

Screening for Acromegaly with Morphable Models

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In collaboration with

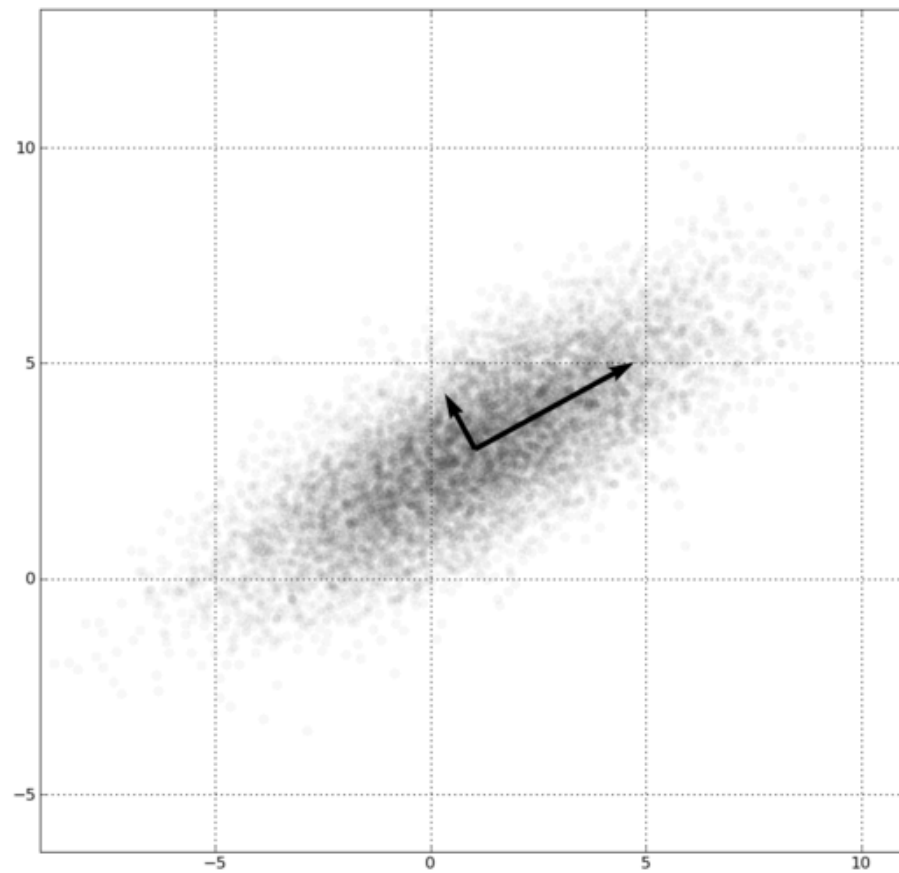
Ralph Miller (Univ. of Kentucky)

Volker Blanz (Max Planck)

Qifeng Lu (UMass, Amherst)

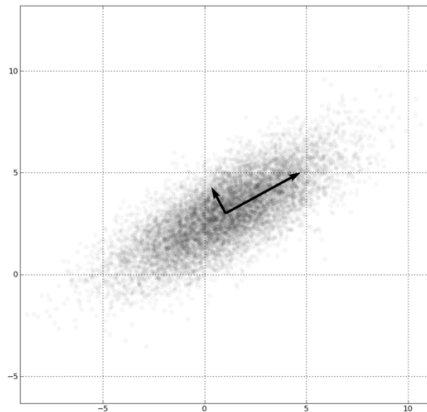
And others

Principal Components Analysis

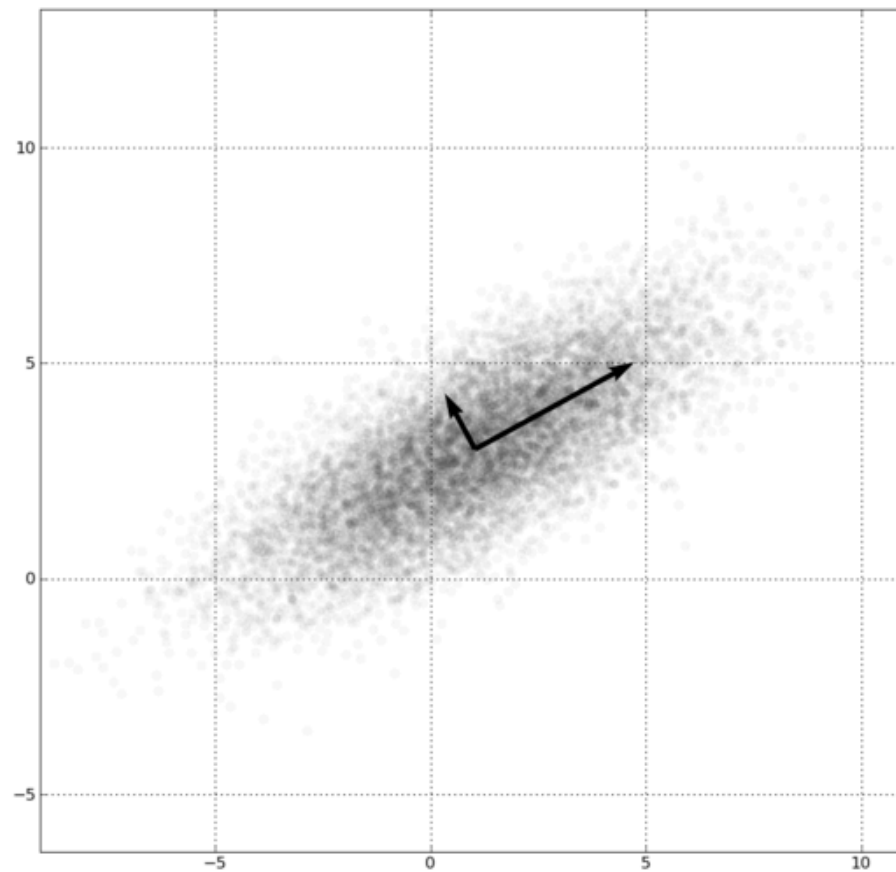


Principal Components Analysis

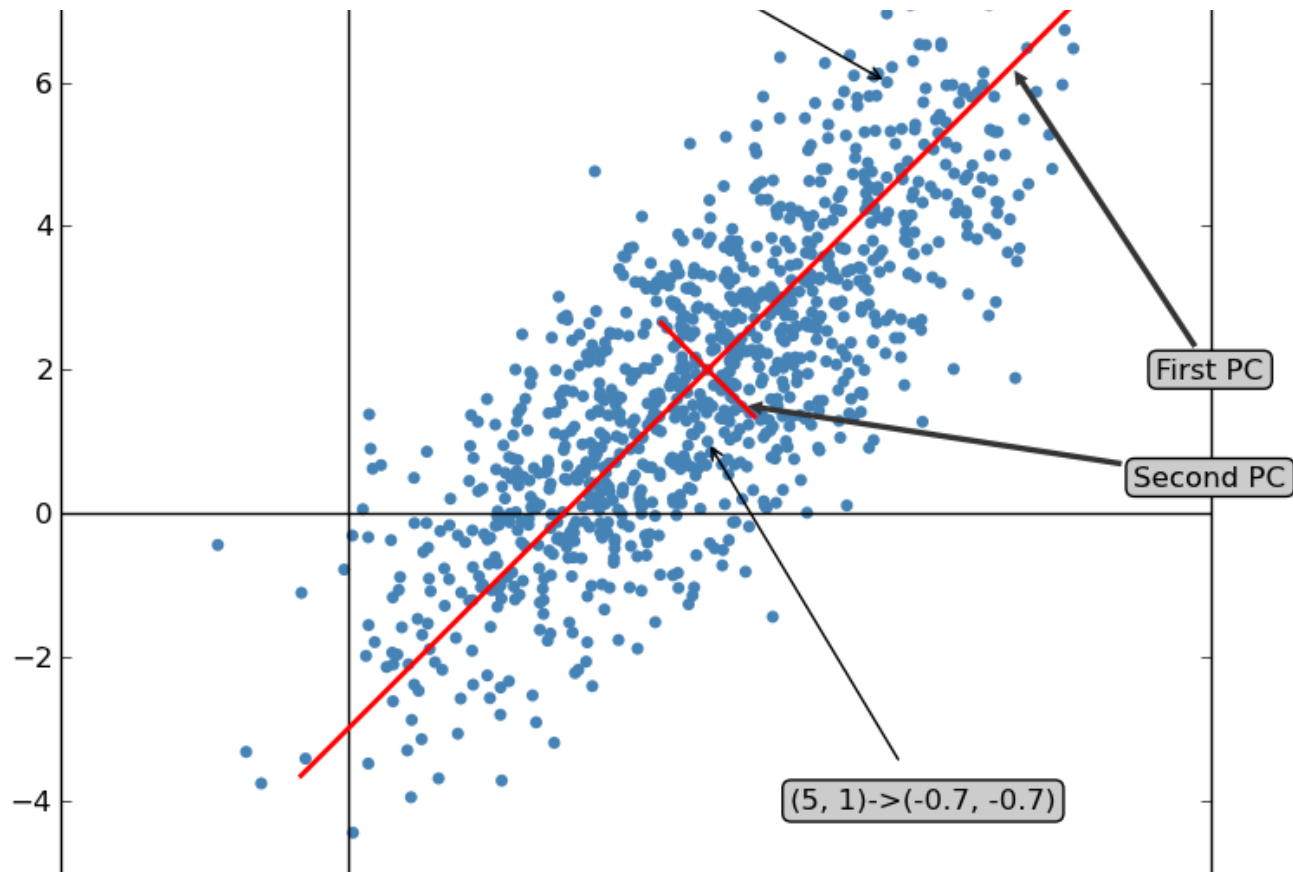
- 1st principal component
 - Direction of greatest variation of the data
 - Equivalently: Direction onto which projected points have least distance from original points



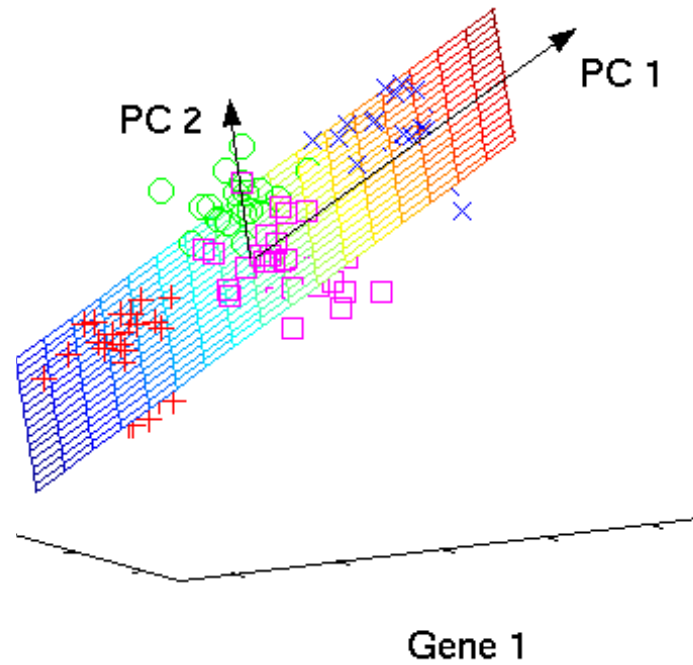
Principal Components Analysis



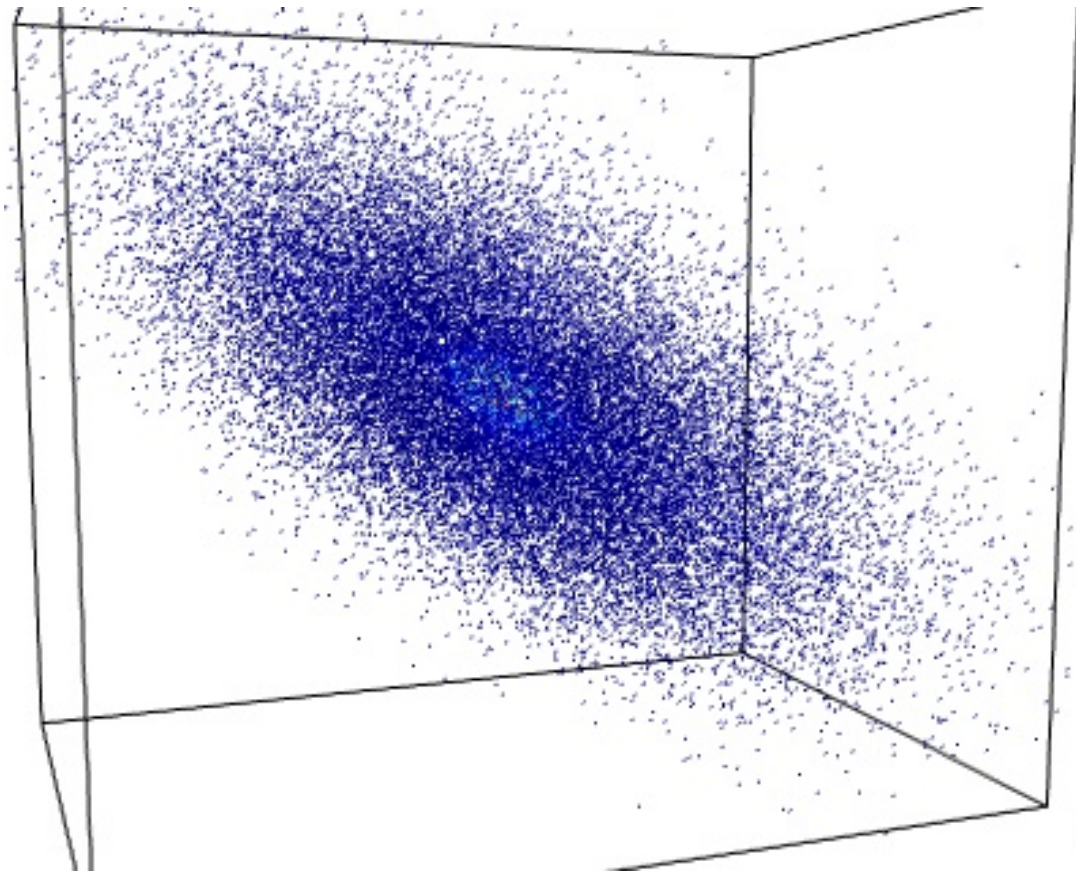
PCA



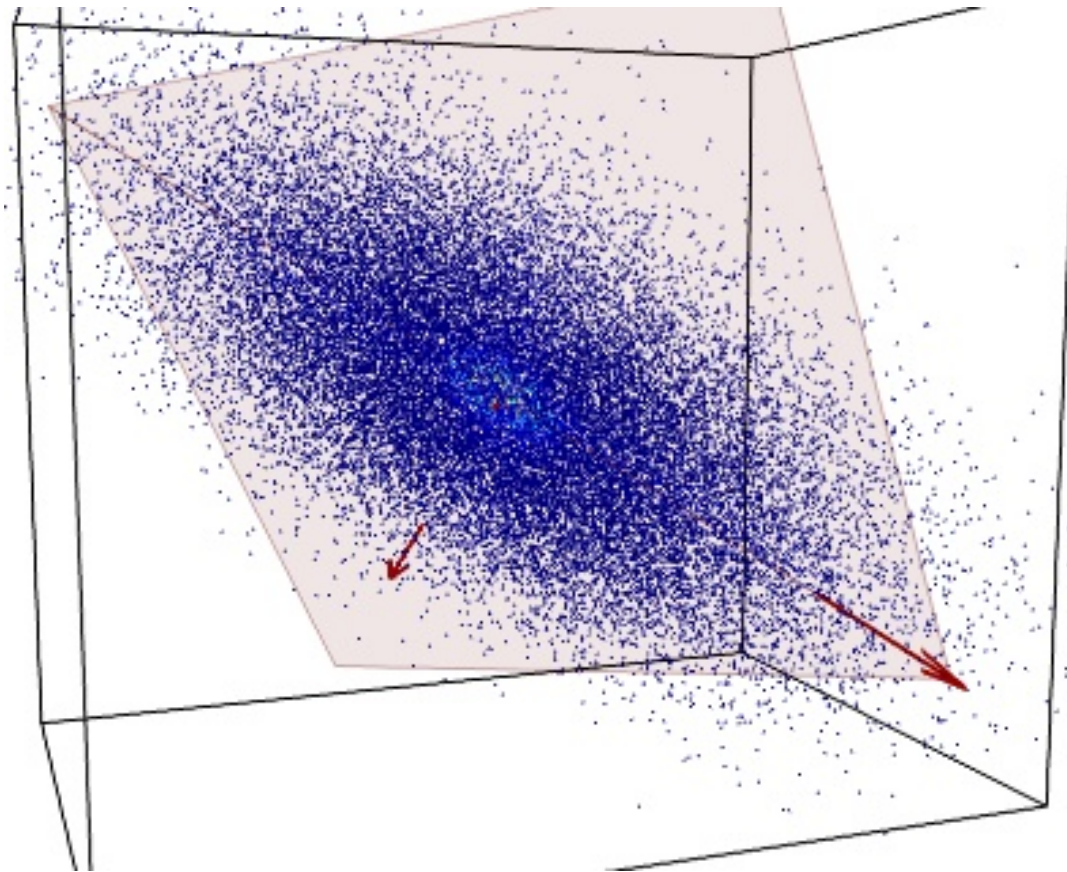
PCA in 3D

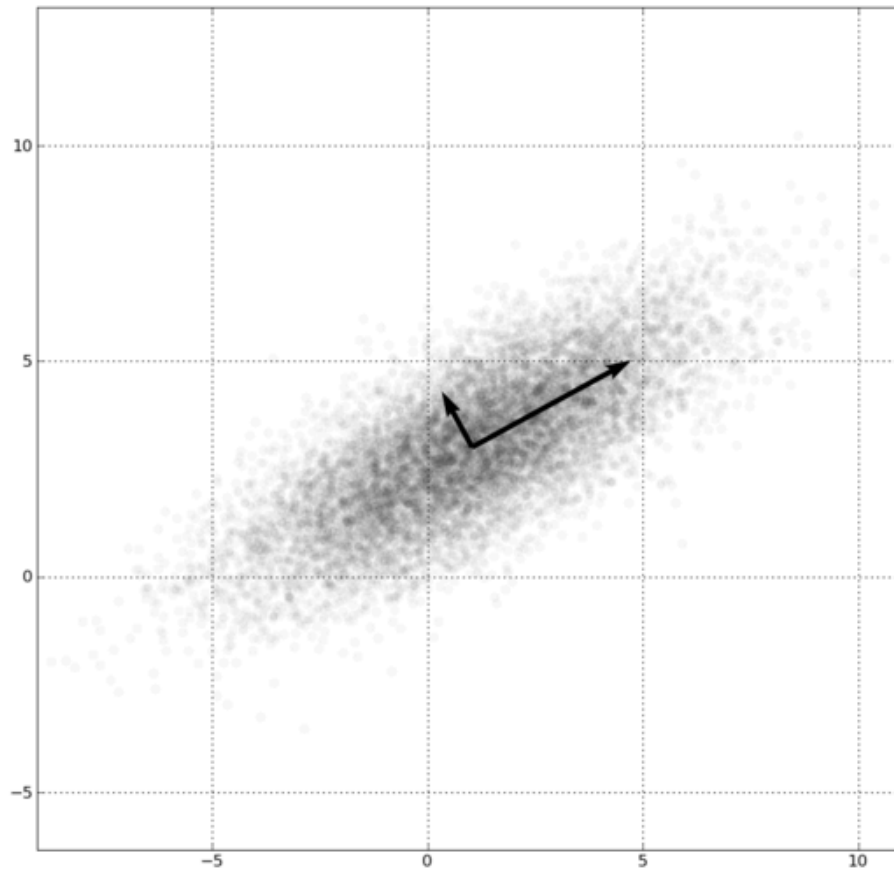


PCA 3d



PCA 3d





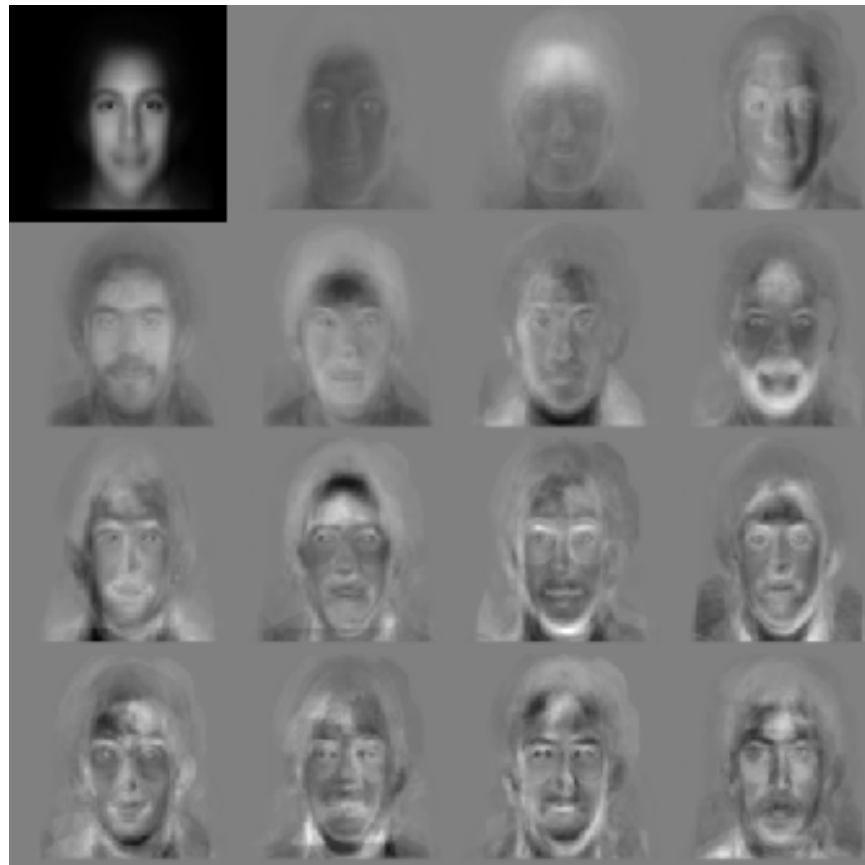
- To “add” the 1st PC to the mean, for each 2 units of f1, I add one unit of f2.

A Leap of Faith

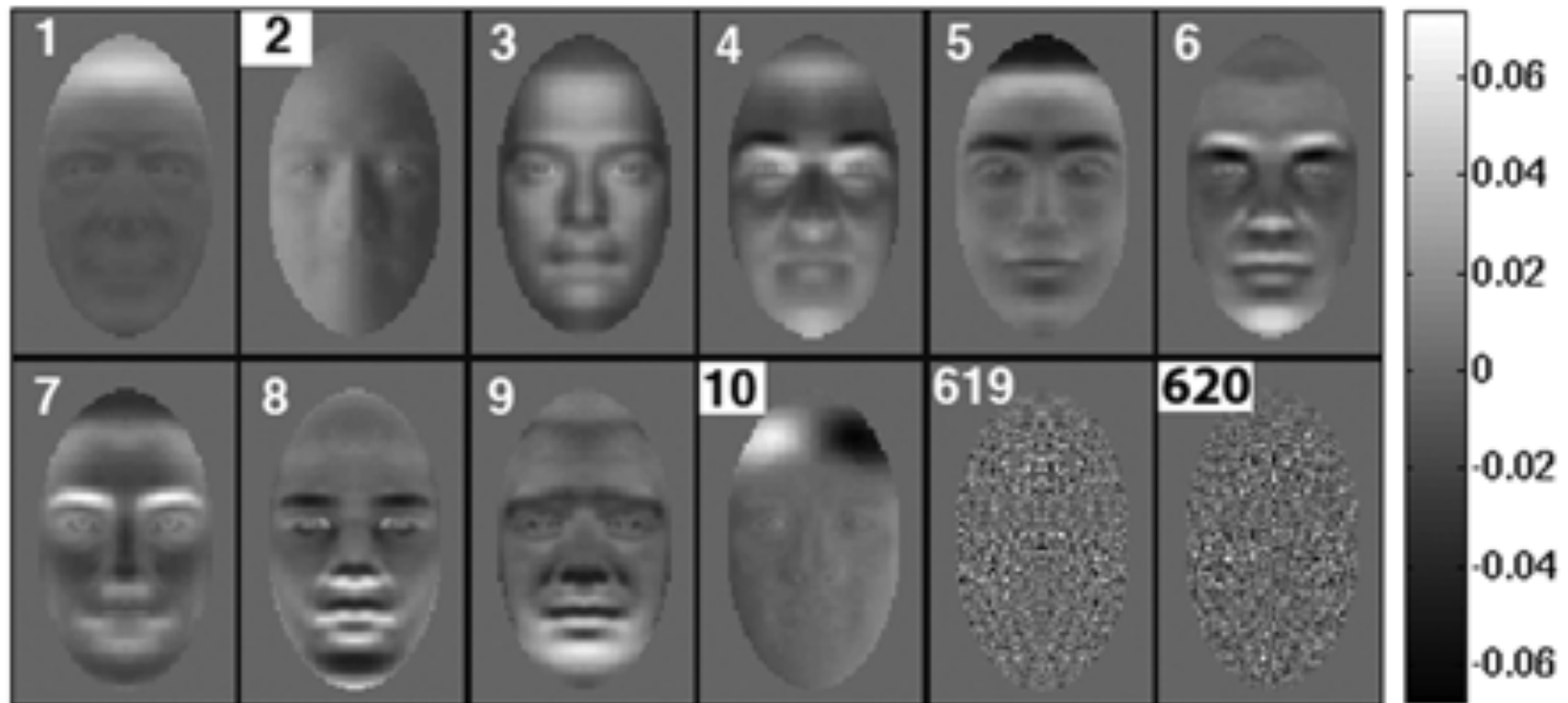
A “mean” face



PCA Faces

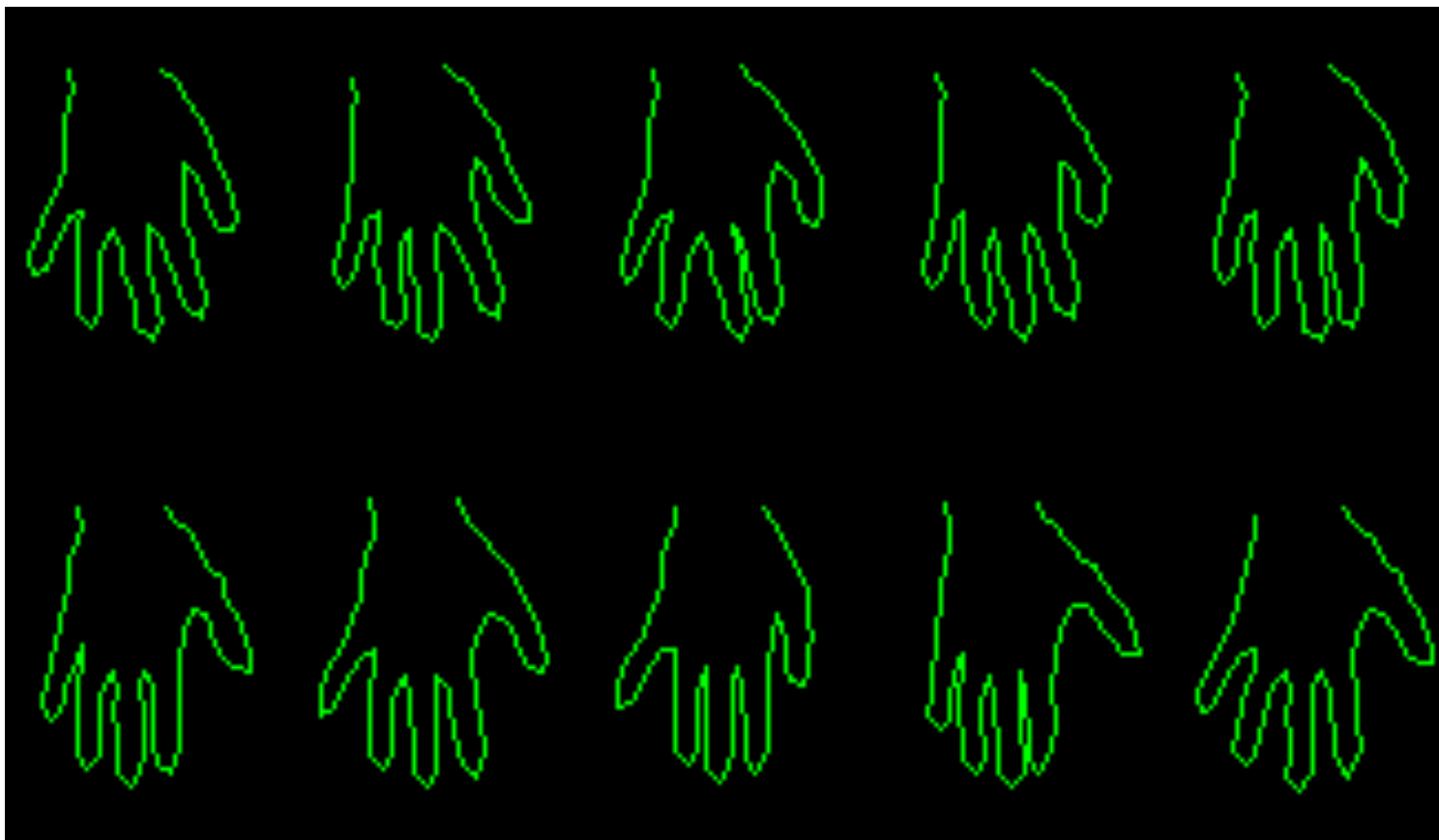


PCA for faces

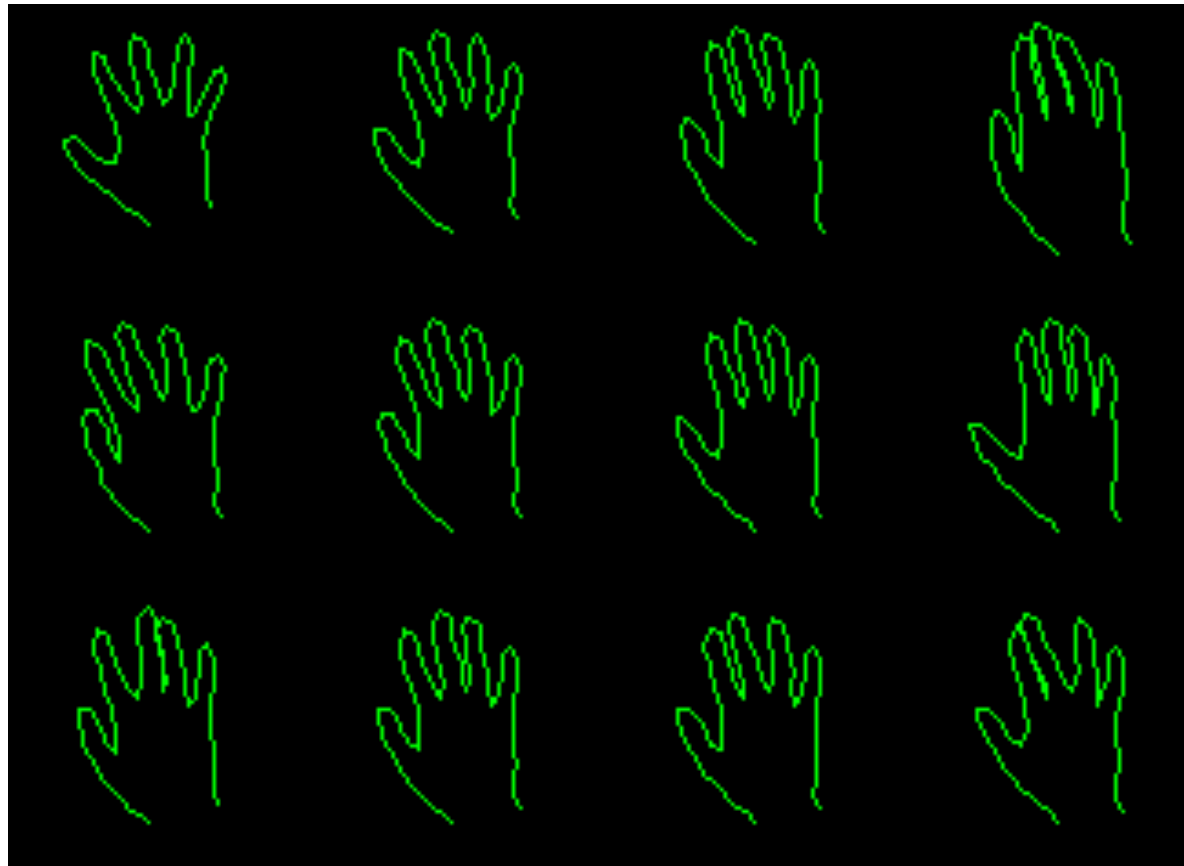


Another leap of faith

Active Shape Models: PCA on coordinates



Active Shape Models: PCA on coordinates



A critical distinction

- “Face PCA”: Treats the **brightness** of each pixel as a variable. Models how pixel brightness values change together.
- Active Shape Models: Treats the **location** of each hand feature (e.g. index fingertip) as a variable. Models how *locations* of features change together.

Morphable models

- Models both location of features **and** appearance given those locations *simultaneously*.
- *Stay tuned for awesome demo!*

Who's sick?



New England Journal of Medicine, 2004

Examples of Acromegaly





ACROMEGALY

Cushing: The pituitary body & its disorders



Before disease



Disease onset



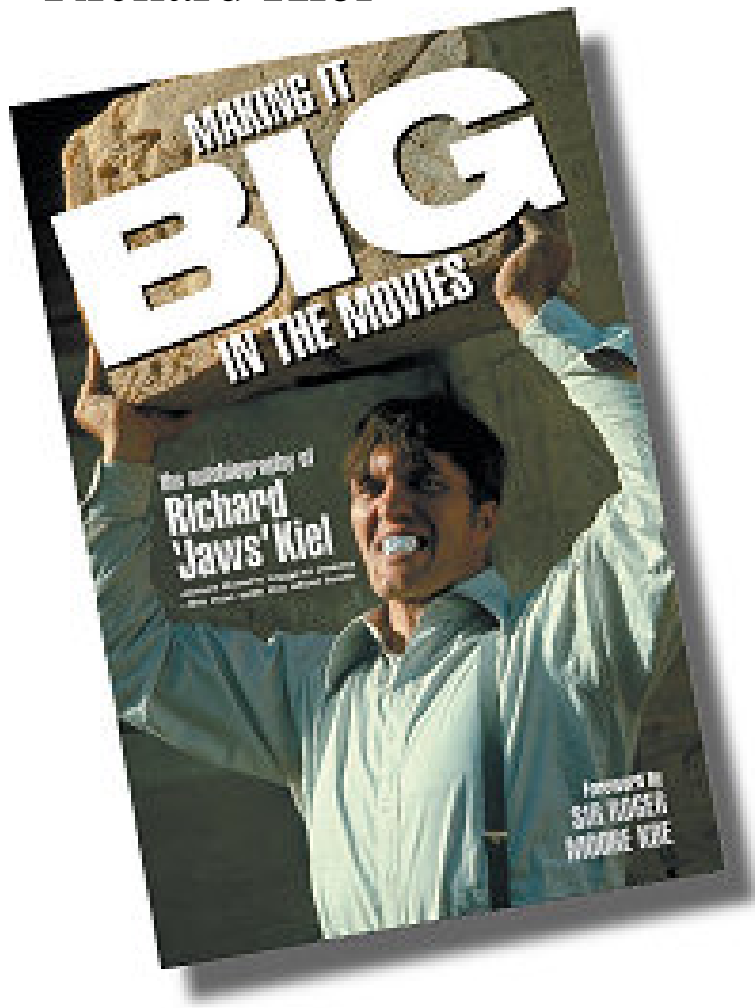
12 yrs of disease



17 yrs of disease

“Actor-megaly”

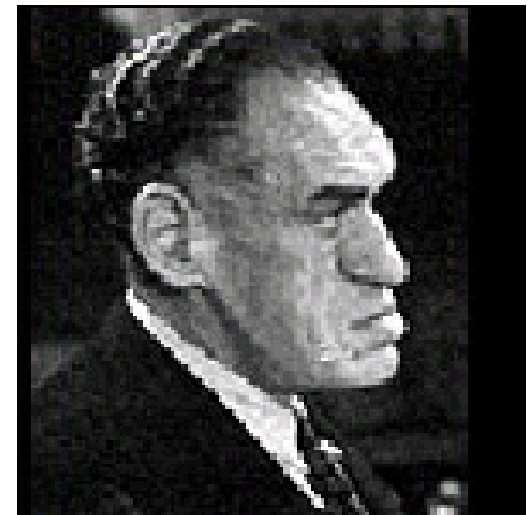
Richard Kiel



Andre the Giant



Rondo Hatton



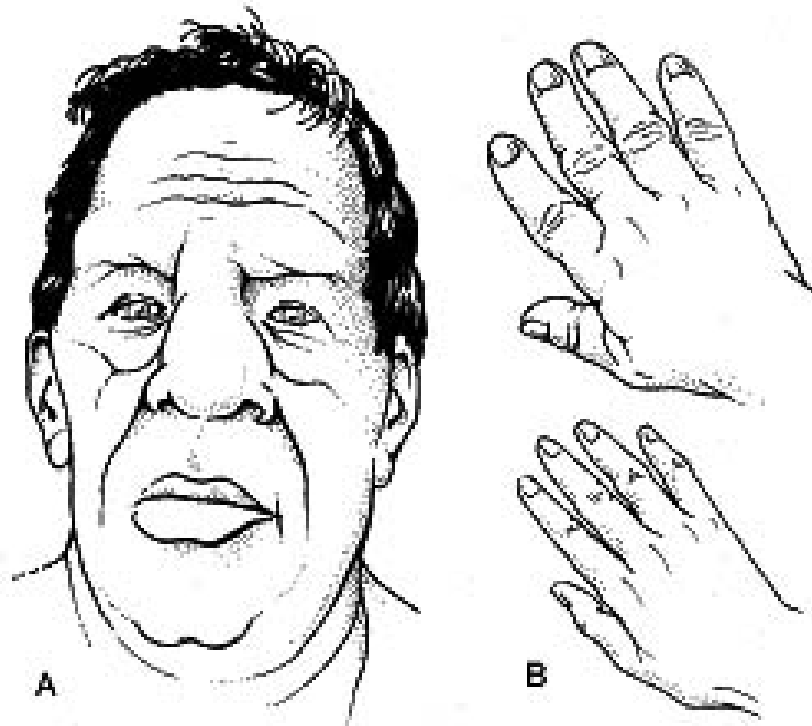
Dad' s Idea

- Assemble database of acromegalics and healthy subjects.
- Train classifier to distinguish between the two.
- Install classifier at Department of Motor Vehicles, and have voluntary screening system.

Remark

- Think carefully before agreeing to do research with a family member!

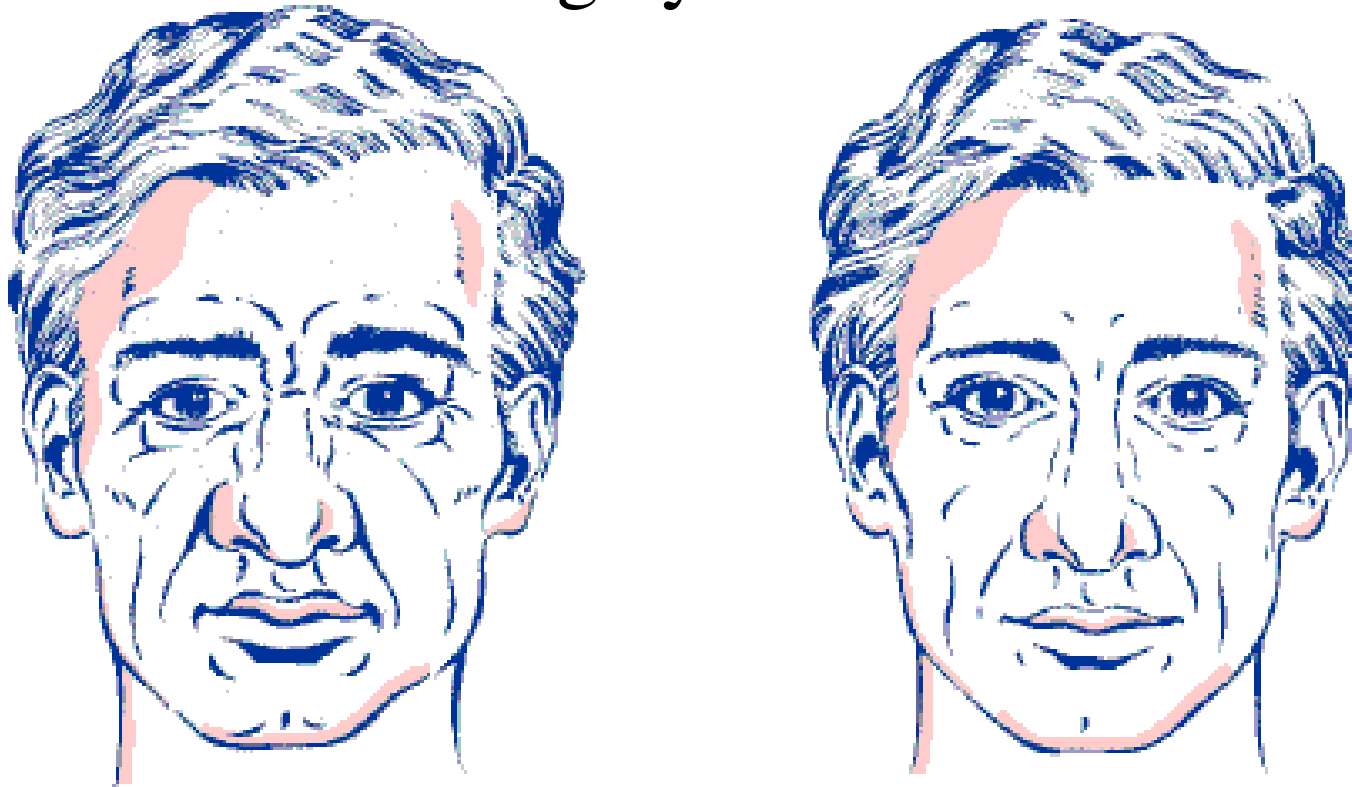
The Symptoms



[http://www.mercksource.com/ppdocs/us
/common/dorlands/dorland/images/fig_a_0012.jpg](http://www.mercksource.com/ppdocs/us/common/dorlands/dorland/images/fig_a_0012.jpg)

The Symptoms

Acromegaly vs. Normal



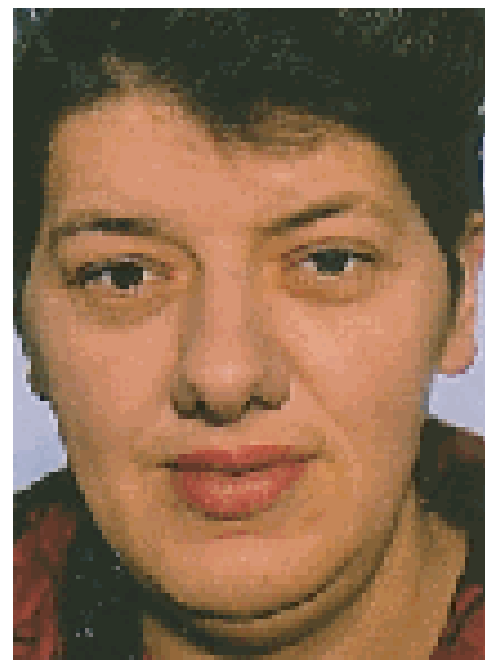
Typical facial features before and after treatment

<http://www.pituitary.org.uk/resources/images/acro-treat.gif>

Symptoms

- Swollen nose
- Nasiolabial folds
- Frontal bossing
- Pasty skin
- Big cheek bones
- Enlarged jaw
- Swollen lips
- Heavily asymmetric face
- Swollen tongue
- Separated eyes
- Bags under eyes
- Underbite
- Drooping eyelids
- Carpal Tunnel Syndrome!

More Examples



Acromegaly Database

- 42 patients and growing
 - largest database ever assembled
 - Dr. Peter Trainer, UK
- 50 normals
- Controlled conditions for photos
 - Lighting, pose, expression, background

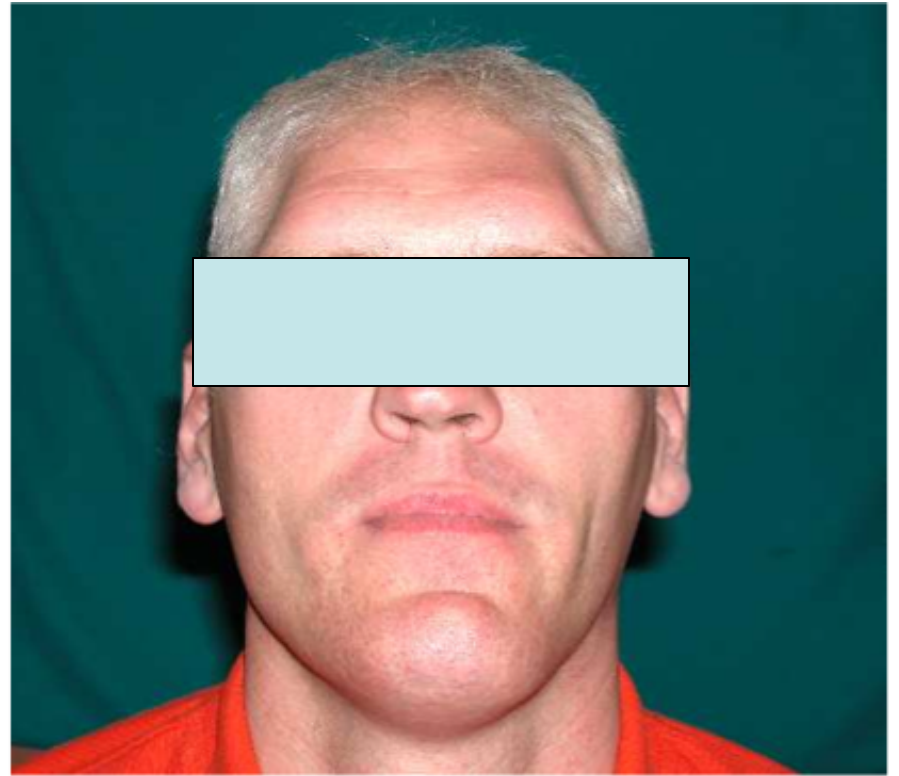
Mild Cases



Moderate Cases



Advanced Cases



Attempt 1

- Measure distances between facial landmarks
- Normalize by iris diameters
- Use binary classifier (SVM) to classify



Difficulties with Landmark Approach

- Common symptoms, such as swollen nose, not captured by landmarks
- Some landmarks not repeatable and hard to find automatically
- Low accuracy $\sim 65\text{-}70\%$, even with *manual* identification of landmarks

Approach #2

- Try to avoid my father
- Difficult due to family obligations, vacations, etc.

Approach #3

- A miracle occurs: Morphable Models (Blanz and Vetter)
- Linear statistical model of head shape, and “texture”
- Built with 200 3D laser scans of “normals”

A Morphable Model for the Synthesis of 3D Faces

Volker Blanz & Thomas Vetter

MPI for Biological Cybernetics
Tübingen, Germany

The Solution

- Using analysis by synthesis, can infer shape of acromegalic's head!
- Idea: Use parameters of morphable model to classify patients. (linear SVM)
- Accuracy way up: 80.0%

An Additional Improvement

- Use models fit to particular parts of face, such as nose and jaw
- Accuracy goes up to 85.7%.

Misclassified Faces



Back to the twins



Models estimated for twins



Classifications (Woohoo!)

Acromegalic



Normal

