# NIST panel on quantifying the weight of evidence

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# Subjective probability and the SLR

- If one is subjective in choice of construction of LR/BF, it should be assumed he/she is coherent and follows the axioms of probability
- Assumptions are made with any model choice and must be valid and upheld
- If/when those model assumptions are found to be invalid, the model is wrong, and the subjective "justification" is wrong and the individual is incoherent
  - Some violations are more/less severe
- Some SLRs do not satisfy basic principles

# Subjective probability and the SLR

-Principles of a well-constructed SLR

Not an exclusive list!

- Coherency Principle
  - In Bayesian decision theory, the coherency principle assumes degrees of belief obey to the axioms of probability and that consistent decisions can be made based on personal probabilities
- Sufficiency Principle
  - All Sufficient statistics based on data $x$ for a given model $p_\theta(x)$ should lead to the same conclusion
  - Also provides that choice in score is a sufficient statistic
- Likelihood Principle
  - Two datasets that produce equal/proportional likelihoods should lead to the same conclusion

# Subjective probability and the SLR

-An example of the Coherency principle

- Let $H_A,\ H_B$ be two mutually exclusive propositions for a population of 2 sources $A, B$ with a set of observations made on a trace $e_u$ and control objects $e_A, e_B$. The LR should not be influenced by the order of proposition.
- Under coherency we get:

$$LR_{A,B} = \frac{\Pr(e_u|H_A)}{\Pr(e_u|H_B)} = \frac{1}{LR_{B,A}} = \frac{1}{\frac{\Pr(e_u|H_B)}{\Pr(e_u|H_A)}}$$

# Subjective probability and the SLR

-An example of the Coherency principle

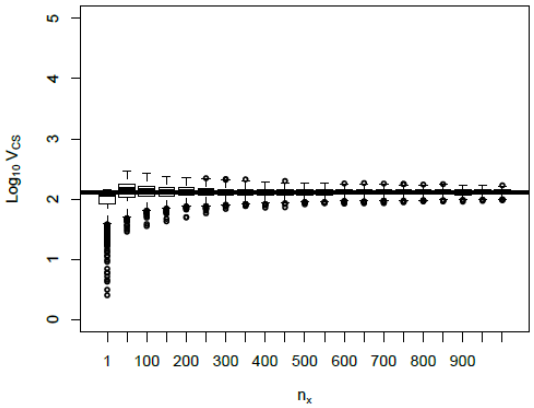
- However, with some SLRs:

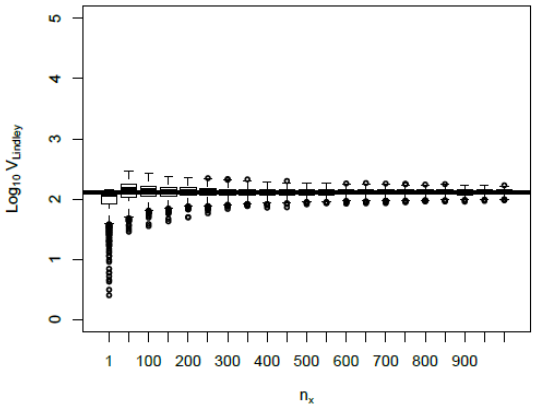
$$LR_{H_A} = \frac{\Pr(e_u|H_A)}{\Pr(e_u|H_B)} \approx \frac{\Pr(\delta(e_u, e_A)|H_A)}{\Pr(\delta(e_u, e_A)|H_B)} \neq \frac{1}{\frac{\Pr(\delta(e_u, e_B)|H_B)}{\Pr(\delta(e_u, e_B)|H_A)}}$$

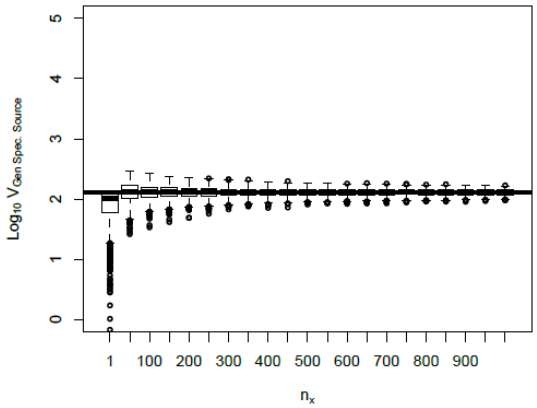
- None of the SLRs we have studied uphold this principle!

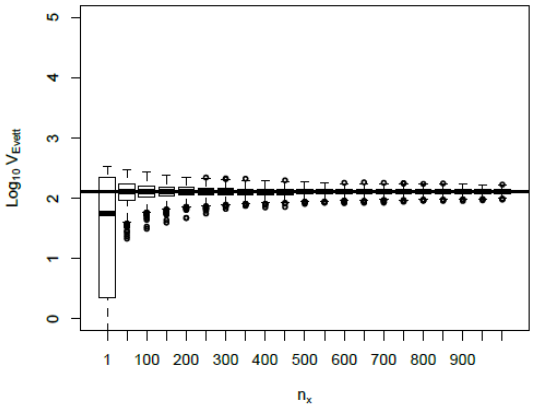
# Subjective probability and the SLR

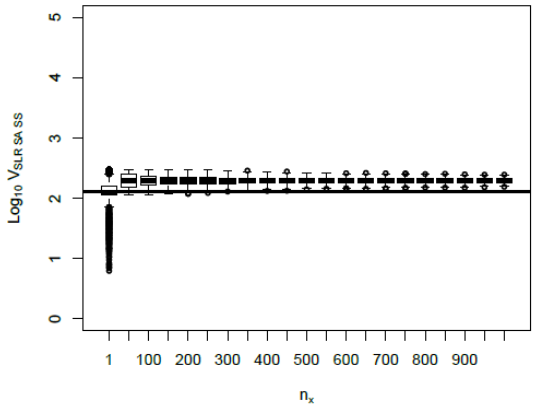
## -Lack of convergence

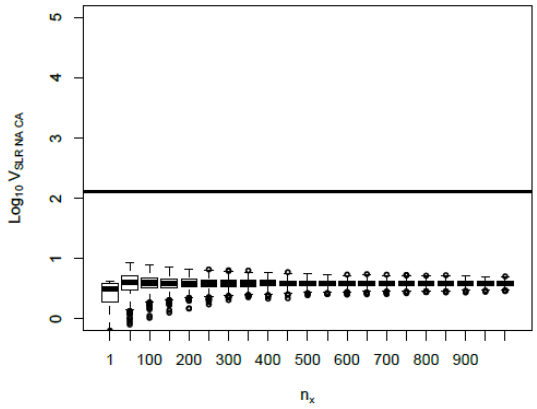


# Subjective probability and the SLR

-SLRs do not consistently meet all principles

- By using some basic principles, we can objectify the selection of a score-based model
- At the end of the day, the courts need to trust that models used to estimate the LR/BF are valid!

# Calibration of the LR

- It is acceptable to calibrate a LR, as long as the resulting calibrated-LR is not reported as a LR
  - When used in this manner, the LR behaves as a metric, and a system is optimized to reduce error rates.
  - A form of supervised training
- These are great in decision engines (speech for instance)

# Calibration of the LR

- Some methods calibrate the LR via the posterior odds
  - These methods suggest prior odds to obtain optimized posteriors
- Calibrated LRs are not appropriate in court-room settings
  - If reported in court, they need to be made clear what they are
  - Any reported LR still needs to follow the first rule of LRs:
    - If LR > 1, support the prosecution (numerator) hypothesis
    - If LR < 1, support the defense (denominator) hypothesis

# Future of the SLR

- We still want to use the data reduction techniques that make SLRs attractive in the first place.
- A method which takes into consideration the relationships and dependencies between the objects in the population of potential sources.
- A method which has similar theoretical properties as the LR

# Future of the SLR

- A method has been suggested by Gantz & Saunders to estimate the numerator of a LR. The method makes use of kernel-based methods, prevalent in pattern recognition
- My current research is focused on extending this method to the denominator and suggesting a set of conditions necessary to ensure convergence to the ideal LR

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