Background

People v. Collins (1968) is an example where conditional probability and independence were used in probability calculations to aid in a court case in the Supreme Court of California. The case involved a purse being stolen. Witnesses claimed to see a young woman with blond hair in a ponytail running away from the the scene in a yellow care that was driven by a black man with a beard. A few days later, a couple was arrested because they matched these descriptions. However, there was no physical evidence on them.

A mathematician was hired, and they calculated the probability that a randomly selected couple in this California area would possess these characteristics. They found the probability to be 8.3×10^{-8}, or about 1 in 12 million. The jury found this probability extremely compelling and convicted the couple. However, the Supreme Court thought, in the light of no evidence, that a different probability might be more useful: Given that there is one couple who meets the descriptions provided by the witness, what is the probability that a second couple also has those same characteristics?

Set-up

Let p be the probability that a randomly selected couple from a population of n couples has these characteristics. Let us assume that the n couples are mutually independent.

Define A as the event that *at least one* couple in the population has the characteristics, and B as the event that *at least two* couples in the population have the characteristics. The probability of interest is:

Breaking events into manageable pieces

Suppose we number the n couples in the population from 1 to n.

Let A_i be the event that couple i has the characteristics described by the witness, for $i = 1, \ldots, n$.

Let C be the event that *exactly one* couple has the characteristics.

Then we can re-write A and C as follows:

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Observations

1.

2.

3.

Calculations

Results

Because the crime occurred in a heavily populated area of California, they estimated n to be in the millions. Letting $p = 8.3 \times 10^{-8}$ based off the mathematician's calculations and $n = 8,000,000$ couples: