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# JS165

## Forensic Biometrics

### Class 1: Introduction

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# Outline of this Lecture

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## Introduction and terminology

- The problematic unity of “biometrics”
- A working definition for use in this class
- Some historical notes
- The tension between “Forensics” and “Science”
- Forensic admissibility
- The question of identity
- The difficulty of individualization/individuation

# The problematic unity

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- Our modern subject of biometry is amazingly diverse; so much so that the question could be raised as to whether or not it has sufficient unity to constitute a single discipline -- Stigler, S. M. (2000). The problematic unity of biometrics. *Biometrics*, 56, 653-658.
- “the application to biology of the modern methods of statistics” – Sir Francis Galton, *Biometrika* (1901)

# Editorial ,“The Spirit of Biometrika” (1901)



- It is almost impossible to study any type of life without being impressed by the small importance of the individual... Evolution must depend upon substantial changes in considerable numbers and its theory therefore belongs to that class of phenomena which statisticians have grown accustomed to refer to as mass-phenomena...we recognise that the problem of evolution is a problem in statistics, in the vital statistics of populations.”
- **THIS IS NOT OUR APPROACH!**

## Some other approaches

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- “Biometry, the active pursuit of biological knowledge by quantitative methods” – R.A. Fisher, *Biometrics*, 1948
- “The field concerns itself with using fingerprints, voice patterns or other physiological traits to verify a person’s identity” -- New York Times, 9/24/81
- "Biometric technologies are automated methods of verifying or recognizing the identity of a living person based on a physical or behavioral characteristic“ – Ben Miller, *Biometric Industry Sourcebook*, 1989
- “the automated recognition of individuals based on their biological and behavioral characteristics” -- ISO/IEC JTC1 SC37 “Standards Committee on Biometrics”



# A Proposed Definition for this Course

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- Biometrics – technical approaches to individualization/individuation of persons using biological and behavioral characteristics
- NOT INCLUDED IN THIS DEFINITION
  - Deception
  - Intent
  - Personality analysis
  - Identity

# The Historical Need for Individualization

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- England pre-1834 – “The Bloody Code”
- England 1830 – 1853 Australian exile
- 1844 – Bonneville, De la Recidive
  - Punishment = perversity of the delinquent
- 1853 – Penal Servitude Act
  - Parole
- 1869 – Habitual Criminals Act

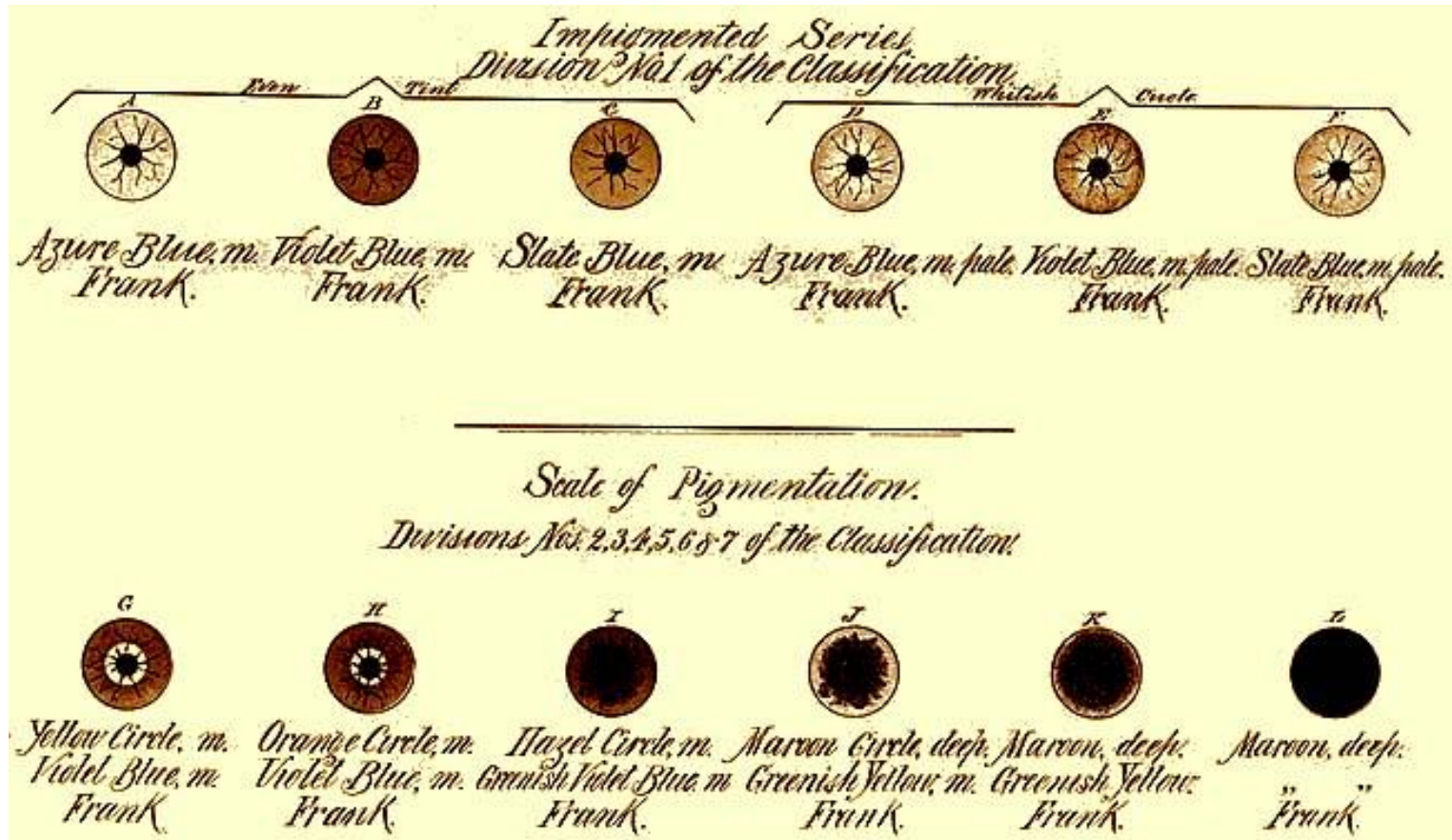
# Modern History of Anthropometric Recognition

- Bertillon -- 1880





# Bertillon on Iris Distinctiveness



# Bertillon



San José State  
UNIVERSITY

UNITED STATES PENITENTIARY, ATLANTA, GA.

Name John Arnold Reg. No. 1035 Color White

Aliases Ben Kilpatrick, J. H. Rose, Harry Alonzo, Etal

Crime Forgery (U. S. Bonds) Sentence 15 yrs — mo — days

Date of Sentence Dec. 17-1900 Date of Reception Mar. 25-1905

Sent from Ca term District of Mo (St Louis)

Good conduct time expires June 11<sup>th</sup> 1911


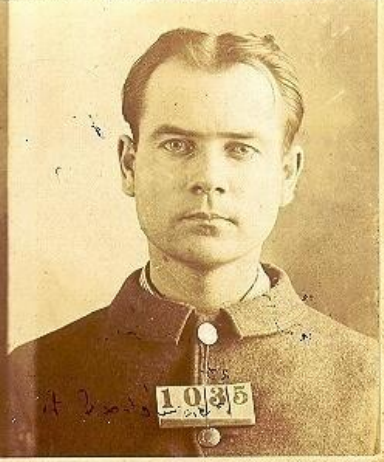
Criminal History One of the Harvey Logan gang of train robbers

Residence (Home) Claims none (Transferred from O.S.P. 3-25-05)

| ORDER | SCARS, MARKS, MOLES, ETC.   |
|-------|---|
| I     | Sm nr @ 11 ~ ab. e. Vac of 3.4 X 3.5 @ 10 ~ ab. e. Sm nr @ 10 ~ ab. e. Wn of 1 X 1.2 @ 11 ~ ab. e. Wn ind. sc of 4 from Pt + 9 ~ remaining to pg. e. r. sc of 3.2 X 2 @ 1 ph. M. a. Pit. sc (white) at 3 j. P > + e.        |
| II    | Sm hr. nr @ 3.5 ~ ab. e. Sm hr. nr @ 6 ~ ab. e. Sm hr. nr @ 13 ~ ab. d. Sm hr. nr @ 11.5 ~ pge. Hor scar of 2.2 @ 7 ~ ab. i.  |
| III   | r. sc of 2.5 X 2 @ 5.5 ~ e. f. sc. Pit. sc (white) @ 1.2 ~ m. of R. arc. 12 white sc. of 1.6 @ 3 ~ m. R. eye. Hr. nr @ 4 ~ + 4 ~ of R. lobe nr. of 7 X 9 @ 6.5 ~ R. lobe 5 from mid. Pit. sc on L. lower. max. 8. from mid. |
| IV    | Sm nr @ 6 ~ incl 5 to L. of mid.  |
| V     | Sm nr @ 15 ~ 7% of 2.5 to left of elm. Hr. nr. of 3 X 5 @ 5 ~ left buttock 1.6 L. of elm. Hor sc of 1 at small of back at elm.  |

|         |                  |            |              |         |             |              |               |              |                 |
|---------|------------------|------------|--------------|---------|-------------|--------------|---------------|--------------|-----------------|
| Height  | 1 m. <u>81.3</u> | Head lgth  | <u>19.5</u>  | L Foot  | <u>27.2</u> | Class        | <u>2</u>      | Age          | <u>30</u>       |
| Eng Hgt | <u>5-11 3/8</u>  | Head wth   | <u>15.7+</u> | L Mid F | <u>12.0</u> | Color L. Eye | <u>2</u>      | Apparent Age | <u>25</u>       |
| Out A.  | 1 m. <u>75.0</u> | Cheek wth  | <u>14.6+</u> | L Lit F | <u>8.8</u>  | Periph       | <u>violet</u> | Nativity     | <u>Texas</u>    |
| Trunk   | <u>97.3</u>      | R Ear lgth | <u>6.7</u>   | L Cubit | <u>48.0</u> | Pecul.       |               | Occupation   | <u>Merchant</u> |

Remarks relative to Measurements.

|        |              |         |            |                   |         |                |            |                |        |                |
|--------|--------------|---------|------------|-------------------|---------|----------------|------------|----------------|--------|----------------|
| Inc.   | <u>vor</u>   | Profile | Bridge     | <u>rec (hump)</u> | Sup Bor | <u>f. i.</u>   | Hair       | <u>ch. not</u> | Beard  | <u>ch. and</u> |
| Hght   | <u>m. g.</u> | Base    | Root       | <u>m. g.</u>      | Pos Bor | <u>f. i.</u>   | Complexion | <u>Ruddy</u>   | Weight | <u>160 lbs</u> |
| Width  | <u>m. g.</u> | Height  | Projection | <u>m. g.</u>      | Lobe    | <u>f. i.</u>   | Teeth      | <u>m. ball</u> | Build  | <u>m.</u>      |
| Pecul. |              | Pecul.  |            |                   | Chin    | <u>m. ball</u> |            |                |        |                |

Examined March 29<sup>th</sup> 1905

By J. M. Nye

# Fingerprinting

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- Faulds, Herschel -- 1880
- Galton, “Personal ID and Description” -- 1888
- Vucetich -- 1891
- Galton, Fingerprints, 1892
- Twain, Life on the Mississippi, Pudd’nhead Wilson 1892





# Galton's Criticism of Bertillon

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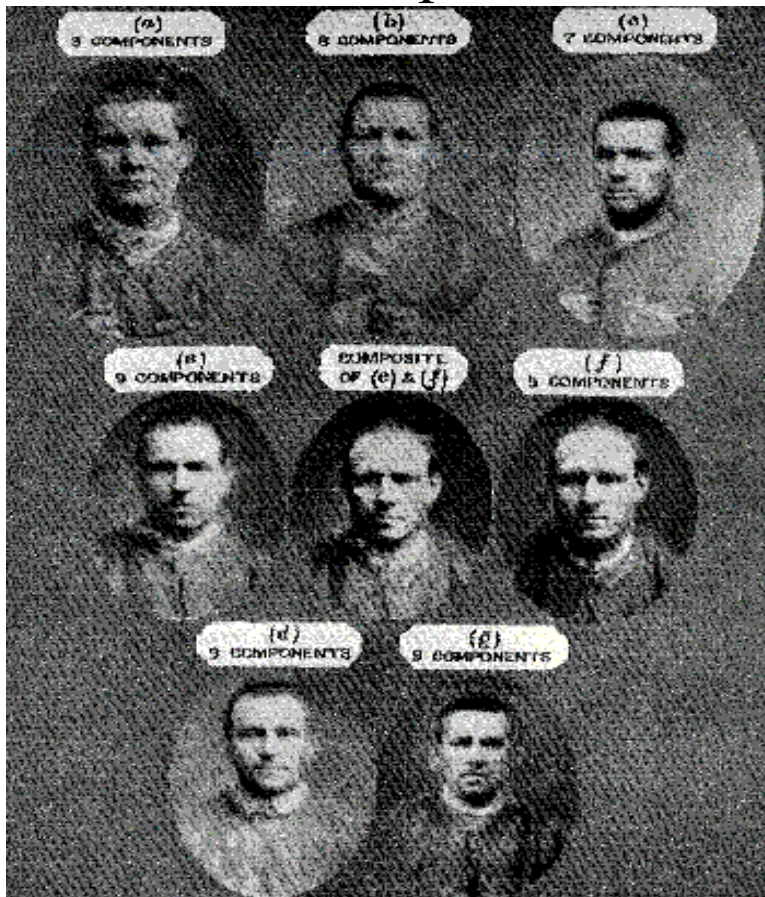
There was...a want of fulness in the published accounts of it, while the principle upon which extraordinary large statistical claims to its quasi-certainty had been founded were manifestly incorrect, so further information was desirable. The incorrectness lay in treating the measures of different dimensions of the same person as if they were *independent* variables, which they are not. For example, a tall man is much more likely to have a long arm, foot, or finger, than a short one. The chances against mistake have been overrated enormously owing to this error; still, the system was most ingenious and very interesting. Galton, *Memories of My Life* (1908), p. 251.

# Historical Excesses



(See S.J. Gould, The Mismeasure of Man (Norton, 1981))

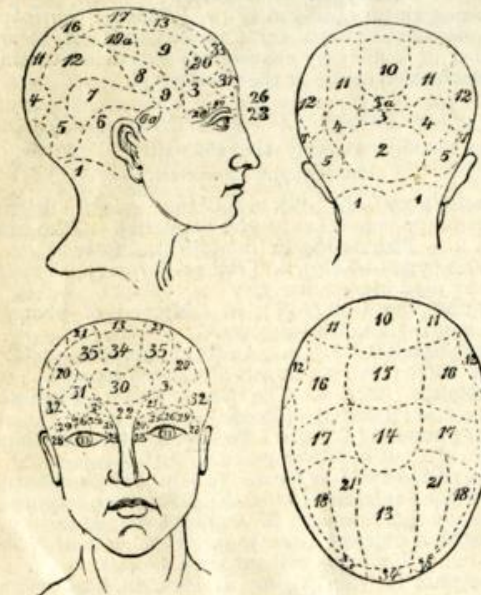
## Galton's composites



24 August, 2011

## Phrenology

**Phre-nol'o-gy** (-nól'ô-jÿ), *n.* [Gr. φρήν, φρενός + -logy.] **1.** Science of the special functions of the several parts of the brain, or of the supposed connection between the faculties of the mind and organs in the brain. **2.** Physiological hypothesis that mental faculties, and traits of character, are shown on the surface of the head or skull; craniology. — **Phre-nol'o-gist**, *n.* — **Phren'o-log'ic** (frén'ô-lôj'ik), **Phren'o-log'ic-al**, *a.*



A Chart of Phrenology.

**1** Amativeness · **2** Philoprogenitiveness · **3** Concentrativeness · **3 a** Inhabitiveness · **4** Adhesiveness · **5** Combaticiveness · **6** Destructiveness · **6 a** Alimentiveness · **7** Secretiveness · **8** Acquisitiveness · **9** Constructiveness · **10** Self-esteem · **11** Love of Approbation · **12** Cautiousness · **13** Benevolence · **14** Veneration · **15** Firmness · **16** Conscientiousness · **17** Hope · **18** Wonder · **19** Ideality · **19 a** (Not determined) · **20** Wit · **21** Imitation · **22** Individuality · **23** Form · **24** Size · **25** Weight · **26** Coloring · **27** Locality · **28** Number · **29** Order · **30** Eventuality · **31** Time · **32** Tune · **33** Language · **34** Comparison · **35** Causality. [Some raise the number of organs to forty-three.]

JS165

# Forensics

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- “Belonging to courts of justice” – Black’s Law Dictionary
- Does “forensic” include investigations?
- Fourth Amendment of the U.S. Constitution
  - The right of the people to be secure in their persons, houses, papers, and effects, against unreasonable searches and seizures, shall not be violated, and no Warrants shall issue, but upon probable cause, supported by Oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized
- Should this course be “Forensic and Investigatory” biometrics?



# Science: The “demarcation” problem

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1. The epistemology of science is empiricism
2. Critical (and self-critical) social structure
3. Science is primarily inductive, arguing from specific data to “universal” principles or laws.
  - Induction: one white swan, two white swans,.. “All swans (everywhere) (forever) are white”
  - John Latham discovers Australian black swans (1790)
  - So scientific theories and laws are always open to revision

Math is deductive, arguing from “self evident” postulates to specific examples.

- Allows logical proofs given truth of postulates

# Value Differences Make for Strange Bedfellows

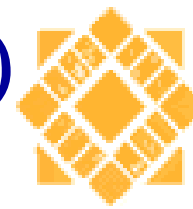


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- Values in Science
    - Accuracy, Consistency, Scope, Simplicity, Fruitfulness – Kuhn(1973)
    - The role of science is to create models of predictive and explanatory value -  
- Achinstein (1994)
    - All models are wrong. Some models are useful – George Box (1979)
    - Probabilistic reasoning and Bayesian priors
  - Values in the courts (references???)
    - Speed
    - Fairness
    - Presumed innocence
    - Transparency
    - Criminal decision threshold: “beyond reasonable doubt”

# Forensic (not investigatory!) Admissibility

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## Frye v. United States (D.C. Cir. 1923)

- sufficiently established to have gained general acceptance in the particular field in which it belongs

## Daubert v. Merrill Dow Pharmaceutical (U.S. 1993)

Testimony admissible as “scientific” if:

- Theory or technique has or can be tested
- Subjected to peer review and publication
- Existence and maintenance of standards for use
- General acceptance in scientific community
- Known potential rate of error

# Extended to all Expert Testimony

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## Kumho Tire Co. v. Carmichael (U.S., 1999)

- The initial question before us is whether this basic gatekeeping obligation applies only to "scientific" testimony or to all expert testimony. We, like the parties, believe that it applies to all expert testimony...
- (Daubert) made clear that its list of factors was meant to be helpful, not definitive. Indeed, those factors do not all necessarily apply even in every instance in which the reliability of scientific testimony is challenged

See Mnookin, et al, The need for a research culture in the forensic sciences. *UCLA Law Review*, 725, 2011



# The Question of “Identity”

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- Who am I? Who are you?
- Historical question in philosophy
  - Martin, R. & Barresi, J. (2003). *Personal identity*. Hoboken, NJ: Blackwell-Wiley.
- Certainly, this can't mean a personal name!

# “Identity” for Our Purposes

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- An incomplete list of attributes for a natural “person”
- S. Kent and L. Millett, “Who Goes There? Authentication Technologies Through the Lens of Privacy”, National Academies of Science Press, 2003, [www7.nationalacademies.org/cstb/pub\\_authentication.html](http://www7.nationalacademies.org/cstb/pub_authentication.html)
- A person will have multiple records across different systems
- A biometric characteristic can be an attribute or (if distinctive enough) as a pointer to an attribute record
- A biometric characteristic can allow:
  - linking of records across systems
  - linking bodies to single records



# Individualization by Biometrics

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- Recognize “me” by inspecting my body
- Define “me” by my body
- “Derived” recognition – indirect through the body
- This discomfort articulated as “invading my privacy”

# Inherent Challenges of Individualization

- Between-class variation  
(Distinctiveness)

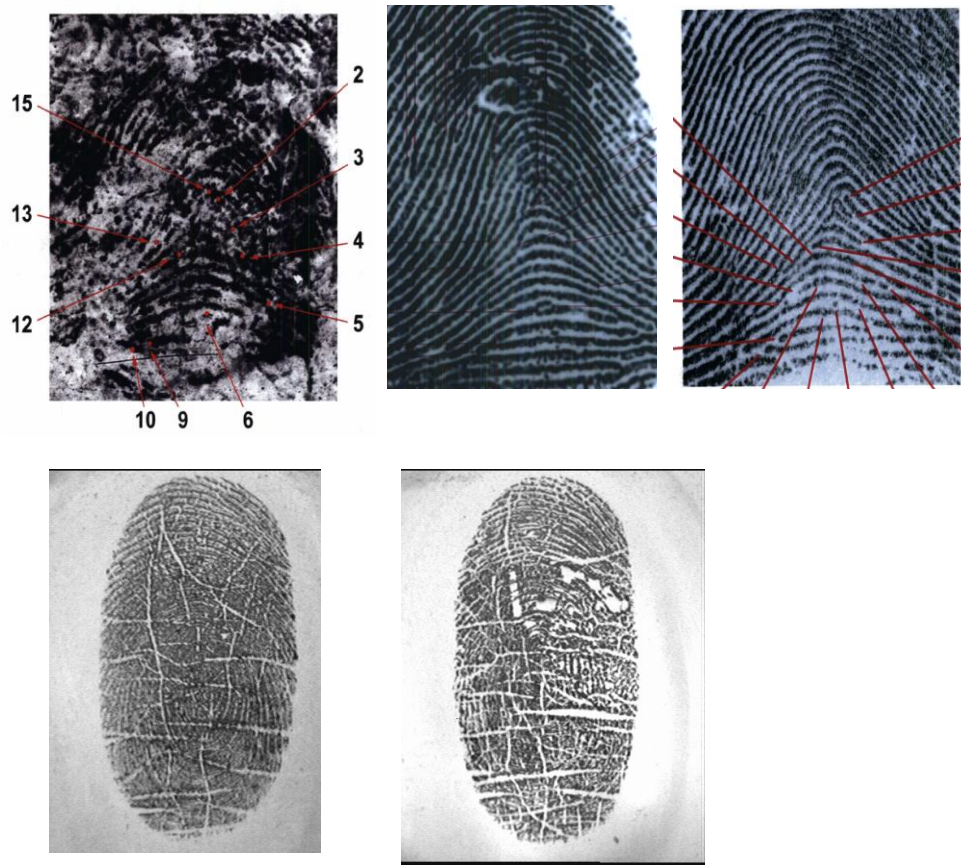
Mayfield – Doude  
confusion

[www.usdoj.gov/oig/special/s0601/PDF\\_list.htm](http://www.usdoj.gov/oig/special/s0601/PDF_list.htm)

- Within-class variation  
(Stability)

FIGURE 6A

Level 2 Details Used To Identify Mayfield Also Used To Identify  
Daoud (LFP 17)



# Fundamental Errors

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- False positives
  - False matches
- False negatives
  - False non-matches
- Error rates alone do not predict of number of errors
- An error can only occur when there is the opportunity
  - False positives require non-mated comparisons
  - False negatives require mated comparisons
- If mated comparisons dominate, false negatives are the problem
- If non-mated comparisons dominate, false positives are the problem

# Summary

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- Many possible definitions of “biometrics”
  - For our uses, “technical approaches to individualization/individuation of persons using biological and behavioral characteristics”
- Bertillon, Galton and the modern history of biometrics in our sense
- Forensic and investigatory are different
- Defining “Science” is difficult
  - 3 distinctives: empiricism, critical social community, the uncertainties of induction

# Summary

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- A natural tension between forensics and science.
- “Identity” is a philosophical question of great historical significance.
  - For our uses, “an incomplete list of attributes of a natural person”
- Individualization is made difficult by within-class variation and between-class lack of variation
- False positive and false negative errors depend upon error rates AND prevalence of mated/non-mated comparisons



## Suggested Readings for This Week

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- Mnookin, J., Cole, S., Dror, I., Fisher, B., Houck, M., Inman, K., ... Stoney, D. (2011), The need for a research culture in the forensic sciences. *UCLA Law Review*, 725. [pulse.law.ucla.edu/.../mnookin-et-al-pulse-uclaw-need-for-research-culture-2011.pdf](http://pulse.law.ucla.edu/.../mnookin-et-al-pulse-uclaw-need-for-research-culture-2011.pdf)
- Stigler, S. M. (2000). The problematic unity of biometrics. *Biometrics*, 56, 653-658.