People v. Collins

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 car 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's define the following:

- p is the probability that a randomly selected couple from a population of n couples has the aforementioned characteristics. The mathematician found $p = 8.3 \times 10^{-8}$.
  - **We will assume that the n couples are mutually independent**
- A is the event that *at least one* couple in the population has the characteristics
- B as the event that *at least two* couples in the population have the characteristicss
- C be the event that *exactly one* couple has the characteristics
- A_i is the event that couple i has the characteristics described by the witness, for $i = 1, \ldots, n$.

In terms of these events, the probability the Court is interested in is:

What are some relationships between some or all the events A, B, C?

1.

2.

Calculations

Let's begin by finding $P(A)$. Made easier by re-writing A in terms of the A_i

Now let's find $P(B)$.

Realize that we need $P(C)$! Once again made easier by re-writing C in terms of the A_i

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 (according to California statistics):