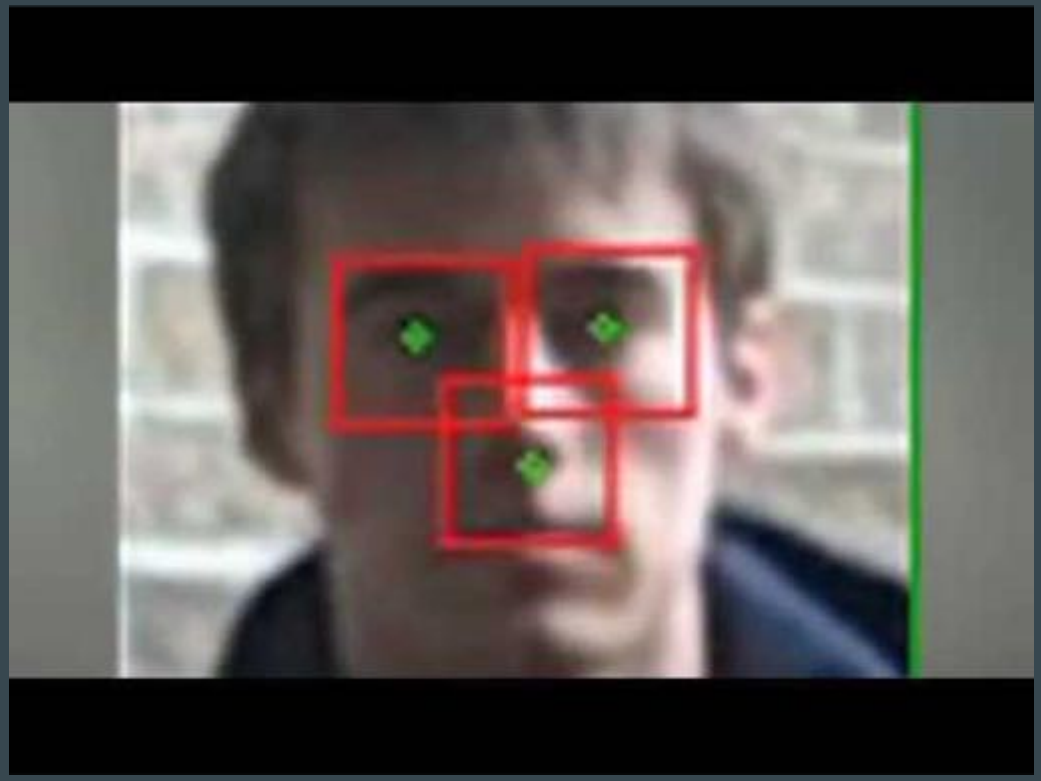
Facebook uses facial recognition

1. Facebook identified me.
2. Why didn't it identify my wife?
3. Why didn't it identify my children?

Introduction to Facial Recognition- ND CSE



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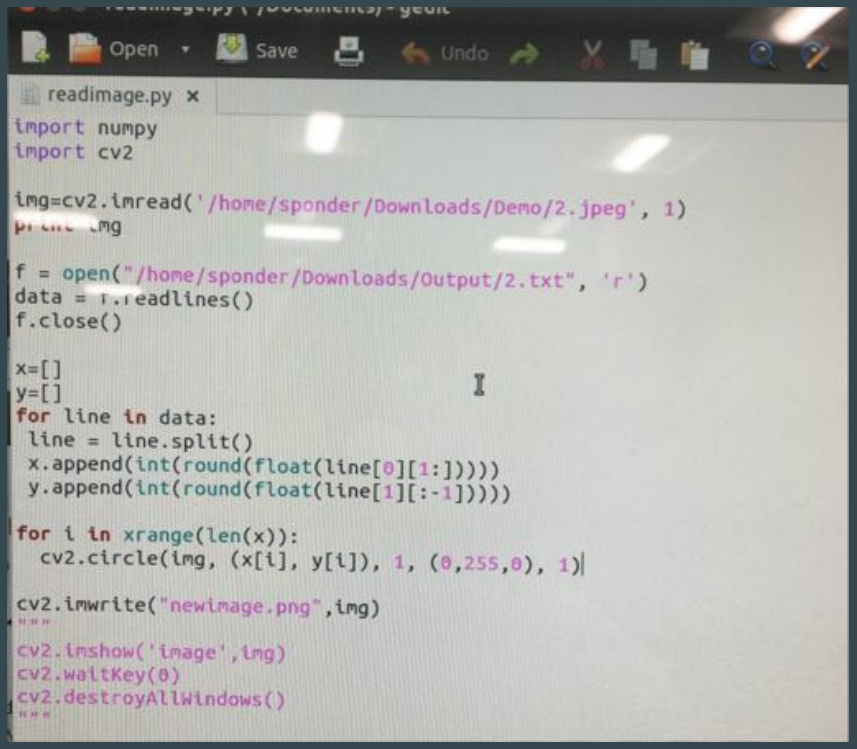
My experience:

1. Learn Unix operating system
2. Learn Python programing language
3. Collect pictures from Notre Dame's database
4. Run the code on small batch of pictures
5. Check for accuracy



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Facial Recognition Assignment #1

1. Create a copy of the assignment by clicking here
   a. Or typing: https://goo.gl/zcV67g
   b. Or downloading Assignment #1
2. On a piece of paper or spreadsheet, record the x & y coordinates for the landmarkers.

- Round to the closest .25
- You have ten minutes to complete the assignment

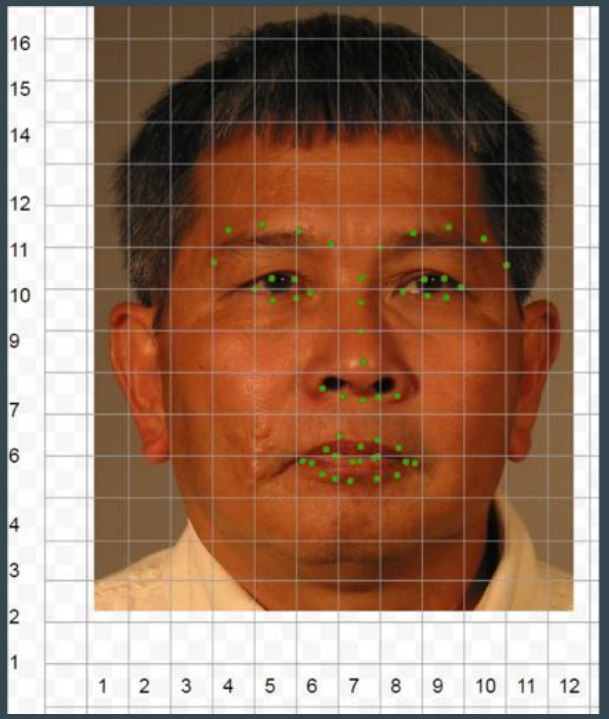

Image Recognition Assignment #1- Debriefing

1. Did you complete the assignment in the time provided?
2. How many sets of numbers did you find?
3. How accurate are your landmarkers?
4. Why is it important to create a program on a computer to do this for us?
5. How do you think the computer would do this differently?

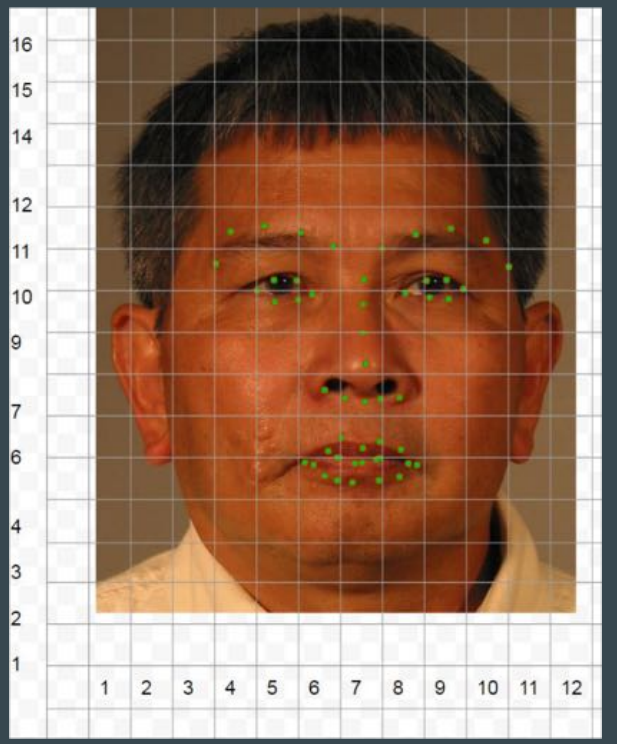

Image Recognition Assignment #2

X axis is left and right & the first number listed

Y axis is up and down & the second number listed

Example (2, 4): 2 is the X & 4 is Y

1. Open a new Google Sheet
    a. Or download Landmarks Assignment #2
2. Copy first picture for coordinates on google sheet or grid paper
3. Copy second picture for coordinates on google sheet or grid paper
4. Use a plot graph to find the landmarks or connect the landmarks

Facial Recognition Assignment #2

X	Y
3.25	11
4	11
4	7.5
3.25	7.5
6.25	7.5
7.25	7.5
6.25	11
8.75	11
10.75	11
10.75	7.25
12.75	11
13.25	11
13.75	10.5
13.75	8
13.25	7.25
12.75	7.25

X	Y
0.25	13
4	13
4	13.5
3.25	13.5
3.25	15
6.25	15
7.5	13
10.75	13
10.75	13.5
10	13.5
10	15
13.5	15
13.5	13.5
12.75	13.5
12.75	13
13.75	13
15.5	11.5
15.5	7

X	Y
13	5.5
12.75	5.5
12.75	3
10.75	3
9	5.5
6.25	5.5
6.25	5
7.25	5
7.25	3
3	3
3	5
4	5
4	5
0.25	5.5
0.25	7.25
1.25	7.25
1.25	11
0.25	11

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Image Recognition Assignment #2- Debriefing

1. What shapes did the groups of landmarkers create individually?
2. What logo did the landmarks create?
3. How do you think facial recognition similar to image recognition?
4. Why is facial & image recognition important to security?

Facial Recognition Assignment #3

1. Take a picture
2. Insert picture under grid on Google Drawing
   a. Type https://goo.gl/gsK0qs
   b. Or download Assignment #3 Grid Template
3. Overlap x and y grid over picture
4. Plot 13+ primary landmarks on face
5. Check landmark differences with classmates

Primary landmarks	
Number	Delimition
16	Left eyebrow outer corner
19	Left eyebrow inner corner
22	Right eyebrow inner corner
25	Right eyebrow inner corner
28	Left eye outer corner
30	Left eye inner corner
32	Right eye inner corner
34	Right eye outer corner
41	Nose tip
46	Left mouth corner
52	Right mouth corner
63,64	Eye centers

ndmark set includes squares representing the primary (first order) la
ed by red squares. Green dots the secondary (second order) landmarks, tot

Facial Recognition Assignment #3- Debriefing

1. Why are landmarkers different between peers?
2. What can hinder plotting landmarks?
3. How do computers plot landmarks?

Primary landmarks	
Number	Definition
16	Left eyebrow outer corner
19	Left eyebrow inner corner
22	Right eyebrow inner corner
25	Right eyebrow inner corner
28	Left eye outer corner
30	Left eye inner corner
32	Right eye inner corner
34	Right eye outer corner
41	Nose tip
46	Left mouth corner
52	Right mouth corner
63,64	Eye centers

ndmark set includes squares representing the primary (first order) la
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Facial Recognition Assignment #4

1. Introduce Computer Programming with Khan Academy
2. Sign in with School Google Account
3. Visit khanacademy.org/coaches
4. Class Code:
    a. 4th Period: 9X75UE
    b. 5th Period: U8UCHQ

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