

Coding a Safer Society through Computer Interpretation of DNA Evidence

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Blairsville, PA dentist
Dr. John Yelenic



Murder victim



April 2006: Death in home by exsanguination

State Trooper arrested



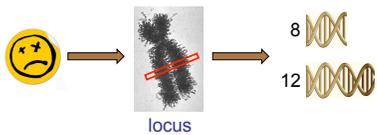
November 2007: Kevin Foley charged with crime

Fingernail DNA evidence



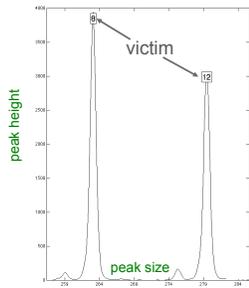
93% victim + 7% other person

One person, one genotype

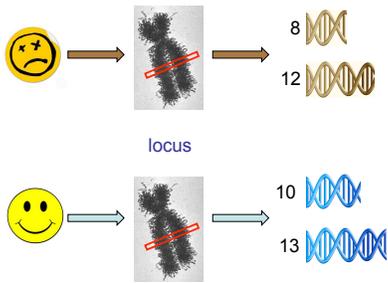


DNA data

One or two allele peaks at a locus

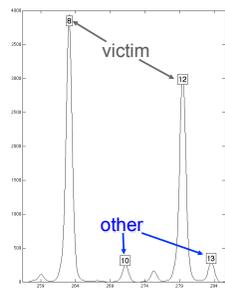


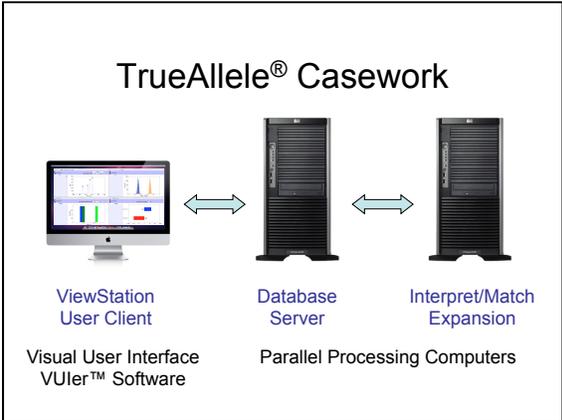
Two people, two genotypes

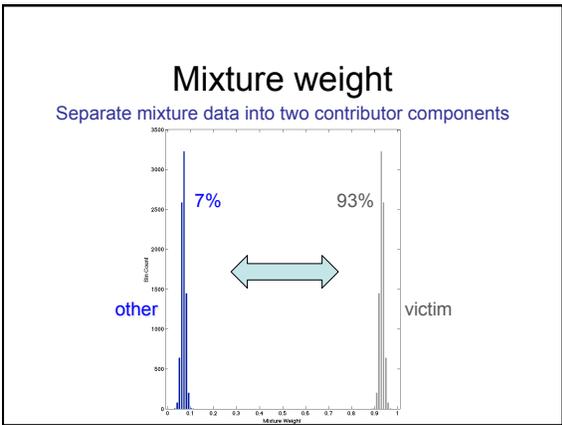


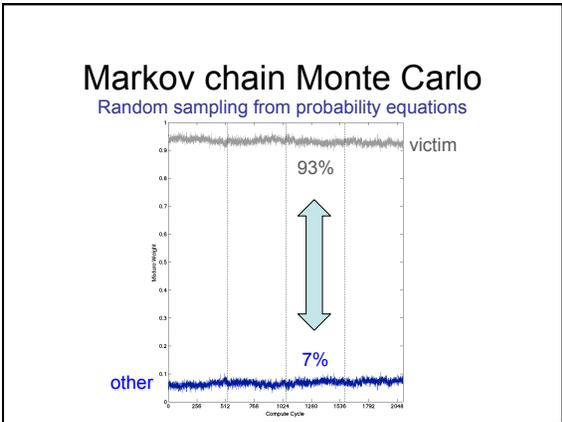
DNA mixture data

Peak height pattern at a locus

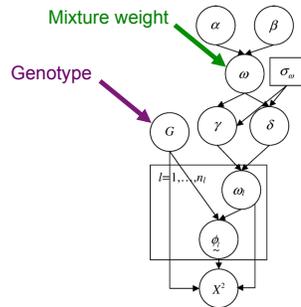








Hierarchical Bayesian model

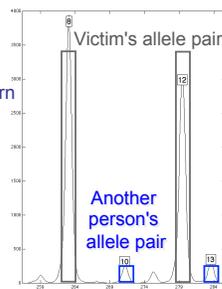


Genotype inference

Thorough: consider every possible genotype solution
Objective: does not know the comparison genotype

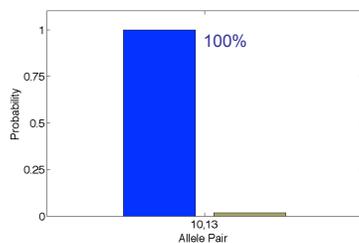
Explain the peak pattern

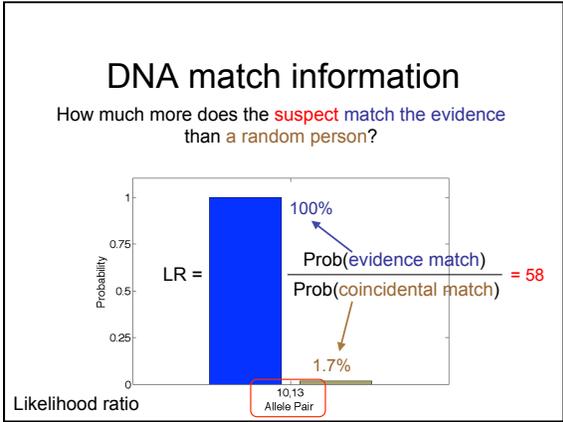
Better explanation has a higher likelihood

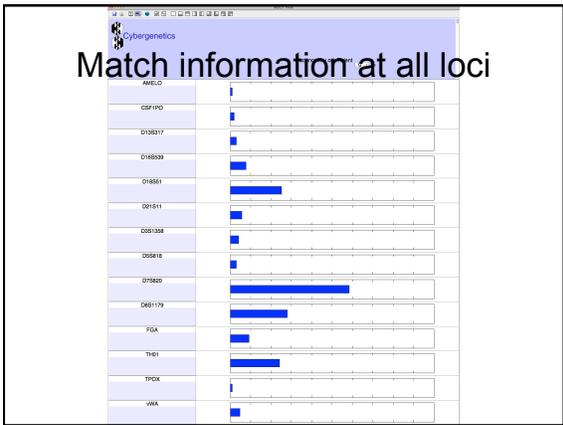


Evidence genotype

Objective: genotype determined solely from the DNA data.
 Never sees a comparison reference.







DNA match statistic

A match between the **victim's fingernails** and **Kevin Foley** is **189 billion** times more probable than coincidence.

<u>Statistic</u>	<u>Method</u>
CPI = 13 thousand	inclusion (human)
LR = 189 billion	TrueAllele (computer)

Legal challenge: admissible?

"The less informative methods ignored some of the data, while the TrueAllele computation considered all of the available DNA data."



"A scientist may look at the same slide using the naked eye, a magnifying glass, or a microscope. A computer that considers all the data is a more powerful DNA microscope."

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Jury convicts trooper of dentist slaying

Published: Thursday, March 19, 2009 12:46 AM EDT

An Indiana County Court jury this evening convicted state trooper Kevin Foley of first degree murder in the April 13, 2006, slashing death of Blairsville dentist John Yelenic.

"John Yelenic provided the most eloquent and poignant evidence in this case," said the prosecutor, senior deputy attorney general Anthony Krastek. "He managed to reach out and scratch his assailant," capturing the murderer's DNA under his fingernails.

Pennsylvania precedent

2012 PA Super 31
COMMONWEALTH OF PENNSYLVANIA IN THE SUPERIOR COURT OF PENNSYLVANIA
Appellee
v.
KEVIN JAMES FOLEY, Appellant
No. 2009 WDA 2009

Appeal from the Judgment of Sentence of June 1, 2009
in the Court of Common Pleas of Indiana County
Criminal Division at Bucks CP-24-CR-00017R-2007

BEFORE: PANELLA, SHOGAN, and COLVILLE, JJ.
OPINION BY PANELLA, J. FILED: FEBRUARY 15, 2012

Appellant, Kevin James Foley, appeals from the judgment of sentence entered on June 1, 2009, by the Honorable William J. Martin, President Judge of the Court of Common Pleas of Indiana County, Criminal Division. After careful review, we affirm.

• • •

Because Foley has failed to establish the existence of a legitimate dispute over Dr. Perlin's methodology, he has failed to show that Dr. Perlin's testimony constituted "novel" scientific evidence. See *Reetz*, 998 A.2d at 972. Therefore, we find that the trial court's decision to admit the testimony was not an abuse of discretion. Absent a legitimate dispute, there is no reason to "impede admissibility of evidence that will aid the trier of fact in the search for truth." *Id.*

TrueAllele demonstration



Reliable method

Perlin MW, Sinenikov A. An information gap in DNA evidence interpretation. *PLoS ONE*. 2009;4(12):e8327.

Perlin MW, Legler MM, Spencer CE, Smith JL, Allan WP, Belrose JL, Duceman BW. Validating TrueAllele® DNA mixture interpretation. *Journal of Forensic Sciences*. 2011;56(6):1430-47.

Ballantyne J, Hanson EK, Perlin MW. DNA mixture genotyping by probabilistic computer interpretation of binomially-sampled laser captured cell populations: Combining quantitative data for greater identification information. *Science & Justice*. 2013;53(2):103-14.

Perlin MW, Belrose JL, Duceman BW. New York State TrueAllele® Casework validation study. *Journal of Forensic Sciences*. 2013;58(6):1458-66.

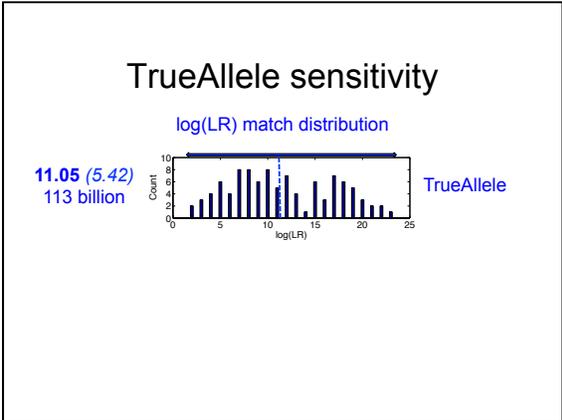
Perlin MW, Dormer K, Hornyak J, Schiermeier-Wood L, Greenspoon S. TrueAllele® Casework on Virginia DNA mixture evidence: computer and manual interpretation in 72 reported criminal cases. *PLOS ONE*. 2014; *in press*.

Sensitive

The extent to which interpretation identifies the correct person

True DNA mixture inclusions

101 reported genotype matches
82 with DNA statistic over a million

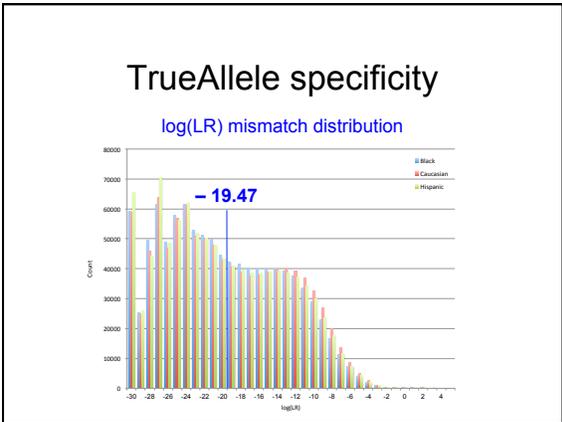


Specific

The extent to which interpretation does not misidentify the wrong person

True exclusions, without false inclusions

101 matching genotypes x 10,000 random references
x 3 ethnic populations,
for over 1,000,000 nonmatching comparisons



Reproducible

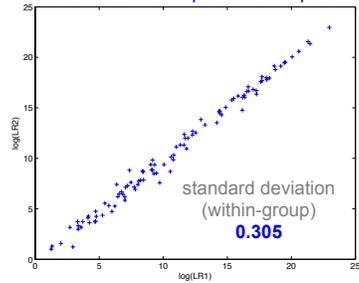
The extent to which interpretation gives the same answer to the same question

MCMC computing has sampling variation

duplicate computer runs
on 101 matching genotypes
measure log(LR) variation

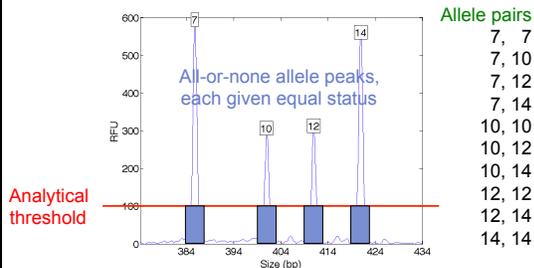
TrueAllele reproducibility

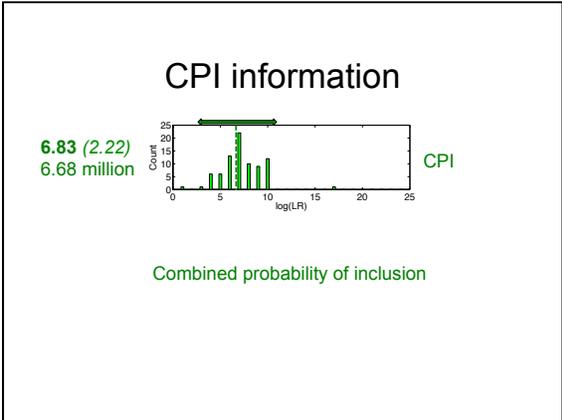
Concordance in two independent computer runs

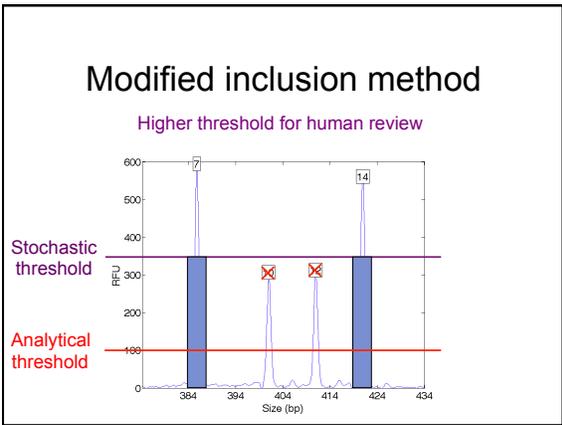


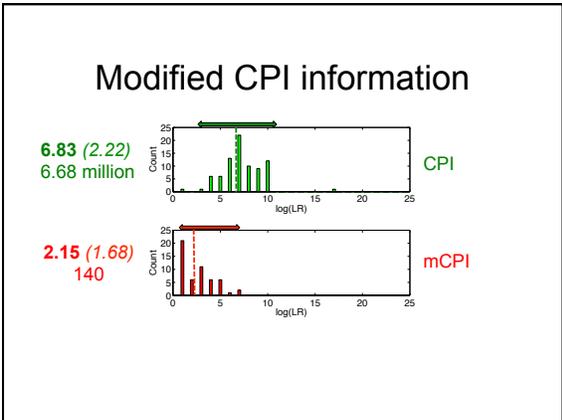
Manual inclusion method

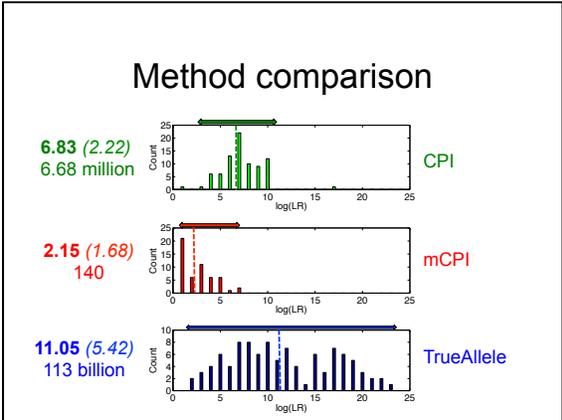
Over threshold, peaks are labeled as allele events

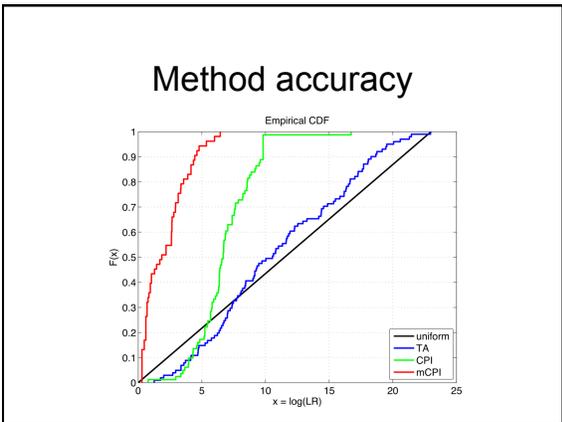




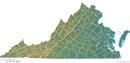








National DNA mixture crisis



375 cases/year x 4 years = 1,500 cases
 320 M in US / 8 M in VA = 40 factor
 1,500 cases x 40 factor = 60,000 inconclusive



1,000 cases/year x 4 years = 4,000 cases
 320 M in US / 8 M in NY = 40 factor
 4,000 cases x 40 factor = 160,000 inconclusive



+ underreporting of DNA match statistics
 DNA evidence data in 100,000 cases
 Collected, analyzed & paid for – but unused



TrueAllele in Pennsylvania

5 trials, 2 exonerations

Crime	Evidence	Defendant	Outcome	Sentence
murder	finger nail	Kevin Foley	guilty	life
murder	clothing	Glenn Lyons	guilty	death
rape	clothing	Ralph Skundrich	guilty	awaiting
murder	gun, hat	Leland Davis	guilty	23 years
rape	clothing	Akaninyene Akan	guilty	32 years
murder	shotgun shells	James Yeckel, Jr.	guilty plea	25 years
murder	finger nail	Anthony Morgan	stipulation	life
weapons	gun	Thomas Doswell	guilty plea	1 year
drugs	gun	Derek McKissick & Steve Morgan	guilty pleas	2 1/2 years
murder	wood	Sherman Holes	guilty plea	10 years



TrueAllele in Virginia

10 trials, 72 case reports

City	Court	Charge	Sentence
Richmond	federal	weapon	50 years
Alexandria	federal	bank robbery	90 years
Quantico	military	rape	3 years
Chesapeake	state	robbery	26 years
Arlington	state	molestation	22 years
Richmond	state	homicide	35 years
Fairfax	state	abduction	33 years
Norfolk	state	homicide	8 years
Charlottesville	state	homicide	15 years
Hampton	state	home invasion	5 years

Cybergenetics role

Invented math & algorithms	20 years
Developed computer systems	15 years
Support users and workflow	10 laboratories
Used routinely in casework	3 labs
Validate system reliability	20 studies
Educate the community	50 talks
Train & certify analysts	200 students
Go to court for admissibility	5 hearings
Testify about LR results	20 trials
Educate lawyers and laymen	1,000 people
Make the ideas understandable	150 reports

Learn more about TrueAllele

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



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