

Week 11

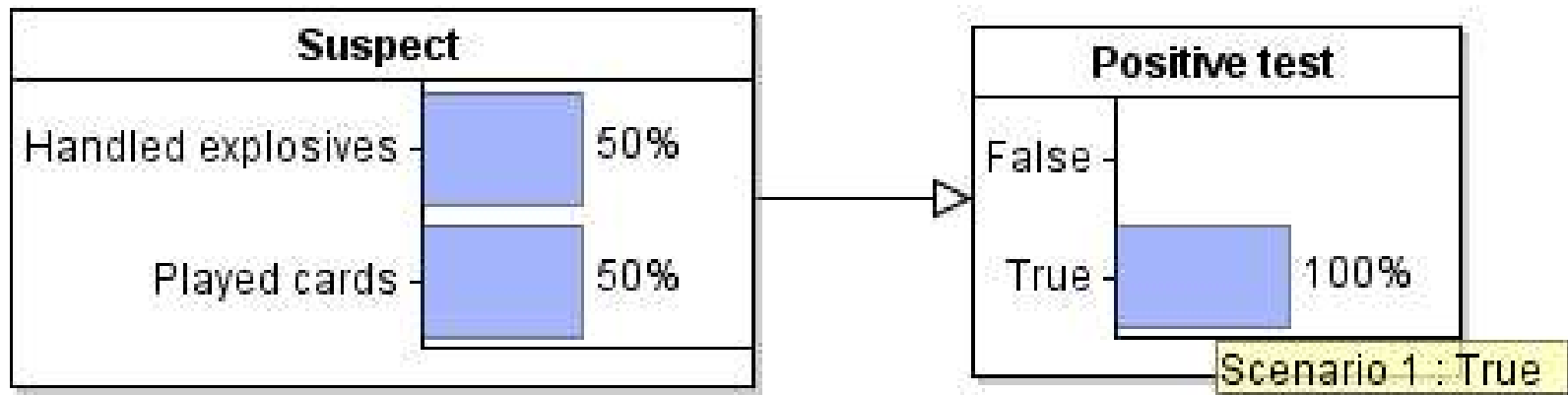
Live Discussion Session

Starts at 2.05pm

- Suspect accused of involvement in a bombing
- Suspect tests positive for explosive substances on hands (test is 95% accurate when explosive substances present)
- The test also has 95% chance of positive results if suspect handled playing cards)

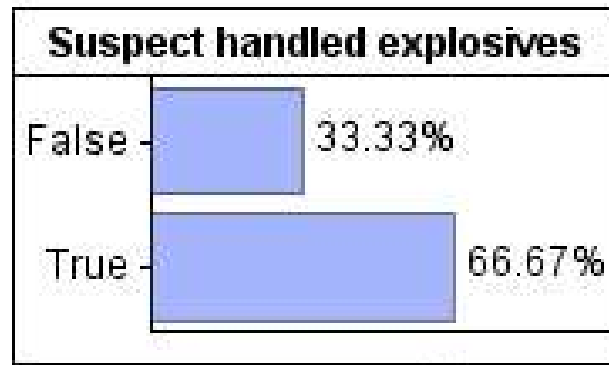
Is the evidence probative?

Simplistic assumption

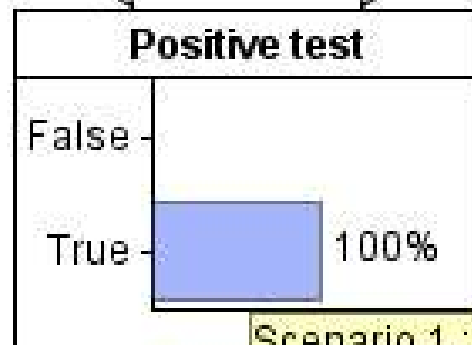


(Posterior) probabilities of the hypotheses are unchanged after the evidence is observed

Realistic assumption



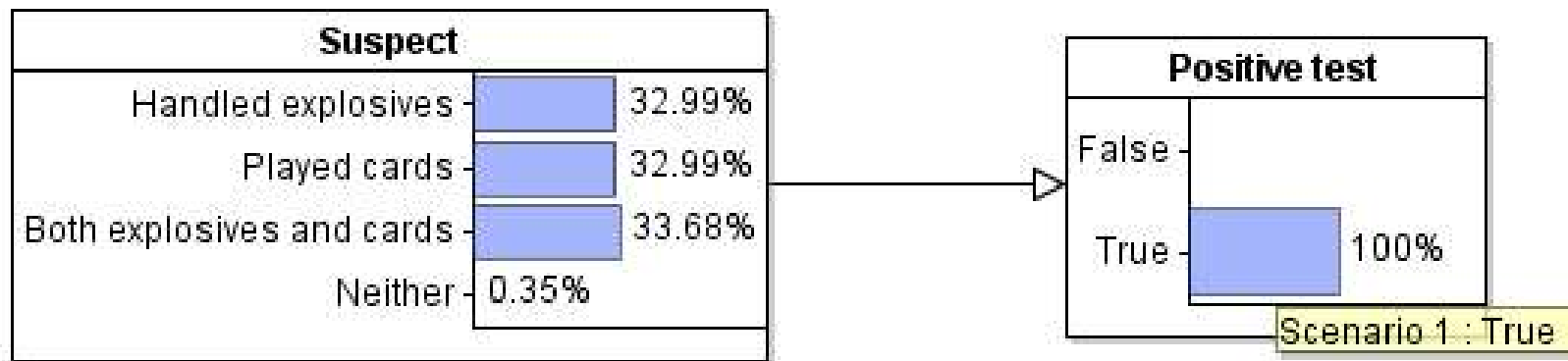
*(Posterior)
probabilities of the
hypotheses are still
equal but the
probability of BOTH
has increased*



Scenario 1 : True

Suspect played cards	False	True	False	True
False	0.99	0.05	0.05	0.03
True	0.01	0.95	0.95	0.97

Or alternative formulation...



Evidence from a crime scene

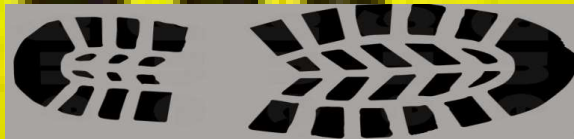
Some of those who were at
the scene of the crime

Fred



Police discover
shoeprint of person who
committed the crime –
it's size 13

Nationally only about 1 in
a 100 men are size 13



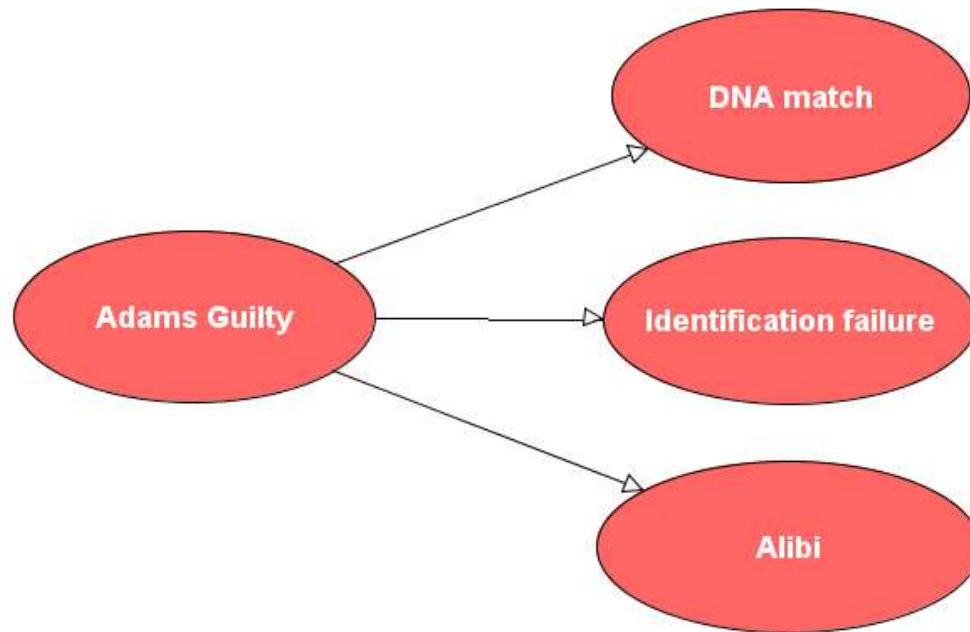
Fred is size 13

What is the probability Fred is innocent?

Court of Appeal Rulings

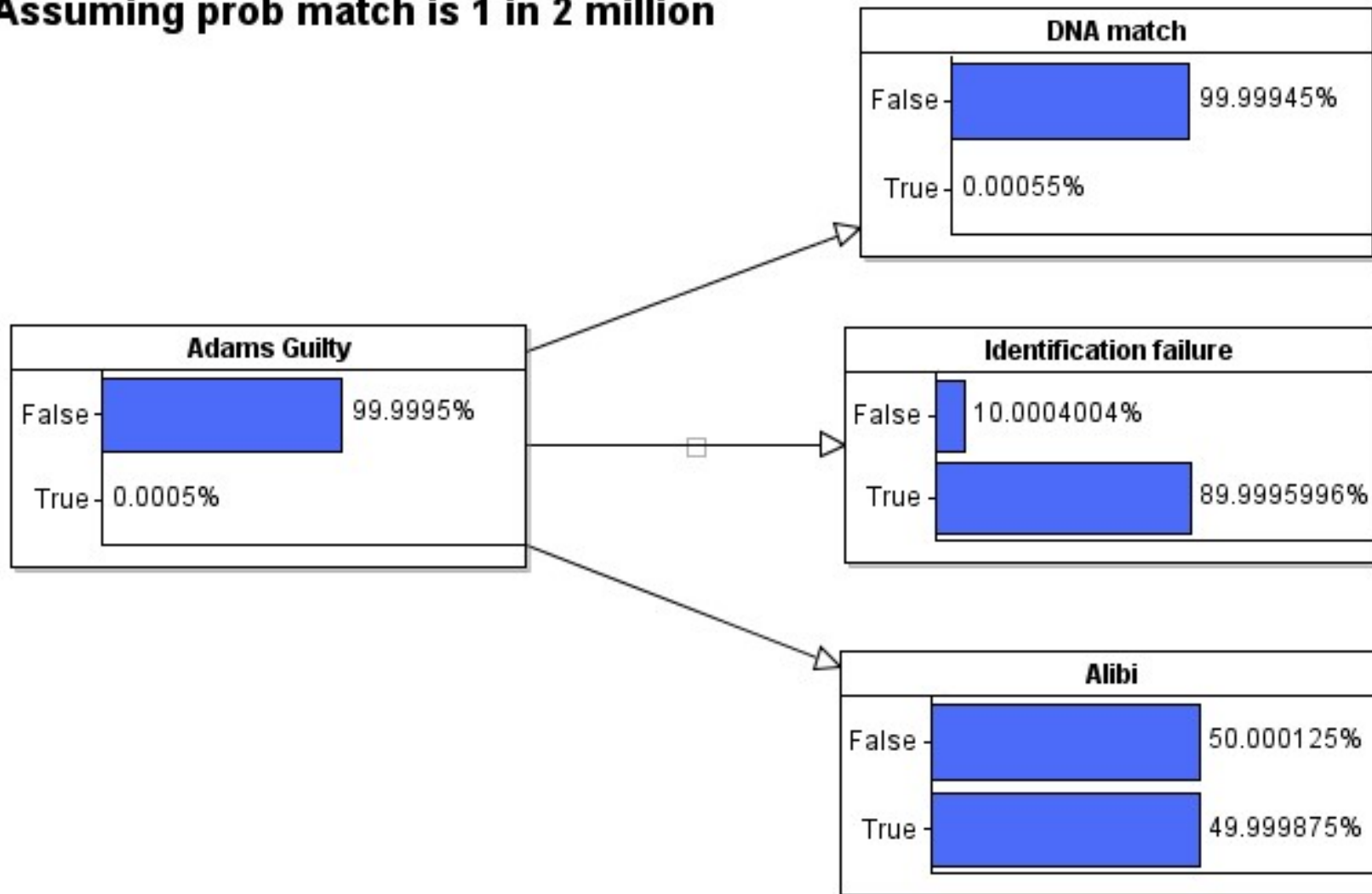
“The task of the jury is to evaluate evidence and reach a conclusion not by means of a formula, mathematical or otherwise, but by the joint application of their individual common sense and knowledge of the world to the evidence before them” (R v Adams, 1995)

Adams' case



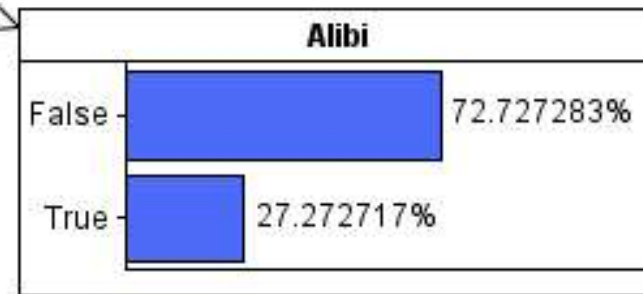
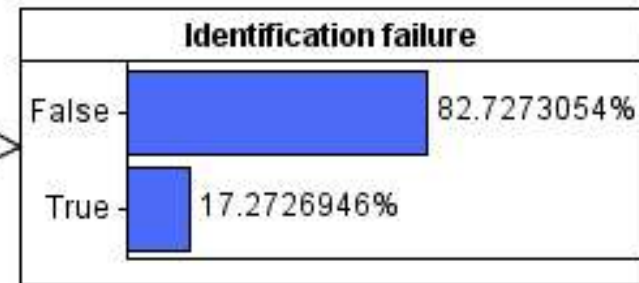
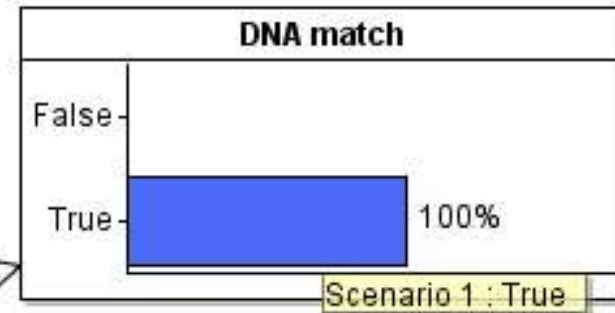
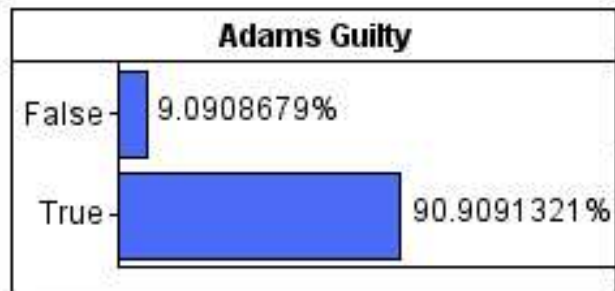
Adams' case

Assuming prob match is 1 in 2 million



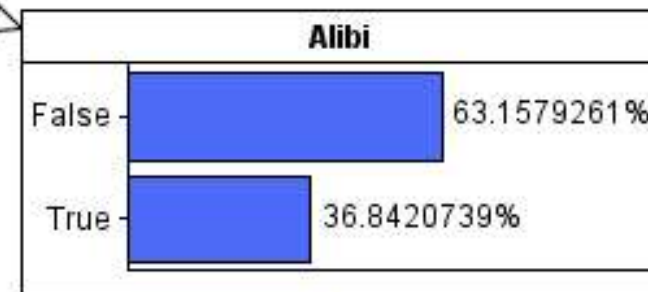
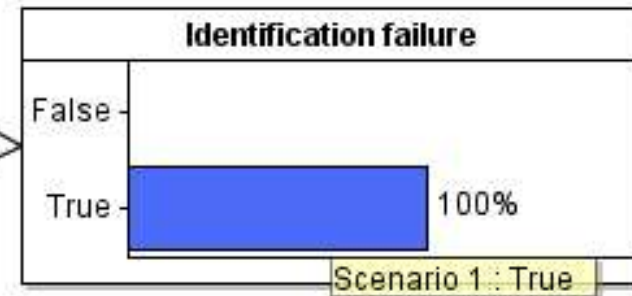
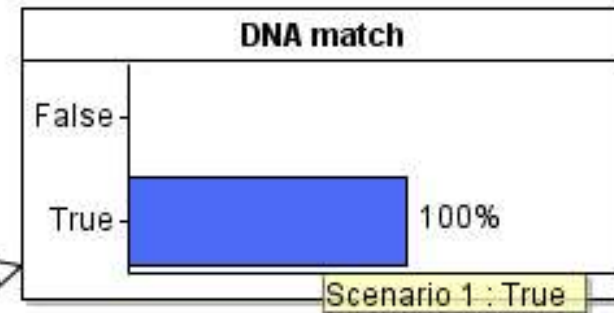
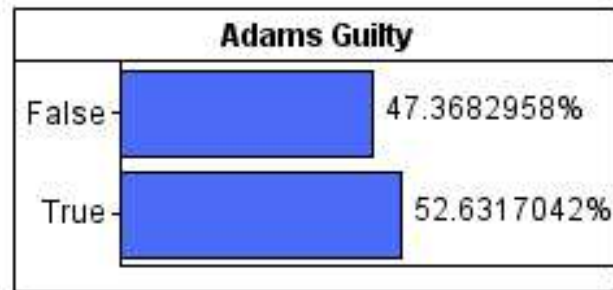
Adams' case

Assuming prob match is 1 in 2 million



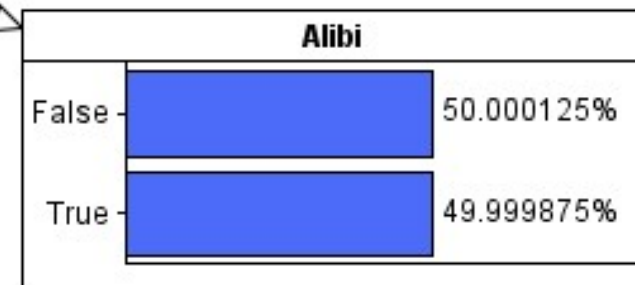
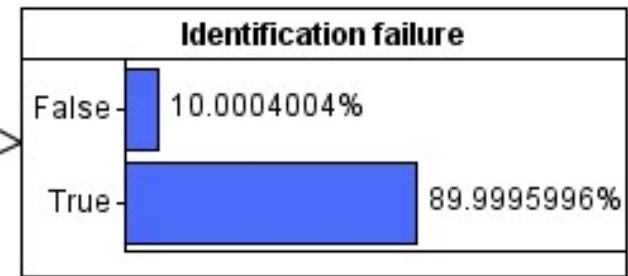
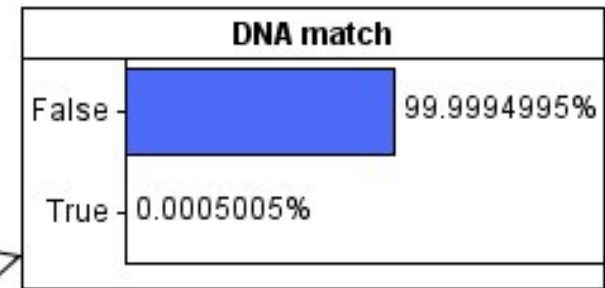
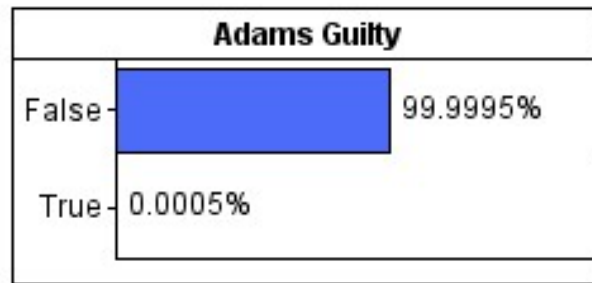
Adams' case

Assuming prob match is 1 in 2 million



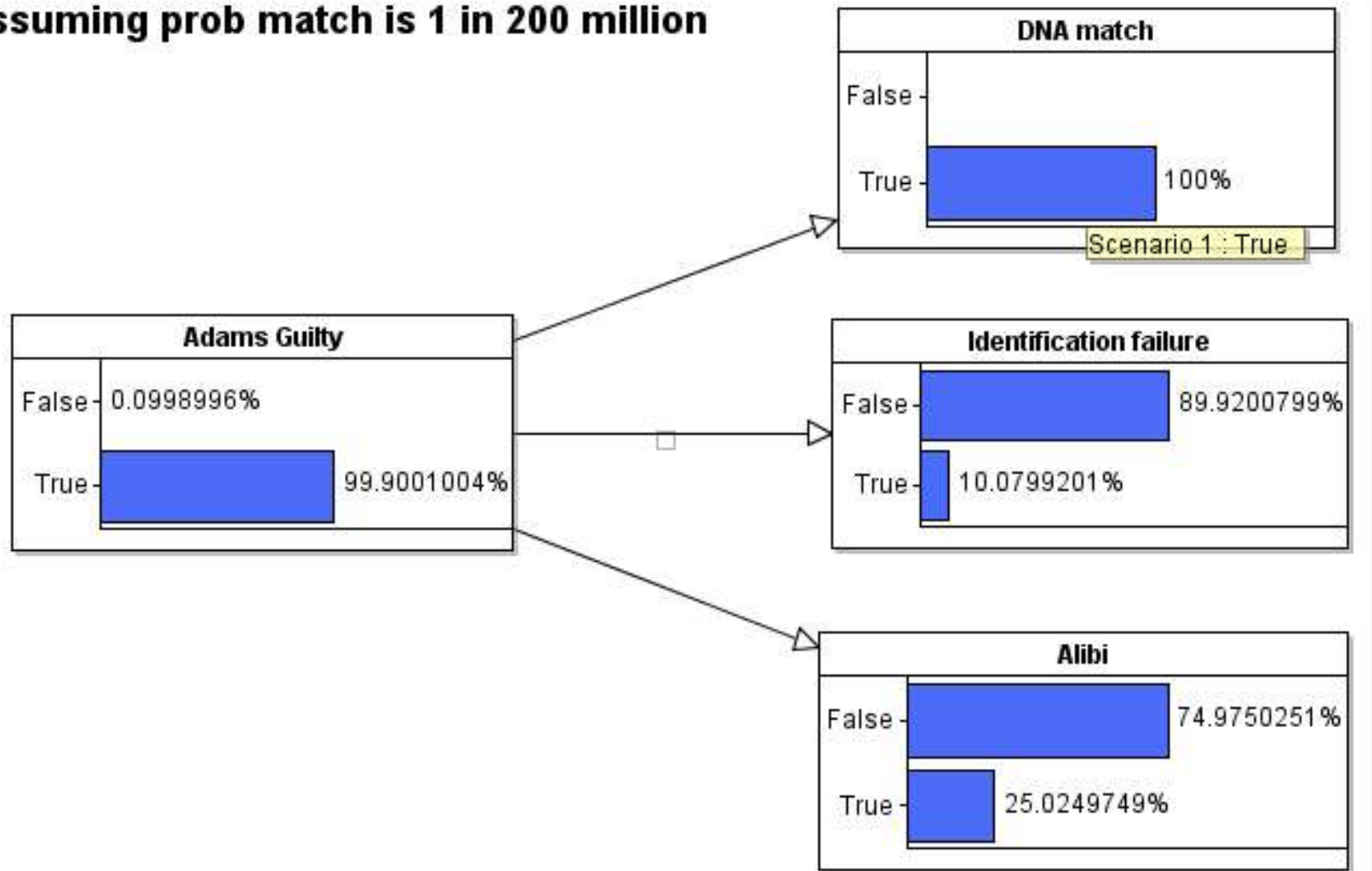
Adams' case: extreme assumption

Assuming prob match is 1 in 200 million



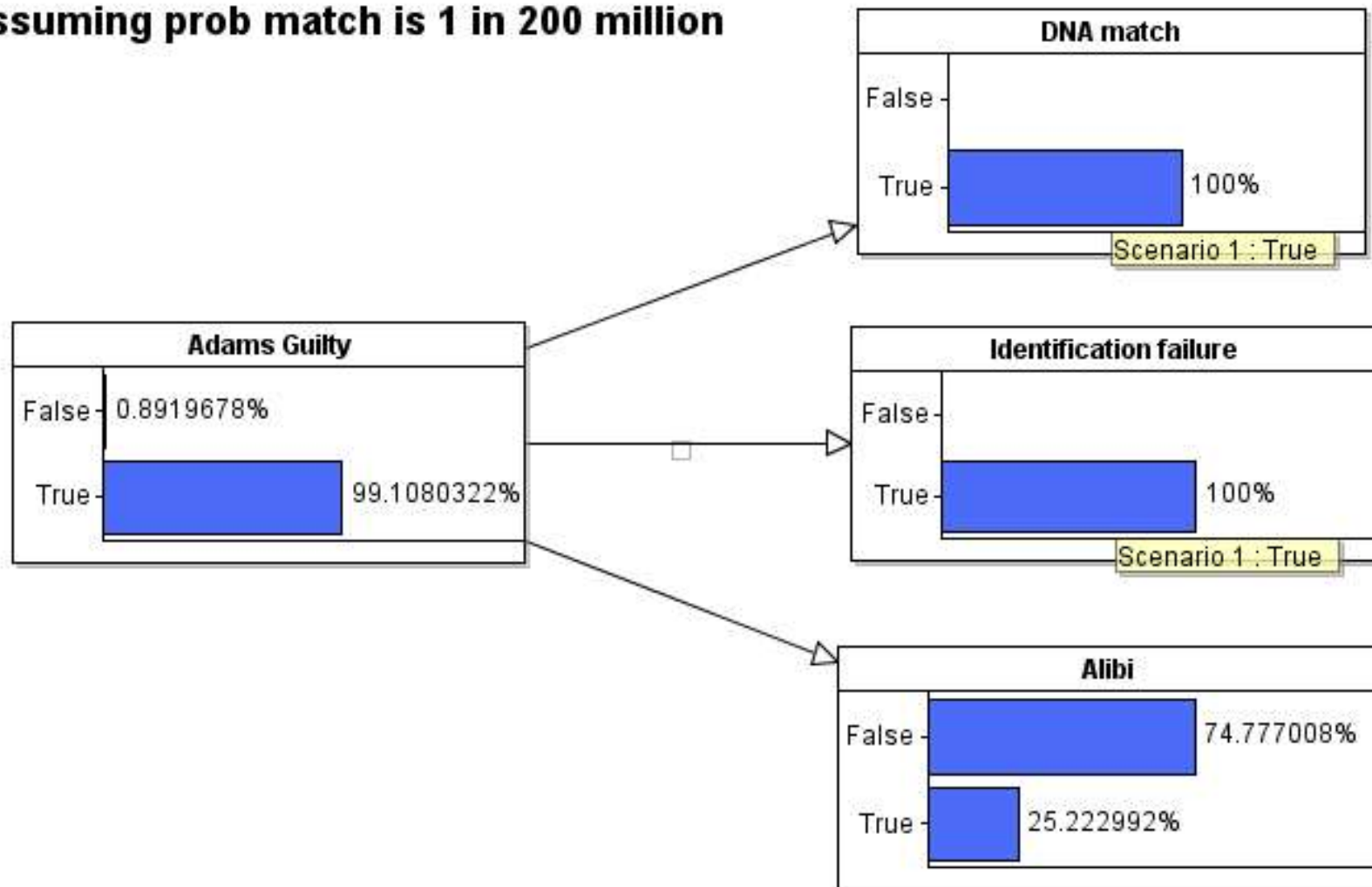
Adams' case: extreme assumption

Assuming prob match is 1 in 200 million



Adams' case: extreme assumption

Assuming prob match is 1 in 200 million



Court of Appeal Rulings

“..no attempt can realistically be made in the generality of cases to use a formula to calculate the probabilities.
.. it is quite clear that outside the field of DNA (and possibly other areas where there is a firm statistical base) this court has made it clear that Bayes theorem and likelihood ratios should not be used” (R v T, 2010)

R v Dobson

Probabilistic flaws in forensic reports

Revealed in cross-examination of experts

Newspaper reported fallacies *wrongly reported*



30 November 2011 Last updated at 17:48

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Stephen Lawrence trial: 'Blood on Gary Dobson's jacket'

A stain on a murder accused's jacket was caused by fresh blood with a one-in-a-billion chance of not being victim Stephen Lawrence's, a court has heard.

Forensic scientist Edward Jarman said if blood found on Gary Dobson's jacket had been old when it made contact, it would not have soaked in.

He said the blood could have been "shed from a knife" and would have dried in a couple of minutes.

Mr Dobson, 36, and David Norris, 35, deny murdering 18-year-old Mr Lawrence.

The defence says police contaminated evidence relating to the killing.



A close-up of a blood spot found on the jacket police recovered from Gary Dobson's home

Related Stories

[Lawrence case database 'altered'](#)

[Questions over](#)

R v Barry George, 2001-2007

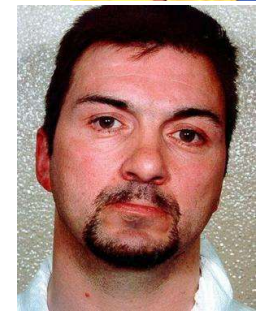
originally convicted
of murder

probabilistic issue
with probative value
of gunpowder
residue evidence



Jill Dando

R v Barry George (revisiting the Appeal Court judgment)



H: Hypothesis “Barry George did not fire gun”

E: Particle of FDR in coat pocket

Defence likelihood $P(E|H) = 1/100$

...

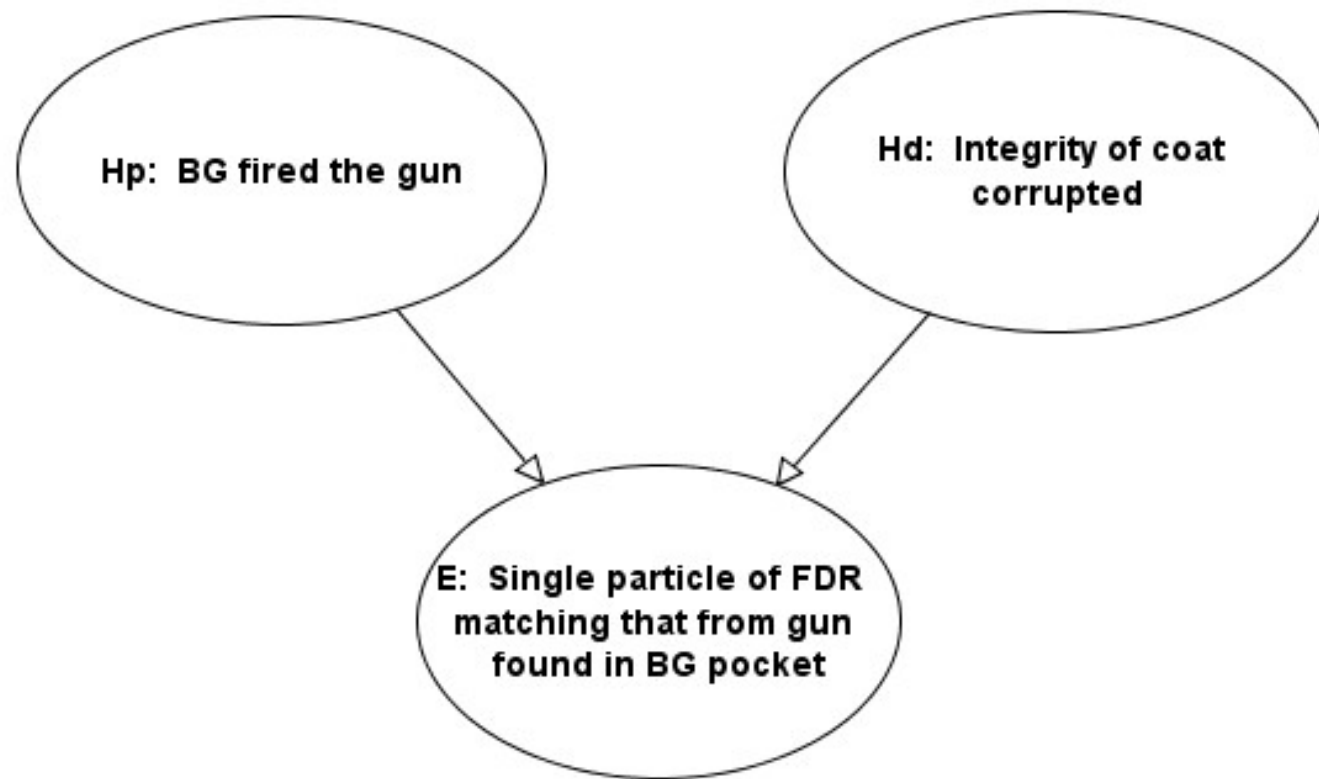
But Prosecution likelihood $P(E|\text{not } H) = 1/100$

So LR = 1 and evidence ‘has no probative value’

But the argument is fundamentally flawed

Fenton, N. E., D. Berger, D. Lagnado, M. Neil and A. Hsu, (2013). "When ‘neutral’ evidence still has probative value (with implications from the Barry George Case)", Science and Justice, <http://dx.doi.org/10.1016/j.scijus.2013.07.002>

LR=1 but hypotheses not mutually exclusive and exhaustive



.....E has real probative value on Hp

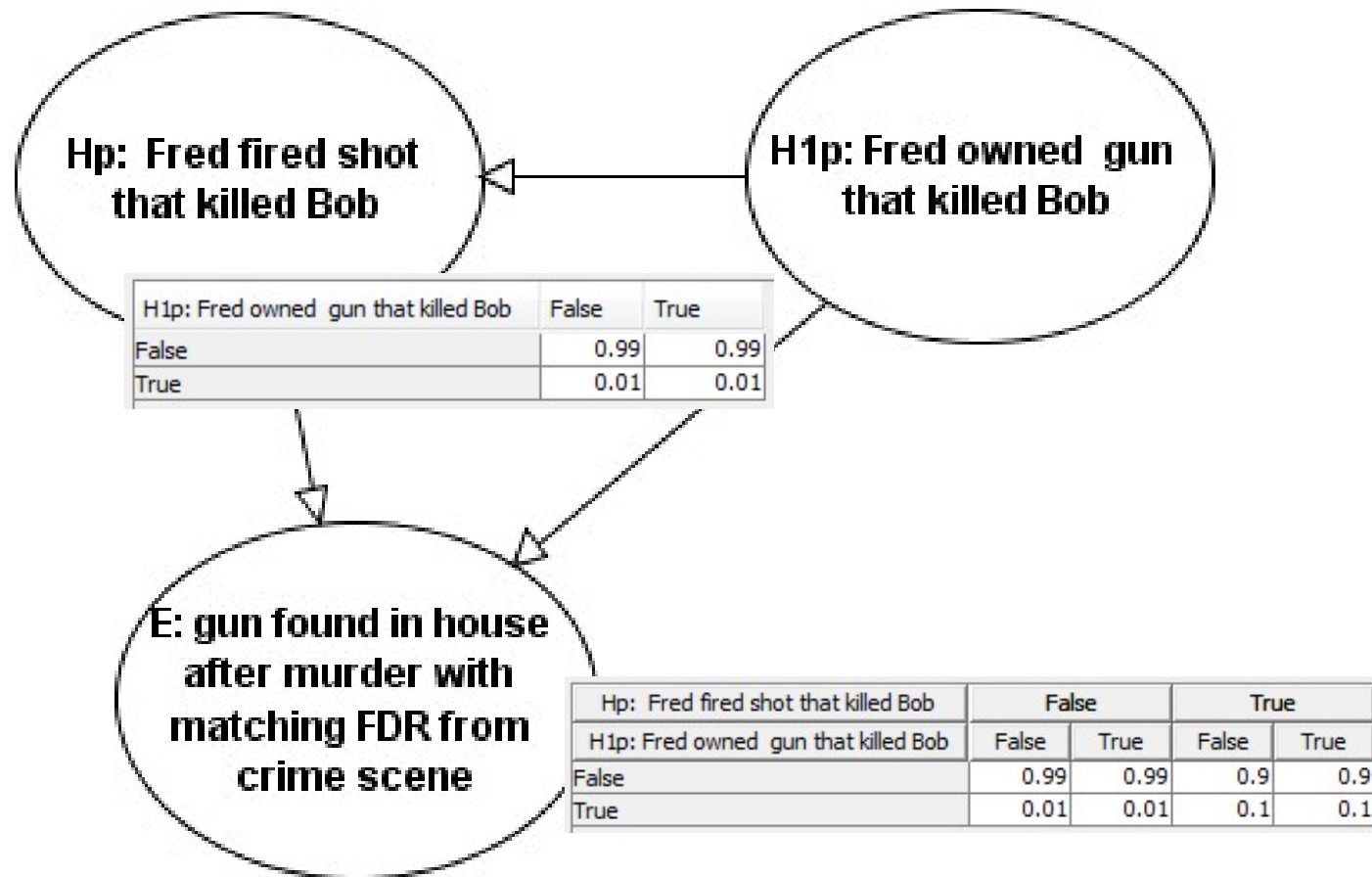
Related (Simpler) Example

Fred and Joe live at the same address. It is known that gun X is registered to that address (but not who the owner is). A man, Bob, is found murdered from a gun shot. Shortly after the murder the police find the following evidence E : there is a gun in Fred's house with FDR that matched that from the crime scene. Fred is charged with the murder of Bob. The offence level hypotheses are:

H_p : Fred fired the shot that killed Bob

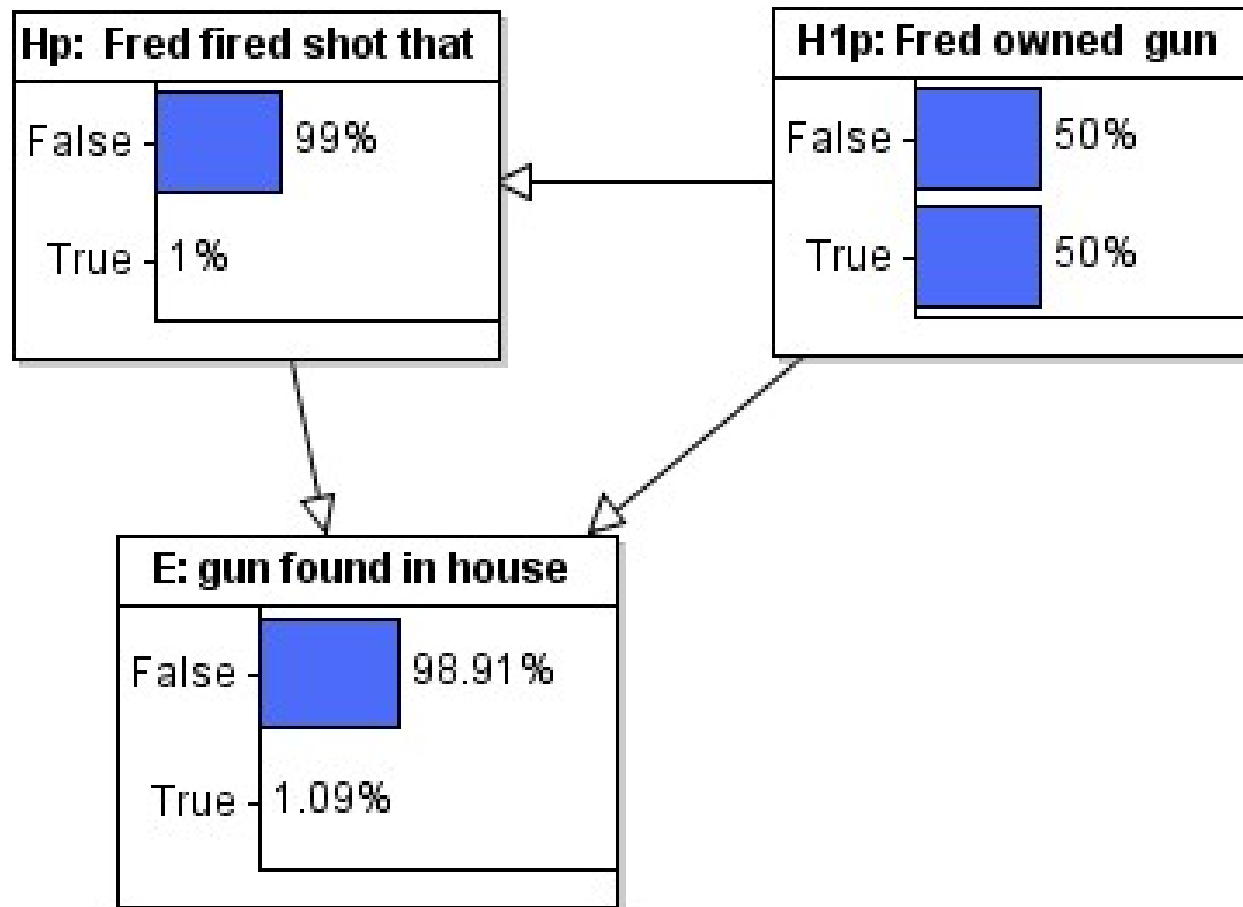
H_d : Fred did not fire the shot that killed Bob

LR=1 but H not ultimate hypothesis

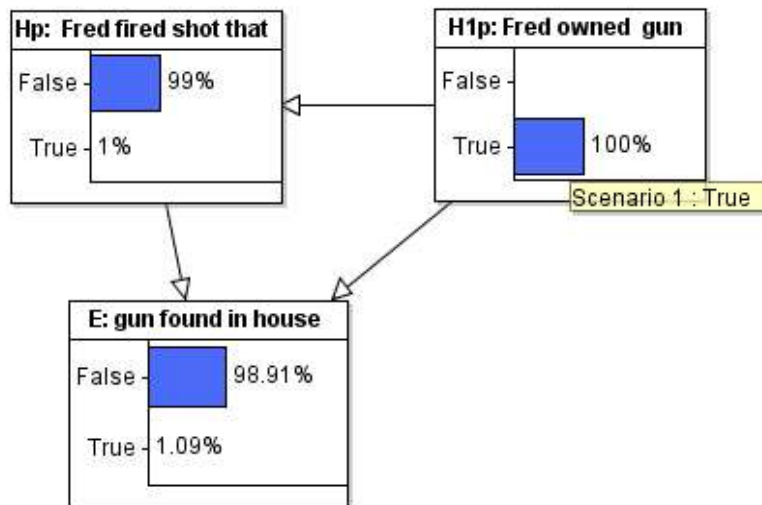


.....E has real probative value on Hp

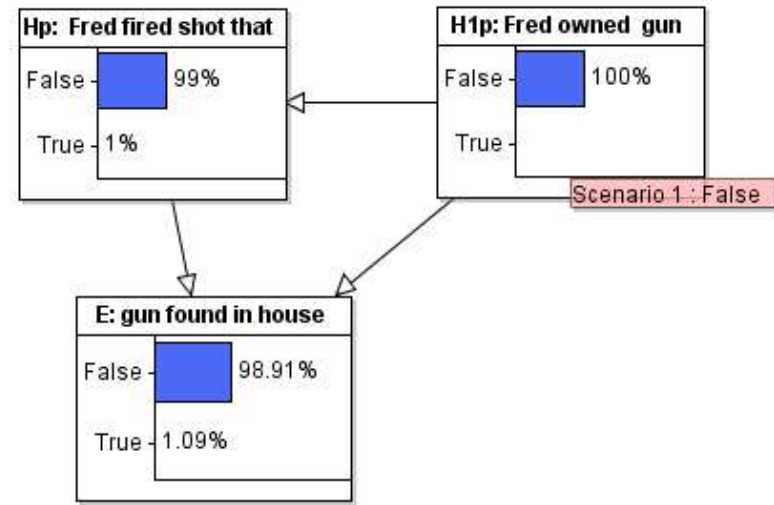
Prior state of the BN



Calculating the probability of evidence E under the two values for $H1p$

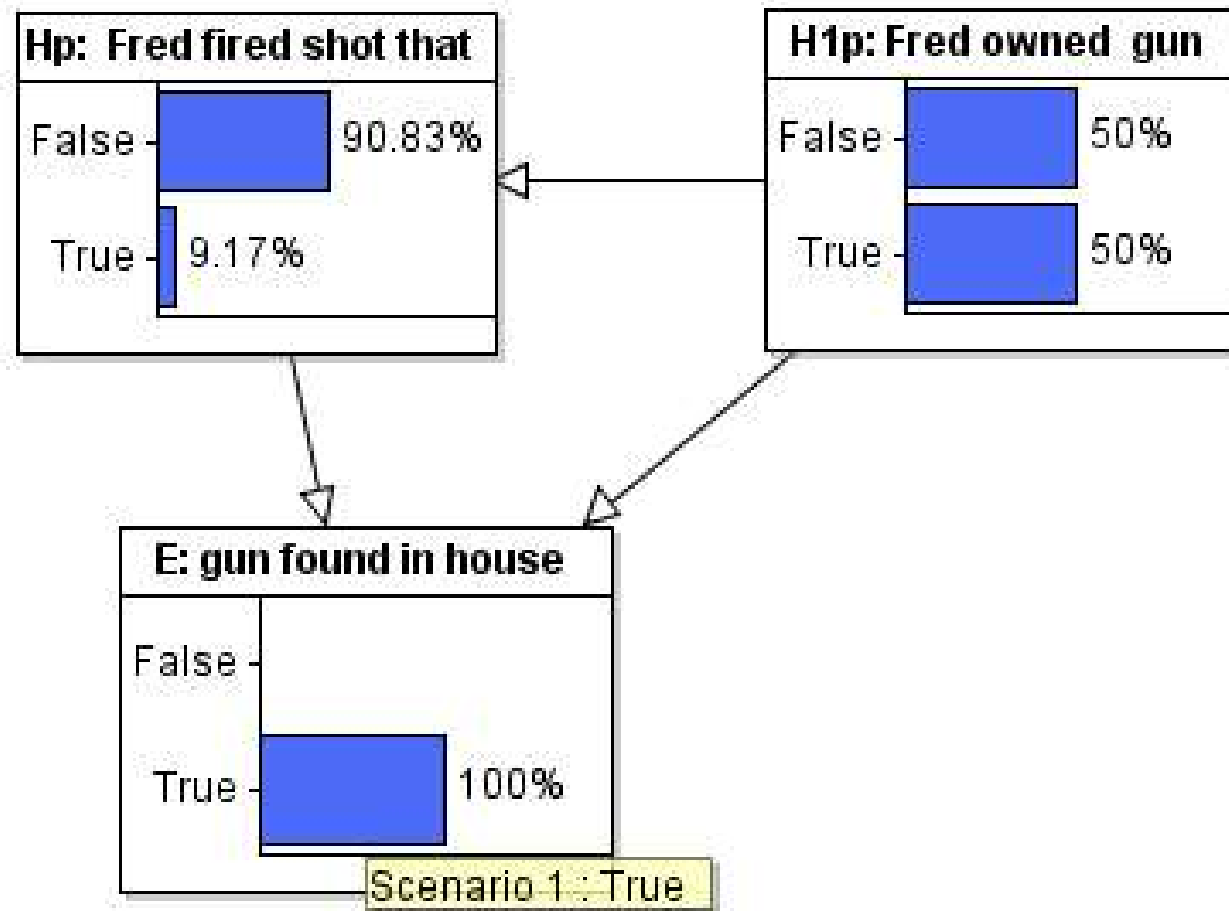


$P(E | H1p) = 0.9891$
(unchanged from prior)



$P(E | \text{not } H1p) = 0.9891$ (unchanged from prior)

Evidence is observed



R vs Levi Bellfield, Sept 07 – Feb 08



Amelie Delagrang



Marsha McDonnell

R v Bellfield

Numberplate evidence

Prosecution opening fallacies

Judge's instruction to Prosecuting QC



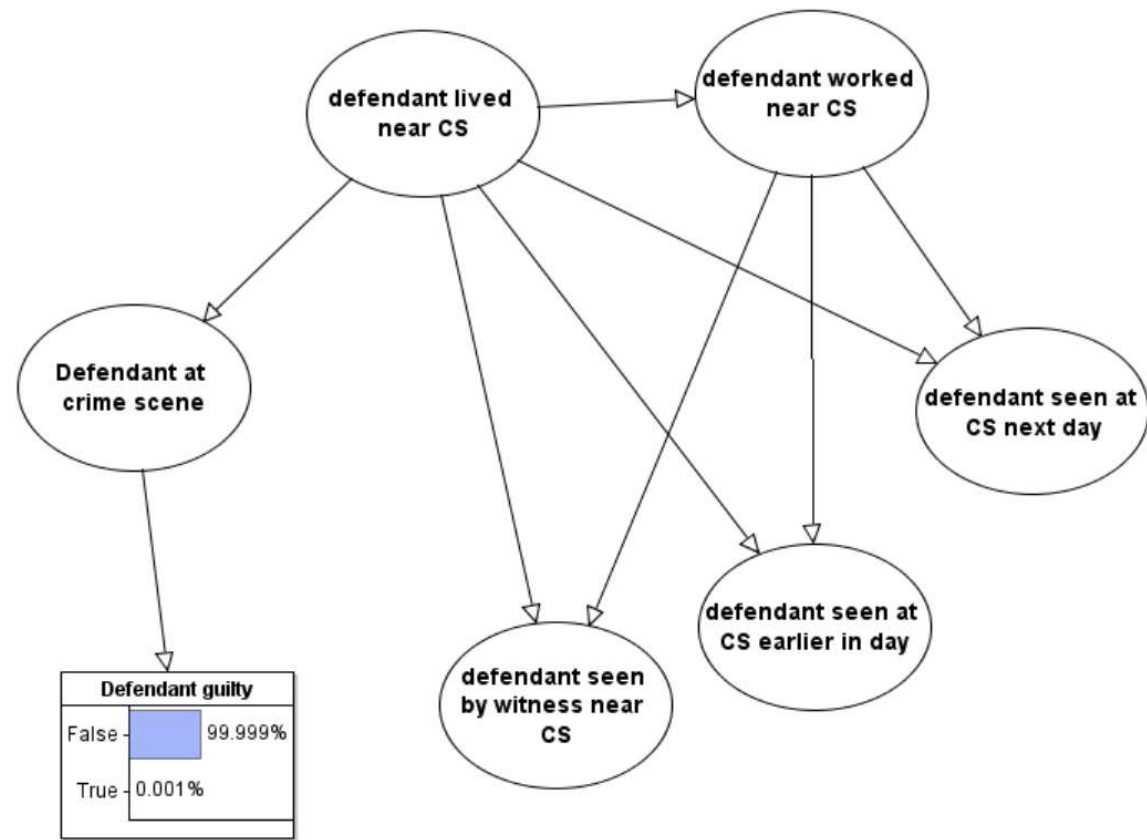
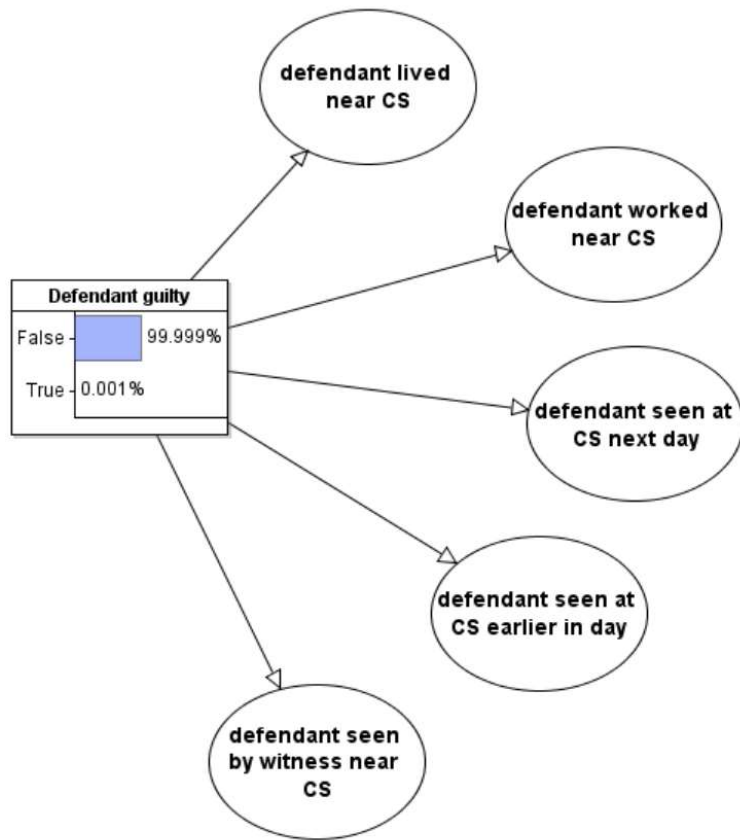
... but on 12 Feb 2008:
"Forensic scientist Julie-Ann
Cornelius told the court the
chances of DNA found on Sally
Anne's body not being from Dixie
were a billion to one."



How the prosecutor's fallacy is also stated

“The chances of finding this evidence in an innocent man are so small that you can safely disregard the possibility that this man is innocent”

Dependent evidence fallacy



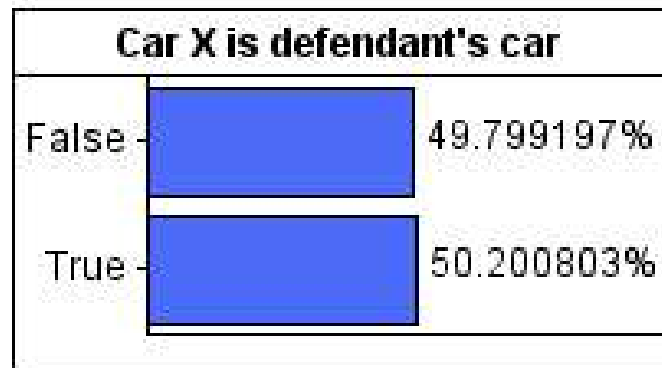
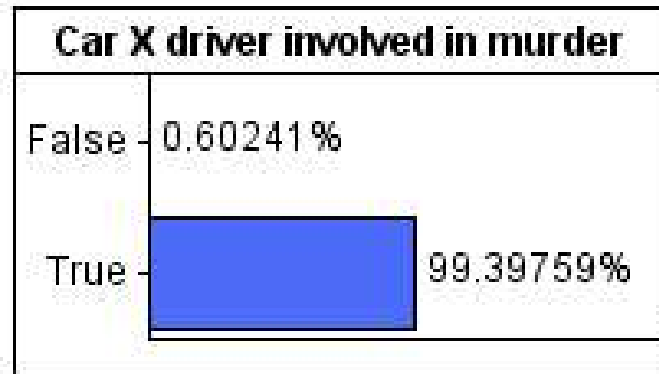
Crimewatch UK Fallacy

- Fact 1: A car of type X was at the scene of the crime and was almost certainly involved in the murder.
- Fact 2: The defendant owned a car of type X at the time of the murder.
- Fact 3: Despite many public requests (including, eg, on Crimewatch UK) for information for an innocent owner of car of type X at the scene of the crime to come forward and clear themselves, nobody has done so

The fallacy:

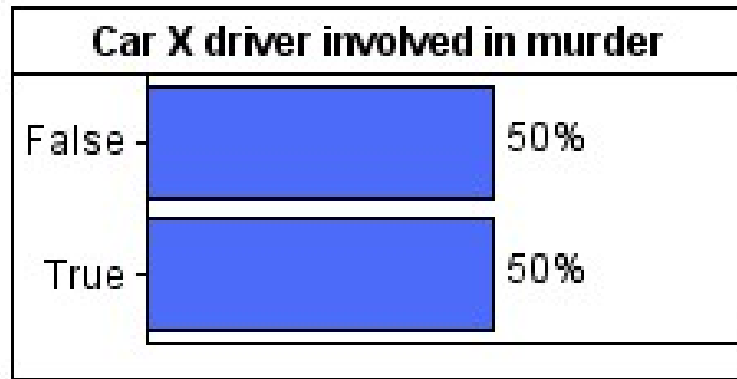
It is therefore highly improbable that the car at the scene of the crime could have been anybody's other than the defendant's.

Now we enter the evidence

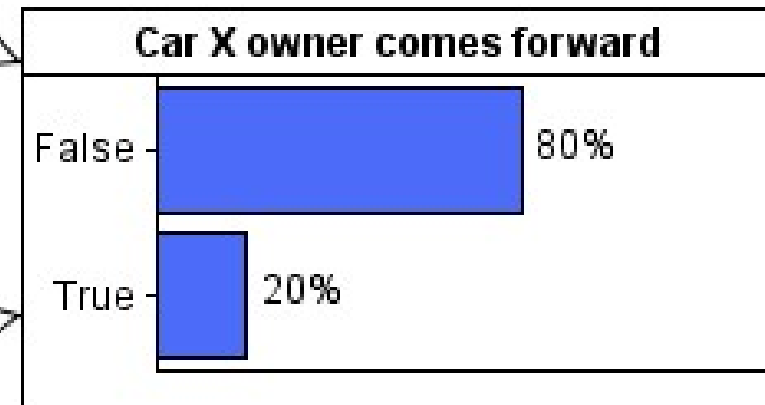
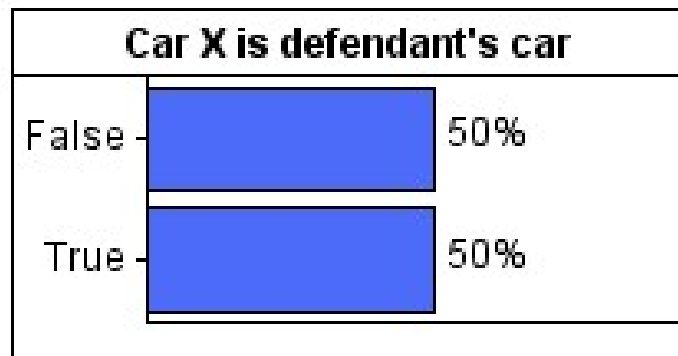


*Contrary to the prosecution claim
the impact is negligible*

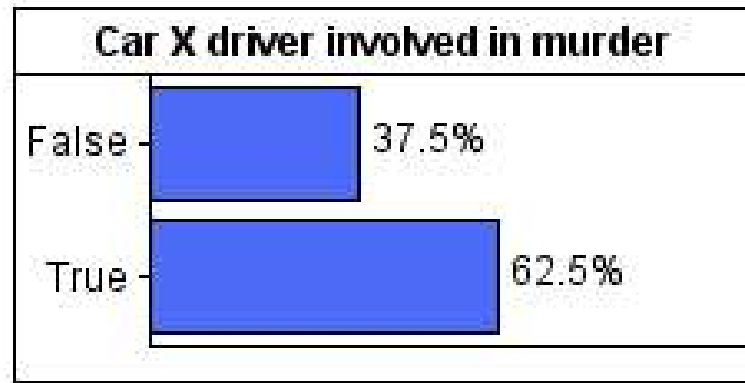
Different priors



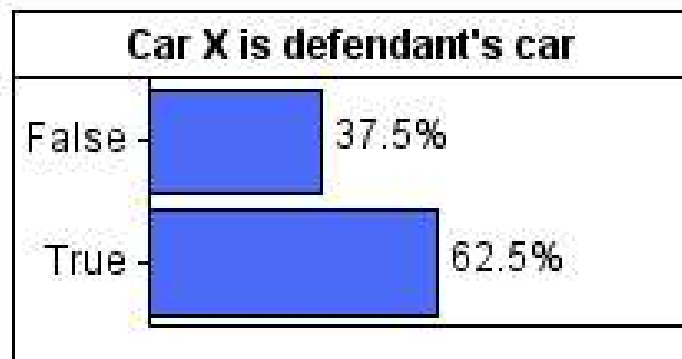
Here we assume just as likely as not to be involved in murder



Evidence now makes a difference



but the priors contradict the core prosecution case



R v Sally Clark

Originally convicted of murder of both her children

Prosecution expert argued $p(\text{SIDS}) = 1/8543$ and hence that

$P(\text{'both SIDS'}) = P(\text{SIDS}) \times P(\text{SIDS}) = 1/72,982,849$

Concluded “P(innocence) about 1 in 73 million”

But this makes two fundamental statistical errors

1. Wrongly assumes two brother's dying of SIDS are independent events
2. Fails to take account of prior probability of murder given an infant death; only 8% of infant deaths are murder, hence if SIDS and murder are the only possibilities, $P(\text{SIDS for a dead infant}) = 92\%$



<https://probabilityandlaw.blogspot.com/2014/01/sally-clark-revisited-another-key.html>

Sally Clark Revisited: A new flaw in the probability experts' reasoning

Hd : Sally Clark's two babies died of SIDS

Hp : Sally Clark murdered her two babies

“(Prior) probability of Hd over 100 times greater than (prior) probability of Hp”

“So assuming LR of 5

Hd : Sally Clark's two babies died of SIDS

Hp : Sally Clark murdered at least one of her two babies.

(Prior) probability of Hd only 2.5 times greater than the (prior) probability of Hp



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Fenton, N. E. (2014). Assessing evidence and testing appropriate hypotheses. Science & Justice, 54(6), 502-504. <http://dx.doi.org/10.1016/j.scijus.2014.10.007>

State v Dominguez 2019

Previous murder conviction – released after
DNA analysis deemed problematic

The San Diego Union-Tribune

Murder case that highlighted DNA-analysis controversy ends with plea to reduced charge, release

The case highlighted the clash between powerful new forensic tools developed by private companies for police and prosecutors and rights of defendants to examine how the tools work

By GREG MORAN
DEC. 6, 2019
3:53 PM

A man who was once sentenced to 50 years to life in prison for a 2008 murder in a San Diego park walked out of custody Friday after pleading guilty to a reduced charge, ending a long-running case that challenged the use of a powerful new DNA testing technology.

In an agreement with the San Diego County District Attorney's Office, Florencio Jose Dominguez, 41, pleaded guilty to a single charge of manslaughter in the 2008 death of 15-year-old Moises Lopez. The agreement calls for Dominguez to get an 11-year sentence, but he has been in prison for a longer time than that, when credits for the time he has already served are factored in.

As a result, Superior Court Judge Charles G. Rogers ordered Dominguez to be released immediately Friday.



<https://probabilityandlaw.blogspot.com/2019/12/problems-with-dna-mixed-profile.html>

Sample output from mixed profile DNA analysis

Locus	Alleles in sample	Suspect alleles
D3S1358	14, 15, 16	15, 15
vWA	15, 16, 17, 19	17, 19
D16S539	10, 11, 12	12, 12
D8S1179	11, 12, 13, 14	11, 12
D18S51	12, 14, 17, 25	13, 25
...
D5S818	7, 10, 11, 12, 13	10, 11
D13S317	8, 9, 10, 12, 13	9, 10
D7S820	8, 8.3, 9, 9.3, 10, 12	10, 11
...
D12S391	15, 16, 18, 19	18, 18
D2S1338	16, 17, 19, 20, 24, 25	23, 25
RESULTS OF ANALYSIS		
Assumed number of contributors: 4 <i>This is a very strong assumption</i>		
Likelihood Ratio: It is 4×10^6 times more likely to obtain the DNA results if suspect is a contributor than if he is not a contributor		
Summary conclusion: Strong support for inclusion of suspect		

'voids' – but the probabilistic genotyping takes care of these

Suggests exhaustive hypotheses but this is NOT done in the calculations

Not when all uncertainty is considered

R v LW since 2010

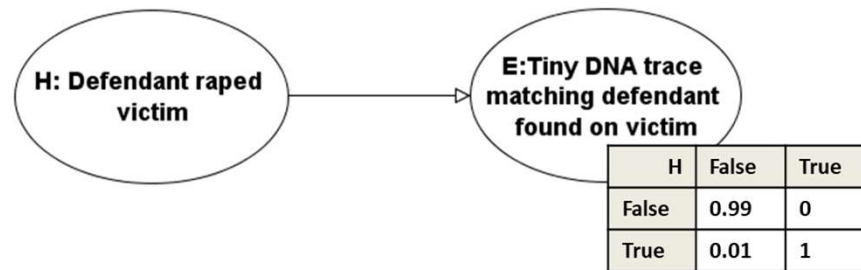
Convicted of rape of half-sister

Low template “DNA match” at issue

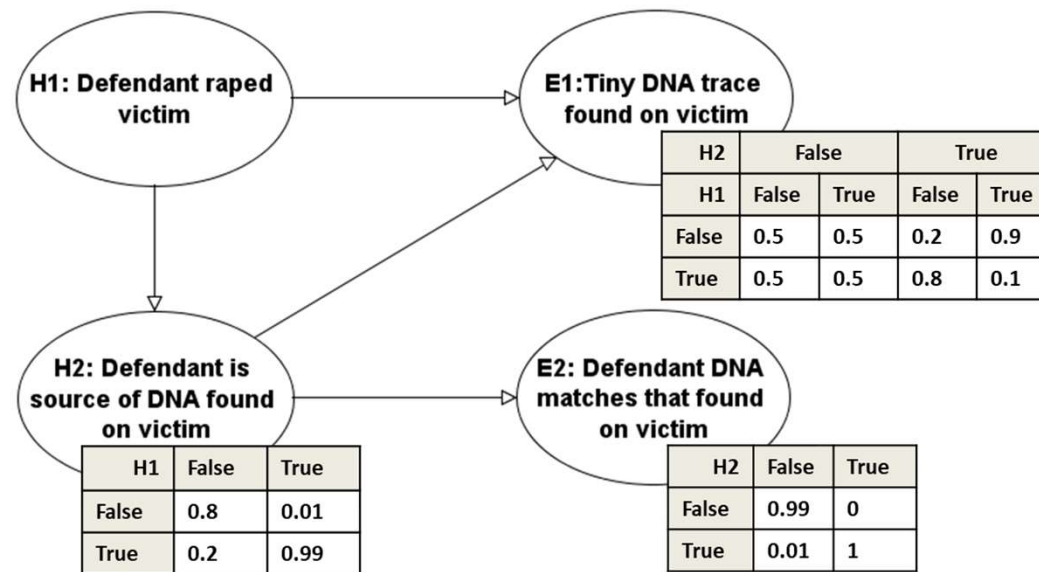


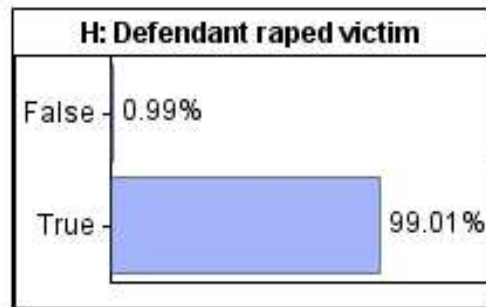
Example: Revealing full BN model reverses impact of evidence

a) Over-simplistic prosecution argument



b) More realistic argument

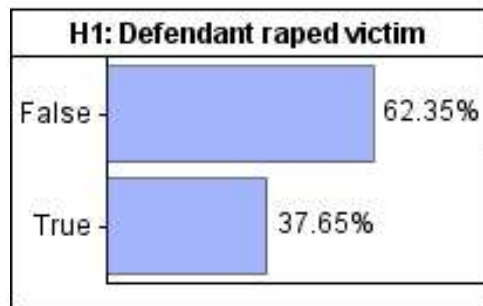




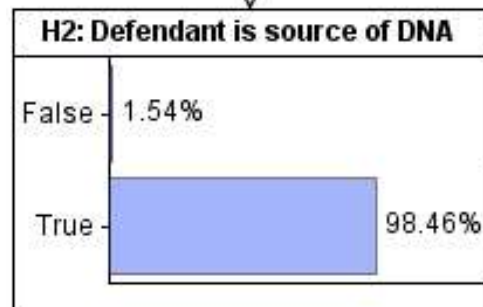
E: Tiny DNA trace matching defendant found on victim

Scenario 1 : True

Posterior probabilities
to 1



Posterior for H1 is
high below 50%
prior



E1: Tiny DNA trace found on victim

Scenario 1 : True

E2: Defendant DNA matches that found on victim

Scenario 1 : True