Computer Interpretation of Uncertain DNA Evidence

National Institute of Justice
Computer v. Human

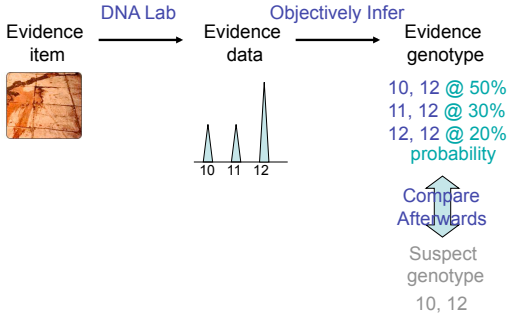
June, 2011
Arlington, VA

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

Cybergenetics

Cybergenetics © 2003-2011

Uncertain DNA Evidence



Automated STR Mixture Analysis NIJ Award 2001-IJ-CX-K003

Provide quantitative DNA mixture analysis on a wide range of data.

Handle known STR artifacts and adapt to new marker technologies.

Interact well with users, including DNA analysts and reporting officers.

Study Design: 40 Mixture Items

5 weights: 90%, 70%, 50%, 30%, 10%

Set 1 Mixture ratio	ng amplified 1	0.5	0.25	0.125
10:0	A1	A2	A3	A4
9:1	B1	B2	B3	B4
7:3	C1	C2	C3	C4
5:5	D1	D2	D3	D4
3:7	E1	E2	E3	E4
1:9	F1	F2	F3	F4
0:10	G1	G2	G3	G4

1, 1/2, 1/4, 1/8 ng
4 dilutions

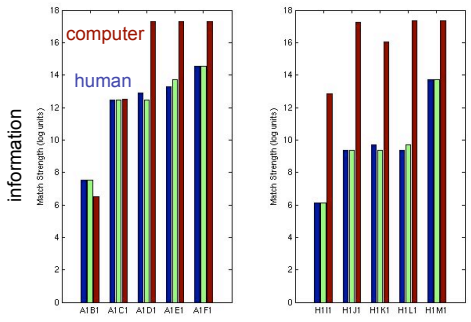
2 pairs

Set 2 Mixture ratio	ng amplified 1	0.5	0.25	0.125
10:0	H1	H2	H3	H4
9:1	I1	I2	I3	I4
7:3	J1	J2	J3	J4
5:5	K1	K2	K3	K4
3:7	L1	L2	L3	L4
1:9	M1	M2	M3	M4
0:10	N1	N2	N3	N4

Margaret Kline
NIST

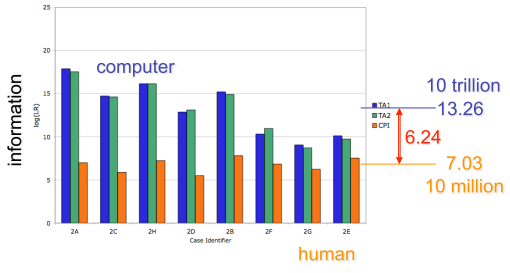
MW Perlin. Real-time DNA investigation. Proceedings of Promega's 16th International Symposium on Human Identification, 2005.

Same Data, More Information



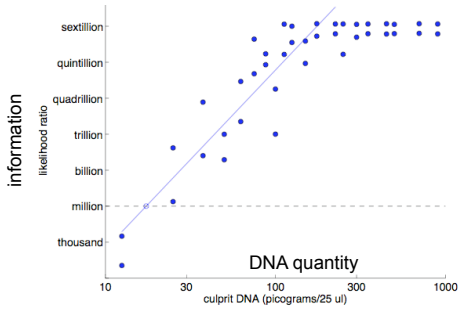
MW Perlin, MM Legler, CE Spencer, JL Smith, WP Allan, JL Belrose, BW Duceman. Validating TrueAllele® DNA mixture interpretation. Journal of Forensic Sciences, 2011.

Computer = million x Human



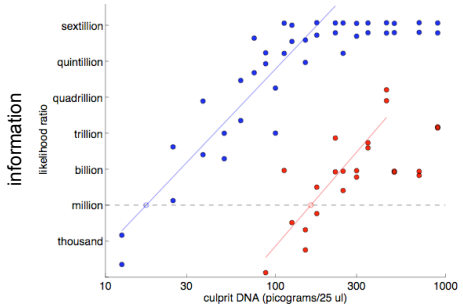
MW Perlin, A Sinelnikov. An information gap in DNA evidence interpretation. PLoS ONE, 2009.

Information Results



MW Perlin, A Sinelnikov. An information gap in DNA evidence interpretation. PLoS ONE, 2009.

Computer v. Human



The DNA Investigator™ Newsletter, 2009
Same Data, More Information – Murder, Match and DNA

Commonwealth v. Foley

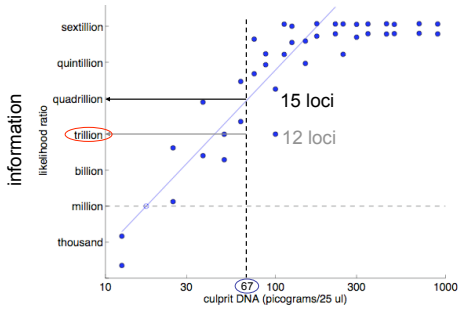
homicide: 7% DNA mixture fingernail evidence

Score	Method
13 thousand	threshold
23 million	use victim
189 billion	quantitative

- probability modeling preserves information
- peak threshold discards information

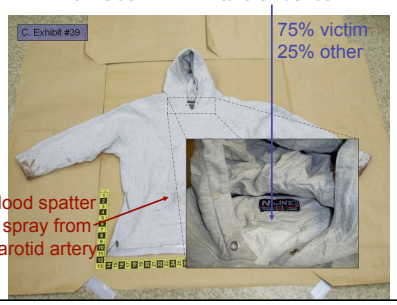
MW Perlin, A Sinelnikov. An information gap in DNA evidence interpretation. PLoS ONE, 2009.

Predictably Preserves Information

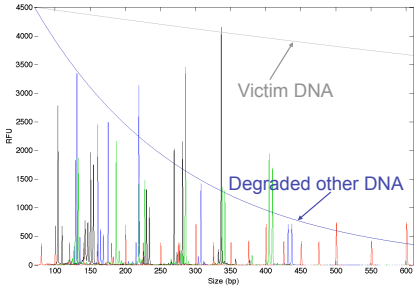


Commonwealth v. Lyons

homicide: DNA mixture evidence



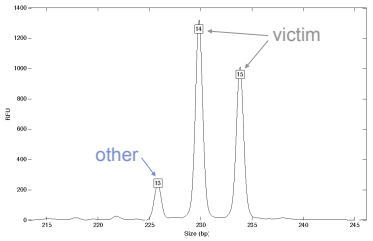
Degraded DNA Mixture



Perlin MW, Szabady B. Linear mixture analysis: a mathematical approach to resolving mixed DNA samples. Journal of Forensic Sciences, 2001.

Quantitative Mixture Evidence

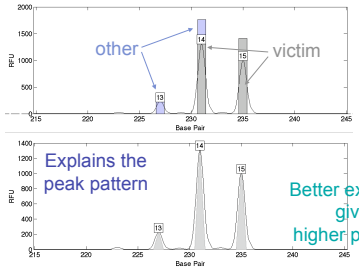
Quantitative peak heights at locus D8S1179



MW Perlin, MM Legler, CE Spencer, JL Smith, WP Allan, JL Belrose, BW Duceman. Validating TrueAllele DNA mixture interpretation. Journal of Forensic Sciences, 2011.

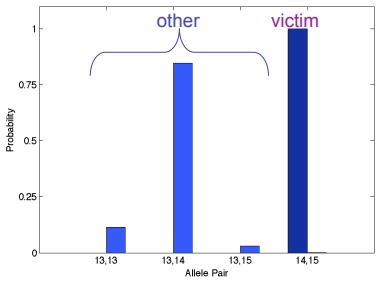
How the Computer Thinks

Considers every possible genotype solution



MW Perlin, MM Legler, CE Spencer, JL Smith, WP Allan, JL Belrose, BW Duceman. Validating TrueAllele DNA mixture interpretation. Journal of Forensic Sciences, 2011.

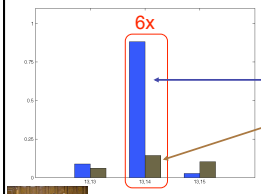
Objectively Infer Genotype



MW Perlin. Explaining the likelihood ratio in DNA mixture interpretation. Proceedings of Promega's 21st International Symposium on Human Identification, 2010.

DNA Match Information

How much more does the suspect match the evidence than a random person?

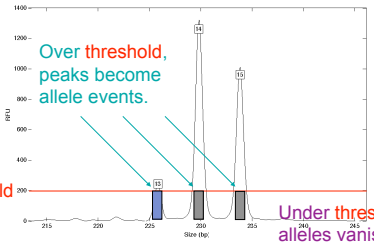


Probability(evidence match)
Probability(coincidental match)

LR = 6

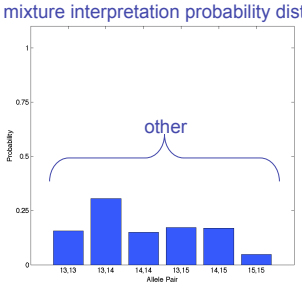
Thresholds Discard Data

All-or-none allele peaks; ignore victim genotype



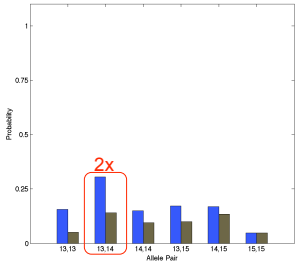
Thresholds Disperse Genotype

Human mixture interpretation probability distribution



Thresholds Discard Information

Human interpretation is less informative



LR = 2

MW Perlin. Explaining the likelihood ratio in DNA mixture interpretation. Proceedings of Promega's 21st International Symposium on Human Identification, 2010.

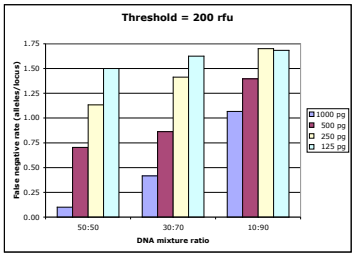
Likelihood Ratio Simple Statement

A match between the suspect and the evidence is 9.5 trillion times more probable than coincidence.

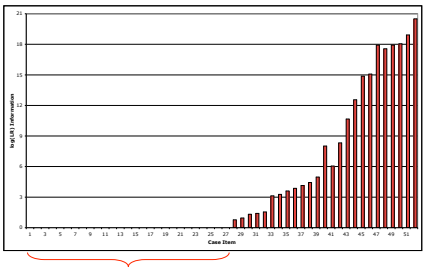
Computer	9,500,000,000,000
Human	42,000

The DNA Investigator™ Newsletter, 2011
DNA Intelligence and Forensic Failure – What you don't know can kill you

Missed Allele Error > 100%



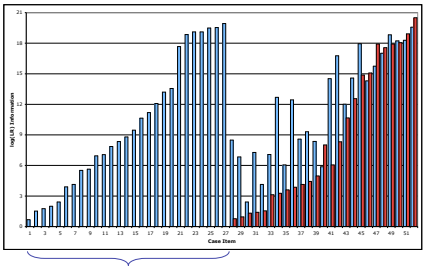
Human Information



25 case items

inconclusive

Computer Information



25 + 27 more

resolved

SWGDAM Triage

Interpret DNA evidence

resolvable → human stochastic threshold

inconclusive → computer probabilistic genotype (3.2.2)

- Library of match information
- On-demand case report

Computer v. Human

No competition

• information	1,000,000x
• reproducible	Validated
• mixture resolution	1, 2, 3, 4, …
• degraded DNA	Quantified
• unsolved cases	Solved
• complex cases	Automated
• interpretation	Easy & fast
• likelihood ratio	Explained
• crime impact	Maximized

People use computer tools to do a better job

Learning More

The science of quantitative DNA mixture interpretation

www.cybgen.com/information

- Newsletters
  gentle introduction to ideas
- Courses
  for scientists and lawyers
- Presentations
  handouts, movies, transcripts
- Publications
  abstracts, manuscripts