

# Transforming DNA Evidence into Reliable Information: Computers, Science and Society

Pathology Informatics Summit  
Association for Pathology Informatics  
May, 2017  
Pittsburgh, PA

Mark W Perlin, PhD, MD, PhD  
Cybergenetics, Pittsburgh, PA



Cybergenetics

Cybergenetics © 2003-2017

---

---

---

---

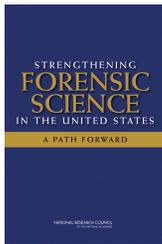
---

---

---

---

## National Academy of Sciences



Trouble in River City  
2009

Where's the  
"science" in  
Forensic Science?

---

---

---

---

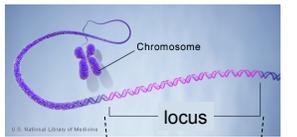
---

---

---

---

## DNA genotype



mother allele



father allele



A genetic locus has two DNA sentences, one from each parent.  
An **allele** is the number of repeated words.  
A **genotype** at a locus is a pair of alleles.  
**10, 12**  
Many alleles allow for many many allele pairs. A person's genotype is relatively unique.

---

---

---

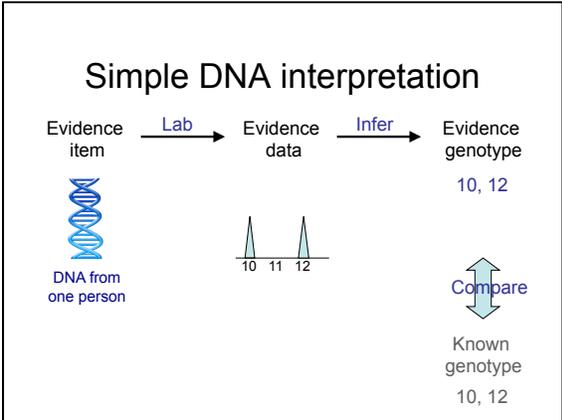
---

---

---

---

---




---

---

---

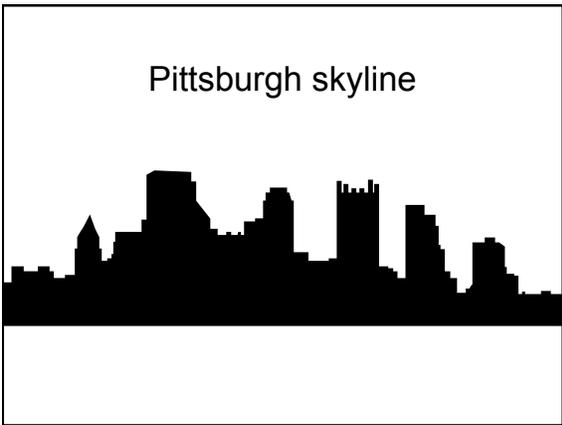
---

---

---

---

---




---

---

---

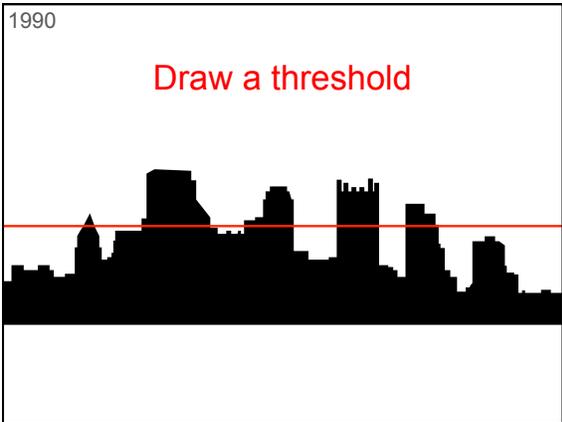
---

---

---

---

---




---

---

---

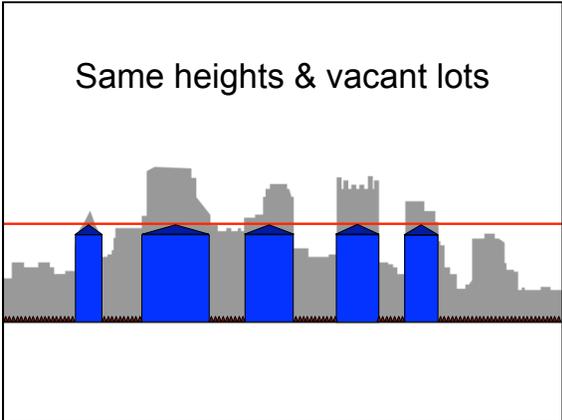
---

---

---

---

---




---

---

---

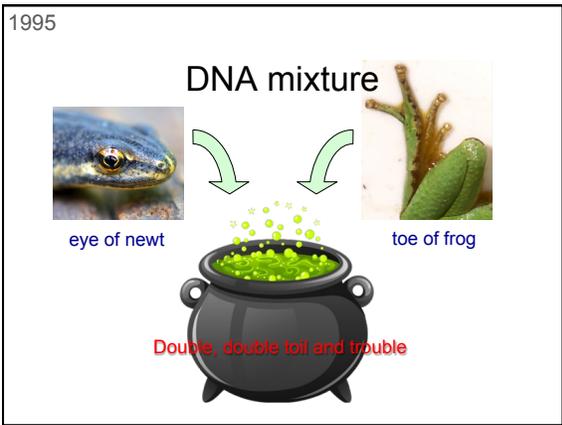
---

---

---

---

---




---

---

---

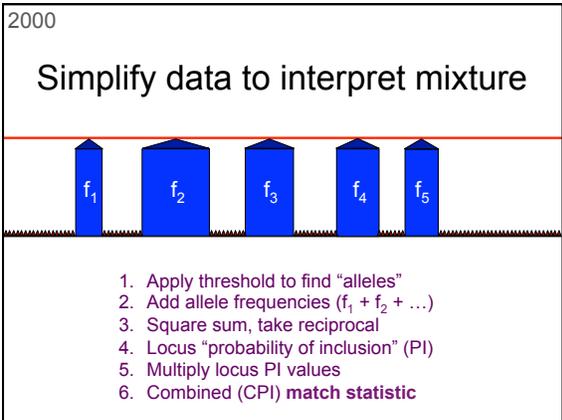
---

---

---

---

---




---

---

---

---

---

---

---

---

2005

## Unreliable DNA mixture statistics

NIST (Commerce Department) study in 2005  
Two contributor mixture data, known victim

Some Differences in Reporting Statistics		Case 1			
LabID	Kits Used	Caucasians	African-Americans	Hispanics	Others
30	ProPlus/Cofiler	1.18E+15	2.19E+14	3.09E+15	1.18E+15
34	ProPlus/Cofiler	2.40E+11	7.86E+07	9.93E+10	2.40E+11
33	ProPlus/Cofiler	2.94E+08	1.12E+08	1.74E+09	2.94E+08
6	ProPlus/Cofiler	40,000,000	3,500,000	280,000,000	40,000,000
9	ProPlus/Cofiler	1.14E+07	1.97E+07	1.54E+09	1.14E+07
79	ProPlus/Cofiler	930,000	47,300	1,350,000	930,000
16	ProPlus/Cofiler	434,000	31,710	399,100	434,000

Remember that these labs are interpreting the same MIX05 electropherograms

When not "inconclusive":  
213 trillion (14)  
31 thousand (4)

Forensic DNA labs put on notice ten years ago

---

---

---

---

---

---

---

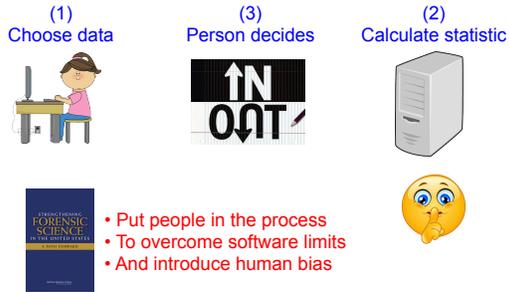
---

---

---

2010

## Biased DNA workflow




---

---

---

---

---

---

---

---

---

---

2015

## Falsely identify innocent people

# Labs	Report Conclusions	Reasons given
6	Exclude Suspect C	detailed genotype checks (D+); True/False negative LFs (D+); assumed major/minor and suspects did not fit (D+); 3 labs noted Penta E missing allele 15 (PP16HS)
3	Inconclusive with C only (A & B included)	All these labs used PP16HS
21	Inconclusive for A, B, and C	
70	Include & provide CPI statistics	All over the road...

Range of CPI stats for Caucasian population:  
FBI allele frequencies: 1 in 9 to 1 in 344,000

---

---

---

---

---

---

---

---

---

---

## Mixture statistics shut down labs

"National accreditation board suspends all DNA testing at D.C. crime lab"  
*The Washington Post* April 27, 2015  
Did not comply with FBI standards

"New protocol leads to reviews of 'mixed DNA' evidence"  
*The Texas Tribune* September 12, 2015  
24,468 lab tests affected

---

---

---

---

---

---

---

---

## Statistics lack scientific basis

Misled courts for 15 years on countless DNA mixtures

**J Pathol Inform**

Editor-in-Chief: Andrew P. Freeman, PhD  
Associate Editor: Mark William Perlin, PhD  
For author instructions visit: [www.jpatholinformatics.org/submitmanuscript.asp](http://www.jpatholinformatics.org/submitmanuscript.asp)

OPEN ACCESS  
HTML format

Research Article

**Inclusion probability for DNA mixtures is a subjective one-sided match statistic unrelated to identification information**

Mark William Perlin<sup>1</sup>

<sup>1</sup>Cybergenetics, Pittsburgh, USA  
E-mail: \*Dr. Mark William Perlin: [perlin@cygen.com](mailto:perlin@cygen.com)  
\*Corresponding author

Received 14 July 2015 Accepted 21 September 2015 Published 08 October 2015

---

---

---

---

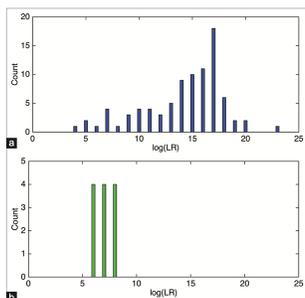
---

---

---

---

## CPI is always a million



---

---

---

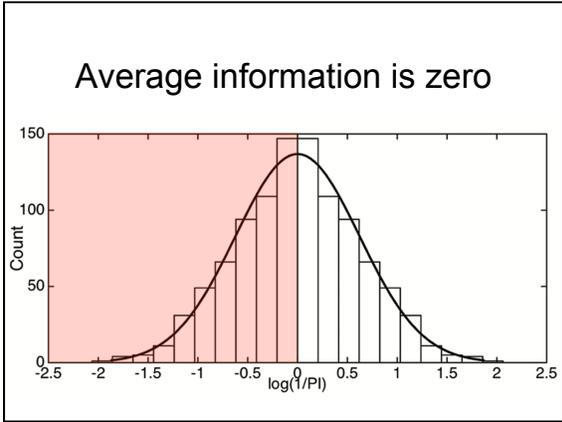
---

---

---

---

---




---

---

---

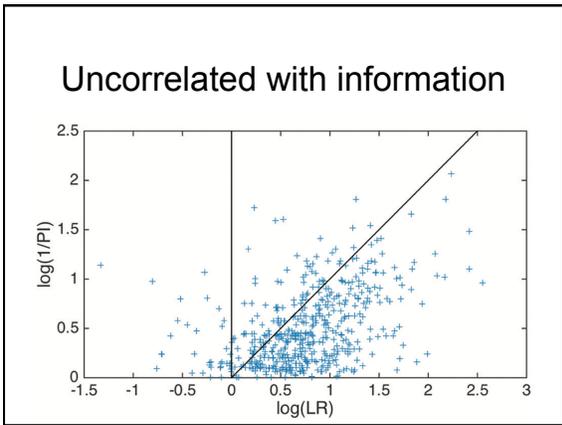
---

---

---

---

---




---

---

---

---

---

---

---

---

### Inclusion just counts tests

- 1 One-sided Match Statistic
- 2 Truncated Normal Distribution
- 3 Positive Tail Centered at Zero
- 4 Uncorrelated with Identification Information
- 5 Inclusion Distribution Has a Positive Mean
- 6 Law of Large Numbers
- 7 Why CPI is Always a Million

A subjective one-sided match statistic  
unrelated to identification information

---

---

---

---

---

---

---

---

## TrueAllele® computer technology

- Accurate. 34 validation studies, 7 published
- Objective. Workflow removes human bias
- Accepted. Reported in 37 states, used by labs
- Transparent. Give math, software (4GB DVD)
- Neutral. Can statistically include or exclude

---

---

---

---

---

---

---

## Wolfe sisters homicide



On February 6, 2014, Susan Wolfe (44) and her younger sister Sarah (38, left) were killed in their East Liberty home in Pittsburgh.

---

---

---

---

---

---

---

## Pennsylvania v. Allen Wade

Thresholds failed to interpret most DNA mixtures

Hat	No conclusions
Cup	Insufficient data
Fingernails	Contamination, insufficient data
Gear shift	Insufficient data
Seat lever	Cannot be excluded
Knit hat	Insufficient data
Sock	Too complex, no conclusions

---

---

---

---

---

---

---

## Pennsylvania v. Allen Wade

The crime lab reported 5 DNA mixture matches  
TrueAllele found 17 matches on the same data

Hat	65.3 thousand	Allen Wade
Cup	20.5 thousand	Susan Wolfe
Fingernails	6.06 trillion	Allen Wade
Gear shift	9.37 million	Sarah Wolfe
Seat lever	385 billion	Sarah Wolfe
Knit hat	25.7 thousand	Allen Wade
Sock	300	Sarah Wolfe

---

---

---

---

---

---

---

---

## Allen Wade Found Guilty On All Counts In East Liberty Sisters' Slaying

CBS News, May 23, 2016

PITTSBURGH (KDKA/AP)

- A man accused of killing two sisters who lived next door to him in East Liberty has been found guilty on all counts.
- Allen Wade was accused of shooting Sarah and Susan Wolfe after they returned from work on Feb. 6, 2014, apparently to steal a bank card.
- On Monday morning, a jury found Wade guilty of first-degree murder, robbery, burglary and theft by unlawful taking.

---

---

---

---

---

---

---

---

## Pennsylvania v. Allen Wade

Thresholds failed to interpret DNA mixture  
TrueAllele succeeded on the same data

A hat left from a burglary of the Wolfe sister's home  
six weeks before the murder matched  
Allen Wade with a 65.3 thousand statistic



Preventable Crime

---

---

---

---

---

---

---

---



## Non-governmental organization



JUSTICE  
THROUGH  
SCIENCE

1. Reanalyze forgotten DNA evidence
2. Educate lawyers, scientists & society

---

---

---

---

---

---

---

---

## More information

<http://www.cybgen.com/information>



- Courses
- Newsletters
- Newsroom
- Presentations
- Publications
- Webinars

<http://www.youtube.com/user/TrueAllele>  
TrueAllele YouTube channel



Cybergenetics



[perlin@cybgen.com](mailto:perlin@cybgen.com)

---

---

---

---

---

---

---

---