

Solving Crimes using MCMC to Analyze Previously Unusable DNA Evidence

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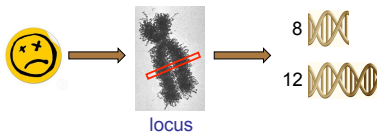
Joint Statistical Meetings
August, 2014
Boston, MA



Cybergenetics

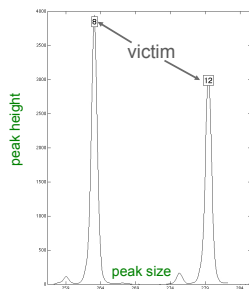
Cybergenetics © 2003-2014

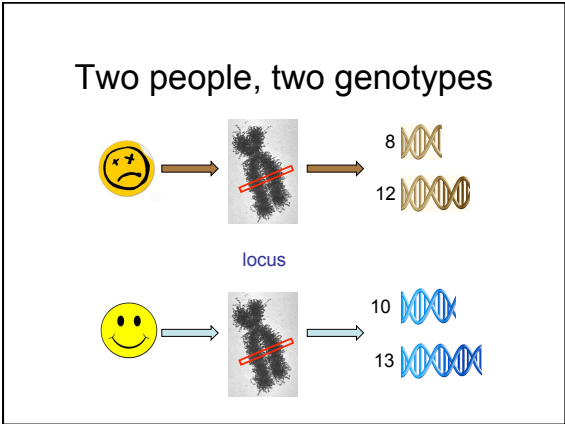
One person, one genotype

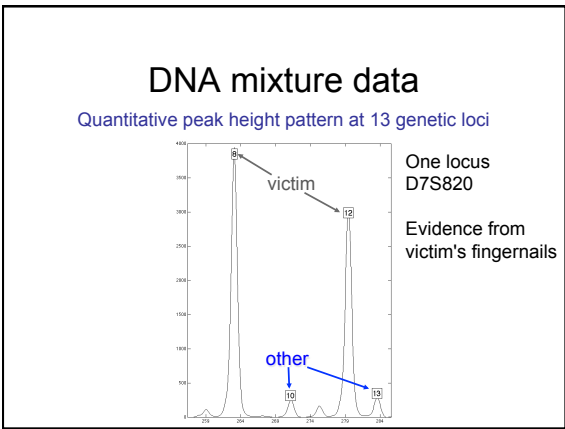


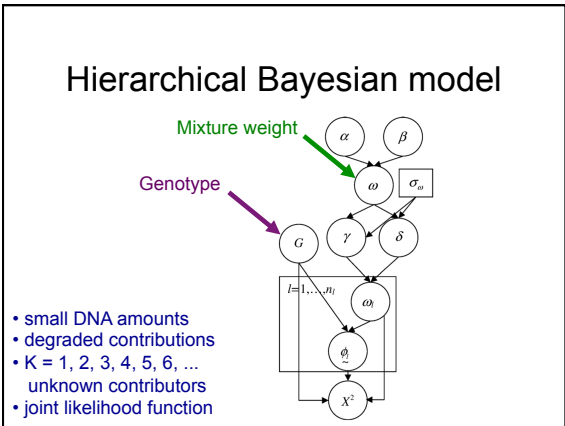
DNA reference data

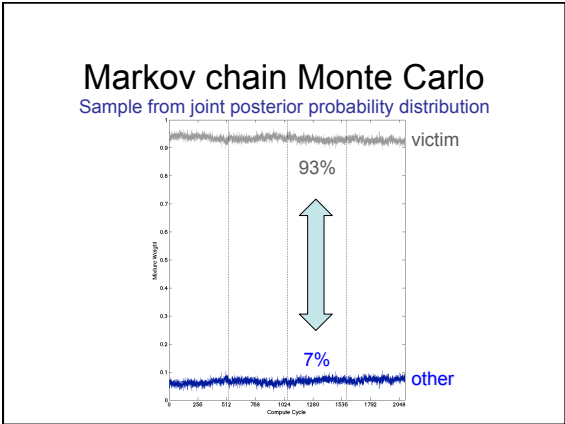
One or two allele peaks at a locus

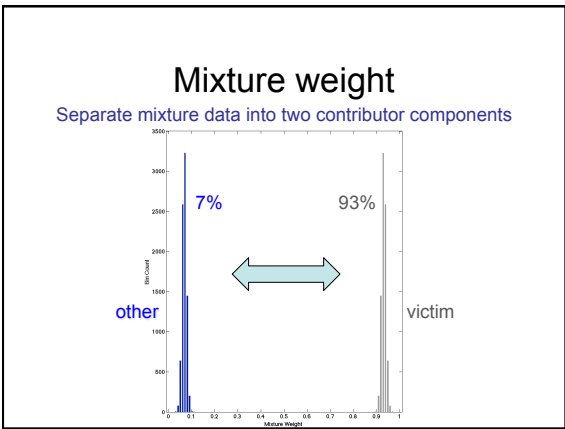


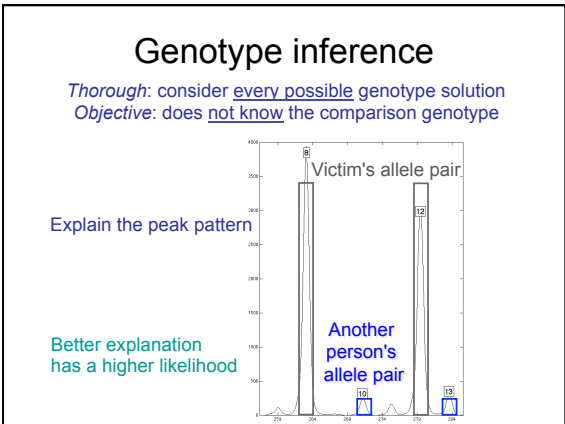






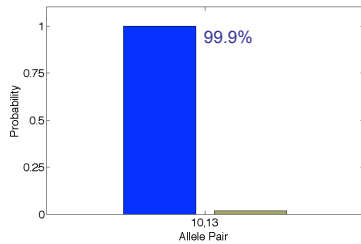






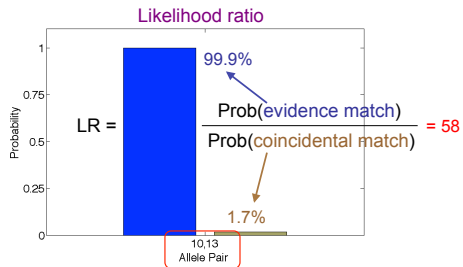
Evidence genotype

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



DNA match information

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



DNA match statistic

Product of 13 independent genetic loci

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

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

TrueAllele Casework on Virginia DNA Mixture Evidence:
Computer and Manual Interpretation in 72 Reported Criminal Cases.
Perlin MW, Dormer K, Hornyak J, Schiermeier-Wood L, Greenspoon S
PLoS ONE (2014) 9(3): e92837

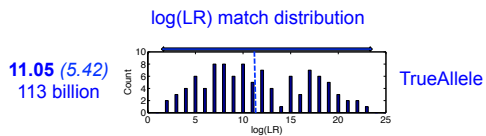
Sensitive

The extent to which interpretation identifies the correct person

True DNA mixture inclusions

101 reported genotype matches
82 with DNA statistic over a million

TrueAllele sensitivity

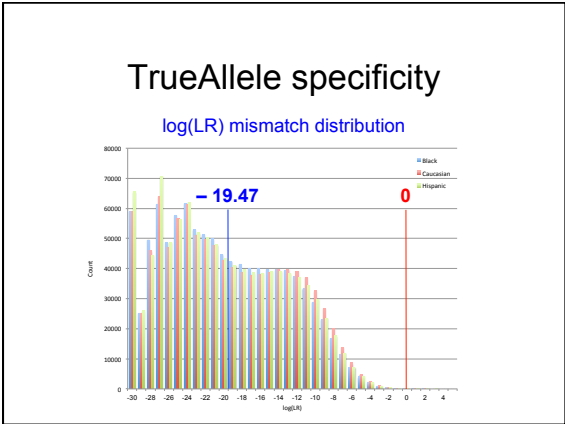


Specific

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

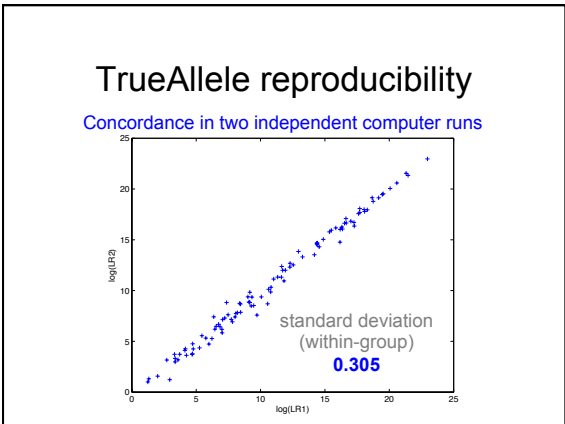


Reproducible

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

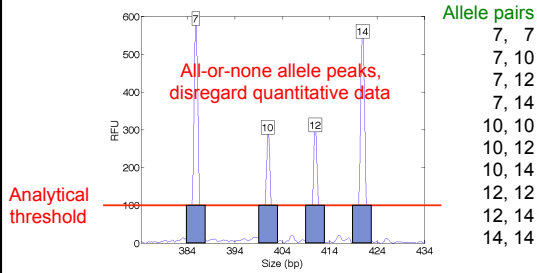
MCMC computing has sampling variation

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



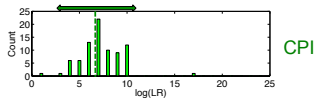
Manual inclusion method

Over threshold, peaks become binary allele events



CPI information

6.83 (2.22)
6.68 million

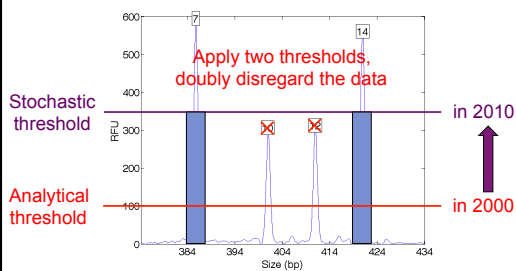


Combined probability of inclusion

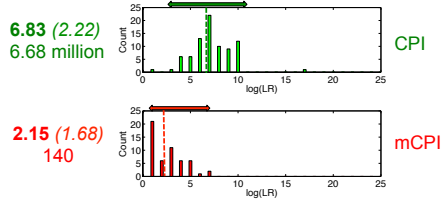
Simplify data, easy procedure,
apply simple formula
 $PI = (p_1 + p_2 + \dots + p_k)^2$

Modified inclusion method

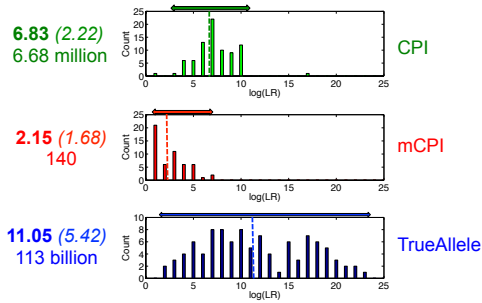
Higher threshold for human review



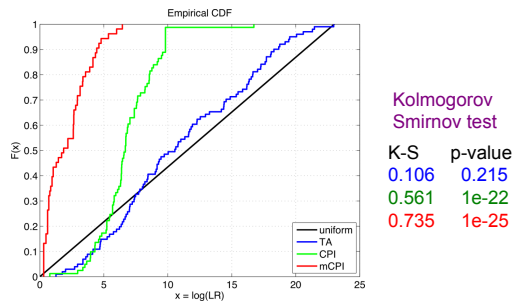
Modified CPI information



Method comparison



Method accuracy



“All the News That’s Fit to Print”

The New York Times

Late Edition
 Today, check a version of the edition: early edition, page 1; the night, check the 45. Tomorrow, a choice in this high. In: Greater map in on Sports/Clubby, Page 12.

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No Longer Ignored, Evidence Solves Rape Cases Years Later

By ERIC LICHOWITZ

MEMPHIS — Meghan Ybos was in a car with a man in a ski mask held a knife to her throat and raped her.

The man said he would kill her if she called the police, but she did so anyway. That led to hundreds of rape kits, but she said that she had to wait for a long time before the evidence she had collected from her rape kit was used to solve her case.

“I felt so vulnerable being held out in a tub, with all my clothes off and in a bag and all the swabs and brushes and combs,” she recalled. But at least, she figured, the police would use the swabs and hair samples to help catch the rapist.

They did not. Like hundreds of thousands of other rape kits across the country containing evidence gathered from victims, the kits of Ms. Ybos lay unused for years in a warehouse.

The reasons for the backlog, experts say, are often a combination of factors: too few forensic analysts, along with a slow recognition among investigators that even when the offender is known, DNA testing might reveal a pattern of sexual rapist. And too often, women’s advocates say, the kits went untested because of an overzealous and outdated response to sexual assault charges.

In recent years, the issue has exploded as one city after another has discovered stockpiles of untested kits.

Today, after years of pressure, a bill is beginning several cities.


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MEGHAN YBOS, RIGHT, AND MATTHEW CARSON SAY THAT THE MEMPHIS AUTHORITIES WERE LATE.



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