## M362K Extra credit #1

## Sally Clark

Please, provide your <u>complete solutions</u> to any problems appearing in this case study. Final answers only, even if correct will earn zero points. Likewise, partial credit will not be negotiable. For short-answer questions, please provide between five and seven sentences touching the salient points of your argument.

1.1. **Introduction.** Here is an excerpt from [2] which introduces the tragic protagonist of this case study.

Sally Clark (August 1964 – 15 March 2007) was an English solicitor who, in November 1999, became the victim of a miscarriage of justice when she was found guilty of the murder of her two infant sons. Clark's first son died in December 1996 within a few weeks of his birth, and her second son died in similar circumstances in January 1998. A month later, Clark was arrested and tried for both deaths. The defense argued that the children had died of sudden infant death syndrome (SIDS).

1.2. **Meadow's Law.** Let's start with a the definition of SIDS (Sudden Infant Death Syndrome) which was in use at the time of the court case introduced above. According to [5], it was formulated by the American pathologist Beckwith, in 1969, and it reads as follows:

"the sudden death of a baby that is unexpected by history and in whom a thorough post-mortem examination fails to demonstrate an adequate cause of death".

In the United Kingdom, SIDS is habitually referred to as "cot death". This is the term used in **Meadow's Law** - in the past frequently cited in court cases - which states that

"one cot death is a tragedy, two cot deaths is suspicious and, until the contrary is proved, three cot deaths is murder".

1.3. **Logical imperatives.** Our first task is to logically unpack the argument made by Roy Meadow in court. Please, consult [5] with a particular focus on the introduction. Which **two** concerns does the author raise? Explain each in your own words.

1.4. In dubio pro reo. As a warm up, start by solving the following simple problem.

**Problem 1.1.** A test is used to determine whether people exhibiting green spots have the *duckpox* or not. It is believed that at any given time 4% of people exhibiting green spots actually have the *duckpox*. The test is 99% accurate if a person actually has the *duckpox*. The test is 96% accurate if a person does **not** have the *duckpox*. What is the probability that a randomly selected person who tests positive for the *duckpox* actually has the *duckpox*?

In the previous (admittedly frivolous) example, we can recognize the ideas behind *sensitivity* and *specificity* as measures of quality of a test (see, e.g., [3]). A medical practitioner must be aware of the consequences of both false positive and false negative findings and should **make a conscious decision** about which to prioritize. Please, provide two scenarios, one in which *sensitivity* is to be prioritized and one in which *specificity* should be prioritized, in your opinion.

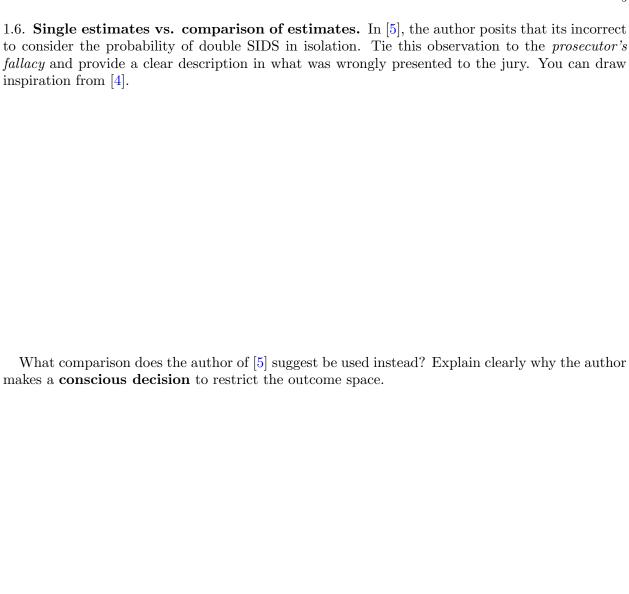
A logically closely related concept exists in the western legal practice. The idea of *in dubio pro* reo is explained in [1]. Explain in your own words the parallels between *sensitivity* vs. *specificity* and the possible errors when a verdict is reached in the court of law. Complete your explanation by tying this legal principle to the first concern raised in [5].

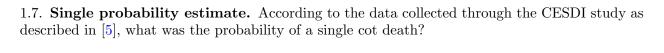
1.5. **The prosecutor's fallacy.** According to [10], the *prosecutor's fallacy* can be summarized as follows:

It's when the probability of innocence given the evidence is wrongly assumed to equal an infinitesimally small probability that that evidence would occur if the defendant was innocent.

Create a probability tree modeling the above situation and clearly indicate which two probabilities are being confused.

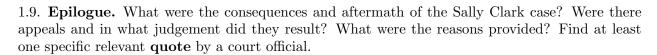
Write your own numerical example - perhaps based on the problem above, or maybe based on one of the citations - in which you point out the difference in **scale** between the two numbers being confused.





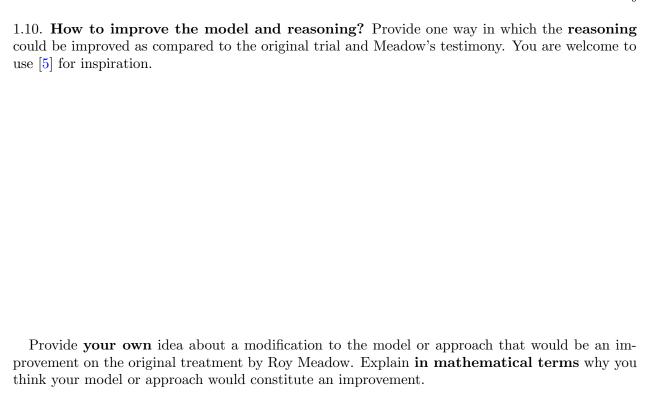
Why is the above figure different from the one used for a **single cot death** by Roy Meadow during the Sally Clark trial?

1.8. <b>The independence assumption.</b> Write down the definition of <b>independence</b> of two events.
Explain how Roy Meadow used the <b>independence</b> assumption in his reasoning in court. At
what number did he arrive?
What was the verdict in the original Sally Clark trial - influenced largely by Roy Meadow's testimony?
Why is the assumption of independent, identically probable events erroneous in this context? You may consult [9] to bolster your reasoning.



What happened to Sally Clark?

Was this trial an isolated case or was *Meadow's law* utilized more widely? Provide at least one more example of a court case in which Meadow's law - despite being erroneous - was used. Explain the mathematical fallacy behind the original verdict in the example you found and state whether the verdict was eventually overturned. *Hint:* The stunning case of Kathleen Folbigg will prove fascinating to those of you with interest in genetics.



1.11. **Further reading.** For more about the randomness around us and how to understand it better, look into [7]. For a more specific treatment of ethics in its relation to probability, I suggest [6]. For an even more specific array of applications, I suggest [8]. All these books are available in the UT libraries with the latter two available as online copies.

## References

- 1. Wikipedia community, In dubio pro reo, https://en.wikipedia.org/wiki/In\_dubio\_pro\_reo.
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- 5. Ray Hill, Multiple sudden infant deaths coincidence or beyond coincidence?, Pediatric and Perinatal Epidemiology 18 (2004), 320–326.
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- 7. Leonard Mlodinow, *The drunkard's walk: how randomness rules our lives*, 1st ed. ed., Pantheon Books, New York, 2008 (eng).
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- 9. Royal Statistical Society, Royal Statistical Society concerned by issues raised in Sally Clark case, https://web.archive.org/web/20110824151124/http://www.rss.org.uk/uploadedfiles/documentlibrary/744.pdf.
- 10. Kathy Taylor, The Prosecutor's Fallacy, https://www.cebm.ox.ac.uk/news/views/the-prosecutors-fallacy.