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COMBATTING BAYESIAN CRITICISM: A BAYESIAN-INSPIRED CRITICAL CHECKLIST FOR JUDICIAL REASONING

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ABSTRACT: This paper develops a Bayesian-inspired checklist of critical questions designed to support probabilistic reasoning in legal contexts. Building on Mackor's (2026) proposal, rather than requiring formal Bayesian models or numerical probabilities, the framework translates key Bayesian principles into a practical sequence of guided questions aimed at helping judges improve and structure their reasoning and avoid probabilistic fallacies. is intended to assist judges in structuring and critically reflecting on their reasoning, while helping to identify and avoid probabilistic fallacies.

The framework addresses common reasoning errors discussed in the legal literature (see Dahlman, 2023), including base-rate neglect, inversion fallacies, false dichotomies, dependence neglect, convergence neglect, and link-skipping. Organised according to key stages of probabilistic reasoning, the checklist is designed as a flexible aid to judicial deliberation and self-evaluation rather than a formal decision-making model. It aims to promote transparency in reasoning, encourage explicit reflection on assumptions and evidential relationships, and support the critical evaluation of expert evidence. Future research will focus on empirical testing and further refinement of the framework.

KEYWORDS: Bayesian reasoning, Legal aid, Probabilistic fallacies

SUMMARY:

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1. INTRODUCTION

The central question addressed by Mackor (2026) is whether the Bayesian model can provide meaningful guidance for the judicial evaluation of evidence, in particular through the modelling of complete criminal cases. While this approach offers a formally coherent framework for reasoning under uncertainty, Mackor highlights the practical and conceptual concerns associated with its application in judicial contexts. These include discussions on the feasibility of constructing full Bayesian networks in real cases, as well as the ability of judges to apply such models reliably and independently.

In light of these limitations, Mackor identifies a number of directions for future research. Among these is the proposal to translate the insights of Bayesian reasoning into a structured checklist of "critical questions" that legal practitioners could use when analysing evidence to help them recognise and avoid probabilistic fallacies.

The present paper takes up this proposal directly. Rather than focusing on the construction of complete Bayesian models, it seeks to operationalise the suggested list of critical questions by developing a structured checklist for use in legal, in particular judicial, reasoning. In doing so, it builds on the insights of Bayesian analysis, while deliberately avoiding the need for numerical quantification or the construction of full Bayesian networks. The aim is to provide judges with a practical tool for identifying and avoiding probabilistic fallacies in their own reasoning, as well as for critically assessing reasoning presented in expert reports. In this way, the paper offers a concrete response to the research agenda outlined by Mackor, by developing and structuring the proposed checklist into an instrument that can be implemented in judicial (and broader legal practice). In its current stage, the research remains a theoretical, offering an initial version of the checklist in the literature. The framework will undergo further refinement through feedback and iterative development before being subjected to rigorous empirical evaluation in future studies.

1.1. The Problem: Probabilistic Reasoning in Judicial Contexts

Judicial decision-making involves reasoning under uncertainty. Judges are required to evaluate competing hypotheses in light of incomplete and often complex evidence, including probabilistic information derived from expert testimony. A substantial body of research has demonstrated that, in such contexts, legal factfinders are susceptible to systematic errors in reasoning (Aitken & Taroni, 2004; Cole, 2004; Dahlman, 2015; Dahlman *et al.*, 2016; De Keijser, J. & Elffers, 2012; Fenton & Neil, 2000; Koehler, 1993; Koehler, 2008; Koehler & Thompson, 2006; Martire *et al.*, 2013; Pilditch *et al.*, 2019; Saks & Koehler, 2008; Thompson & Schumann, 1987). These include a range of probabilistic fallacies, including but not limited to, base-rate neglect, inversion errors, and the misinterpretation of convergent evidence, as identified in the literature (see Dahlman (2023) for a full overview).

Such errors are not merely theoretical concerns; they have been associated with documented miscarriages of justice such as in the case of Lucia de Berk (Gill *et al.*, 2010). They often arise not from a lack of information, but from failures to properly structure and evaluate the relationship between hypotheses and evidence. Importantly, such probabilistic fallacies result in flawed judicial reasoning even if the reasoning does not result in a formal miscarriage of justice (Mackor, 2022). From a normative perspective, the laws of probability provide a framework for coherent reasoning under uncertainty, helping to avoid internal contradictions and inconsistencies in fact-finding (Hunt and Mostyn, 2019).

The approach adopted in this paper therefore assumes that the uncertainty inherent in legal reasoning can, at least in principle, be expressed in probabilistic terms. At the same time, it recognises that the use of probability, more specifically the Bayesian model, in legal contexts remains contested. Some legal scholars and practitioners question whether legal reasoning can or should be quantified (Meester, 2020; Meester & Stevens, 2025). This tension highlights the need for approaches that retain the benefits of probabilistic reasoning while remaining accessible and commonly accepted within legal practice.

1.2. Suggested solutions: The Bayesian Method

Within the literature on rational legal proof in the Netherlands[2], three broad approaches are commonly discussed: Bayesian models, scenario-based (or narrative) approaches, and argumentation-based frameworks (Prakken, 2018). These differ, among other things, in their treatment of probabilistic reasoning. Bayesian and scenario-based approaches typically involve indirect probabilistic reasoning, in which hypotheses are evaluated in light of how well they explain the evidence, whereas argumentation-based approaches often involve more direct reasoning from evidence to conclusions.

The Bayesian method, in particular, offers a coherent framework for reasoning under uncertainty. A key advantage of the Bayesian approach is that it makes the role

[2] This is not limited to the Netherlands, see e.g., the Simonshaven case analysis (Prakken *et al.*, 2020).

of prior assumptions and the impact of new evidence on these assumptions explicit (Lagnado *et al.*, 2012). However, its application in legal contexts has been widely debated. A common criticism concerns the assignment of numerical probabilities, summarised in the question "where do the numbers come from?" (Tillers & Green, 1988; Meester & Stevens, 2024), as well as the complexity and required expertise involved in constructing and interpreting complete Bayesian networks (Prakken, 2020).

Recent research (Vlek *et al.*, 2013), although still limited, further suggests that the construction of complete Bayesian networks for entire criminal cases may not be feasible for judges in practice, due to both time constraints and the level of technical expertise required[3]. This issue was investigated by Hampson & Leeuwen (2026), who independently constructed Bayesian models based on the same criminal case verdict. Their findings indicate that the process of constructing such models yields important qualitative benefits, including greater transparency in reasoning, clearer identification of assumptions, and improved understanding of evidential relationships. Notably, the subsequent comparison and discussion of these models proved particularly insightful, as it helped to clarify the structure and implications of Bayesian reasoning.

Against this background, Mackor (2026) argues that certain objections to Bayesian analysis lose force when judges themselves engage with the method, for example during deliberations. In such cases, Bayesian reasoning need not function as a primary decision-making framework, but rather as a reflective tool. Judges may first arrive at a preliminary assessment of the evidence using more traditional methods and subsequently compare this assessment with the outcome of a more structured Bayesian analysis. In this sense, the method operates as a form of a post hoc inspection, enabling judges to critically evaluate their initial conclusions.

Taken together, this raises the question of whether similar benefits might be achieved through more accessible means, by providing structured support that guides reasoning without requiring the construction of full Bayesian models.

The following section builds on this by outlining how Bayesian principles can be implemented in a structured checklist of critical questions to support correct reasoning and safeguard against probabilistic fallacies in legal reasoning, In doing so, it seeks to retain the normative strengths of Bayesian reasoning, such as the explicit consideration of hypotheses, evidence, and assumptions, while avoiding common criticisms associated with formal Bayesian approaches, including the need for precise numerical probabilities or fully specified Bayesian networks. The checklist is designed as a tool for judicial self-evaluation, intended for both individual and collective use. Its purpose is to support judges in identifying and avoiding probabilistic fallacies in their own reasoning, as well as in critically assessing the reasoning presented in

[3] Although this requires further research, as discussed by Mackor (2026).

expert reports. By structuring reflection through guided questioning, the proposed framework aims to make key elements of probabilistic reasoning more transparent and accessible in practice.

2. METHOD: FROM THEORY TO STRUCTURED CHECKLIST

Building on the conceptual framework outlined above, this section sketches out the procedure through which the proposed checklist was developed. This is not presented as a formalised methodology, but rather as a theory-informed account of the considerations that shaped the design. The aim was to translate theoretical insights from Bayesian reasoning and literature on probabilistic fallacies into a structured and practically applicable instrument.

Thus, the underlying structure of the checklist is informed by Bayesian reasoning, although it is not applied in a formal or quantitative manner. Instead, it reflects key elements of Bayesian inference, such as the consideration of prior assumptions, the evaluation of the likelihood of evidence under competing hypotheses, and the comparison of alternative explanations, and follows the order in which these typically arise in Bayesian modelling[4].

Following Mackor (2026), when implementing a Bayesian framework, it is first necessary to clarify the conditions under which it is to be applied: In particular, three questions must be addressed: who performs the analysis, at what stage is it used, and what is the intended function. In the present case, these questions are answered as follows. First, the analysis is intended to be performed by legal professionals (judges, lawyers) themselves. Second, it is intended to guide deliberations in the court chamber as well as the write up of the judicial ruling. Third, its function is not to replace judicial reasoning, but to serve as a tool for reflection, enabling judges to critically assess, and where necessary, refine their evidential conclusions.

Alongside this, it is necessary to identify where judicial reasoning is prone to error. The checklist draws on a set of probabilistic fallacies identified in the legal literature, most notably the taxonomy proposed by Dahlman (2023). Dahlman list contains twelve fallacies organised into seven categories, of which 6 are discussed in this article: The product fallacy is not discussed here. This aligns with the aim of the checklist to avoid the focus on the numbers and remain usable for factfinders[5].

Each fallacy was treated as a point of departure for question design. The reasoning processes underlying these fallacies were examined, and, for each, a sequence of

[4] It should be noted that there is no universally accepted way to model Bayesian networks. This is based on both the legal idioms outlined by Lagnado *et al.* (2012) and the author's personal experience.

[5] The product fallacy refers to the failure to apply the product rule of probability theory to independent evidence supporting the same hypothesis, leading to an under-estimation of the combined probative value of the evidence (Dahlman, 2023). It inherently involves reasoning with numbers, therefore it is not included in the checklist.

questions was developed. These prompts were designed with the aim to counteract fallacious reasoning by uncovering the assumptions on which they rest, examining the evidential basis for those assumptions, and exploring alternative explanations or competing hypotheses.

Rather than consisting of isolated prompts, the checklist is structured as short sequences of interconnected questions, in which each question builds on the previous one. In this way, it aims to approximate a dialogue-like exchange (akin to discussions in the deliberation chamber amongst three judges) guiding the user step-by-step through the reasoning process whilst encouraging explicit reflection.

The question derivation process was further informed by reference to documented European cases in which such fallacies have occurred[6]. These cases were used as examples to illustrate how factfinders can arrive at erroneous conclusions in practice and to support the development of question sequences by targeting points where reasoning may break down.

Finally, given its intended application in real-world judicial contexts, focus was placed on (1) understandability, (2) transparency, and (3) feasibility. (1) The questions are formulated in clear, non-technical language and (2) are accompanied, where necessary, by brief explanations of relevant probabilistic concepts and fallacies. This is intended to ensure that the tool supports informed reasoning without imposing the technical demands associated with formal Bayesian modelling. (3) The checklist is designed to remain concise and practical within the time constraints of judicial reasoning. Questions are kept limited and organised into subgroups, facilitating the skipping of questions factfinders have already considered or regard as sufficiently addressed.

3. CHECKLIST DEVELOPMENT

Reasoning about legal evidence can be understood, at a basic level, as involving the evaluation of a hypothesis (H), typically whether the defendant is guilty or not, in light of observed evidence (E). While formal Bayesian networks provide a structured representation of these relationships, the present approach translates this structure into a sequence of guided questions. These questions are designed to guide the decision-maker through the key stages of probabilistic reasoning while identifying common sources of error. Accordingly, the checklist is organised into a series of Bayesian reasoning stages, drawing references to relevant probabilistic fallacies that may arise during at each stage.

[6] The Sally Clark and Lucia de Berk cases, amongst others, informed this derivation. Although these cases have already been discussed at length in the literature, they remain useful illustrations of how probabilistic reasoning errors may arise and be identified in practice. NB: The aim was not to provide an exhaustive review of all legal cases involving probabilistic fallacies, particularly as there may also be cases in which such fallacies were committed but not recognised or discussed. Rather, these cases are used as illustrative support for the development of the checklist and its underlying reasoning structure.

3.1, Framing the Hypotheses and Evidence

At the most basic level, probabilistic reasoning requires clarity as to what is being evaluated. Errors can arise where the hypothesis or the evidential basis is left implicit or insufficiently specified (Dahlman, 2023). Accordingly, the checklist begins by requiring the decision-maker to explicitly articulate both:

(1) *What is the main hypothesis under consideration?*

(2) *Have any alternative hypotheses been proposed? What are they?*

(3) *What evidence is available in the case?*

These initial questions establish the structure within which subsequent reasoning takes place, this is akin to the starting point of the construction of a Bayesian network (Lagnado *et al.*, 2012).

3.2. Prior Probabilities and Base Rate Neglect

A key feature of Bayesian inference is the consideration of the prior (Lagnado *et al.*, 2012). The prior refers to the probability of a hypothesis being true before any case-specific evidence is taken into account. Assuming the hypothesis concerns the defendant guilt, the prior probability is the probability of the defendant being guilty before considering any evidence. A simplified example may help illustrate this concept further. Suppose an inmate in a prison is accused of murdering another inmate. Due to the restricted location of the crime, investigators determine that only a limited group of individuals could have realistically committed the offence, including all prison staff and inmates with access to the area. If, for illustrative purposes, this group consists of 100 individuals, the initial probability that any one individual committed the crime is 1 in 100. In a formal Bayesian analysis, this represents the starting probability. Once additional evidence becomes available, this probability may increase or decrease.

Failure to consider this starting probability constitutes a well-documented probabilistic fallacy commonly referred to as 'base-rate neglect' (Bar-Hillel, 1980; Dahlman, 2023; Fenton and Neil, 2011; Gigerenzer, 1991; Koehler, 1996; Thomson and Schuman, 1987). The three following cases clearly illustrate this error.

The first example can be found in a Swedish case from 2019[7], in which an influencer was prosecuted for the murder of his girlfriend, who was found dead in a bathtub. Given that suicide is statistically far more common than homicide in Sweden, the municipal court's failure to adequately consider this base rate may have systematically biased reasoning in favour of the prosecution (Dahlman, 2023). The defendant

[7] Solna tingsrätt, 2019-04-04, B 3252-18

was initially found guilty before the verdict was later overturned by the Court of Appeals. The second example concerns the infamous case of Sally Clark, who was accused of murdering her two infant children. Central to the case was the comparison of two competing hypotheses: either the two babies died of sudden infant death syndrome (SIDS), or both children were murdered by their mother. During the trial, expert testimony focused heavily on the rarity of the two SIDS deaths occurring within the same family, presenting this event as extremely improbable. The fact that the probability of a mother killing both of her infant children is also extremely low, if not lower, was neglected. The final example refers to the case of Lucia de Berk, a Dutch nurse convicted for multiple murders. It was argued that it was a low probability that her proximity to multiple patient deaths was coincidental. Within this line of reasoning, the base rate of fatalities at the hospital, as well as nurses working on shift during such events was neglected. In all three cases, they were first convicted before the verdict was later overturned.

Although the concept of the prior is widely recognised as a central element of Bayesian reasoning, its operationalisation remains highly debated (Cheng & Pardo, 2015; Dahlman & Koflaath, 2021; Dawid, 2002; Friedman, 2002; Meester & Stevens, 2024; Posner, 1999; Stein, 1996; Sullivan, 2019). Various numerical approaches to determining priors have been proposed and explored in the literature (e.g., the opportunity prior (Fenton *et al.*, 2019)). At the same time, scholars have questioned whether such prior knowledge can always, or should always, be expressed in precise numerical form, particularly in legal contexts where the relevant background information may be limited (Meester & Stevens, 2024).

Given that much of the debate surrounding priors concerns the assignment of exact numerical values, the present framework deliberately avoids requiring judges to determine precise numerical probabilities. This is informed by both the literature and the three documented cases discussed above. In each of these cases, the central reasoning error was not necessarily that an incorrect numerical prior had been assigned, but rather that insufficient consideration had been given to the relative probability of competing explanations before the evidence was assessed. The core problem therefore concerned the weighing of competing hypotheses and the tendency to overlook relevant background probabilities altogether.

Accordingly, the proposed checklist does not focus on numerical quantification or provide guidelines on how to arrive at such, but rather on encouraging explicit reflection on whether competing hypotheses in their prior probability. Instead of asking judges to calculate exact probabilities, the checklist instead prompts consideration of which proposed explanation initially appears more probable and why.

(4) *Before considering any of the evidence, which hypothesis appears more probable?*

(4.1.) *Why do you consider this scenario more or less probable?*

3.2.1. Motive and Opportunity

The introduction of contextual factors, such as motive and opportunity, complicates this reasoning. Since motive and opportunity frequently shape the initial probability of competing explanations, these considerations are introduced at this stage of the checklist, before turning to the evaluation of specific items of evidence. In this way, the structure of the checklist follows the broader logic of Bayesian reasoning by first considering factors that may influence the relative plausibility of competing hypotheses, and only thereafter assessing the evidential value of individual pieces of evidence.

Although these factors are not equivalent to the prior probability, they influence the initial probability of competing hypotheses before the main evidential material is evaluated. While the unconditional prior probability of guilt may be difficult to determine, the introduction of motive or opportunity shifts the relevant question towards the conditional probability [8] of guilt given the presence of that motive. Making this distinction explicit helps clarify the role that such factors play in the overall argument (Lagnado *et al.*, 2012).

(4.2.) *Is there a motive? If so, what impact does the presence of this factor have on the probability of the scenario(s)?*

(4.3.) *Is there opportunity? If so, what impact does the presence of this factor have on the probability of the scenario(s)*

3.3. False dichotomies and competing hypotheses

Errors may also arise where factfinders incorrectly assume that competing hypotheses are both exhaustive and mutually exclusive. Hypotheses are exhaustive if they cover all possible outcomes or scenarios, meaning at least one must be true. Hypotheses are exclusive if only one can be true (if one is true, the other must be false). As discussed in the literature on argumentation, this “false dichotomy” can lead to the mistaken belief that evidence supporting one hypothesis necessarily undermines all alternatives to an equal degree (Dahlman, 2019; Govier, 2001).

In the Sally Clark case, two hypotheses were proposed: a double-murder or a double-case of SIDS. These hypotheses are neither exclusive nor exhaustive: They are not exclusive as the babies could have had SIDS and been murdered, these two hypotheses do not cancel each other out, or one baby could have died of SIDS and the other of murder, thus rendering both hypotheses partially true. They are not exhaustive, as they neglected to consider other possibilities such as one SIDS death and one murder, other medical causes, etc.

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[8] The conditional probability of guilt refers to the probability a person is guilty, given specific evidence. It is calculated using Bayes Theorem, updating the prior probability of guilt based on new information.

To address this, the checklist includes prompts such as:

(5) *Are the competing hypotheses exhaustive (i.e., do they cover all possible outcomes, meaning that at least one must be true)?*

(6) *Are they mutually exclusive (i.e., if one is true does the other have to be false)?*

(7) *Does the evidence increase belief in more than one hypothesis at the same time?*

(8) *Is there an alternative explanation for the evidence?*

These questions are intended to prevent probabilistic fallacies, specifically false dichotomy, but also to broaden the scope of reasoning and prevent premature closure (see (8)).

3.4. Evidence Evaluation: Inversion Fallacies

Base-rate neglect rarely occurs in isolation and is often closely caused by another common probabilistic reasoning error: the inversion fallacy. In this fallacy, the probability of the evidence given the hypothesis, $P(E|H)$, is mistakenly equated with the probability of the hypothesis given the evidence, $P(H|E)$. As noted in the literature, a factfinder may for example reason that because the observed evidence is consistent with guilt, the probability of guilt must therefore be high. However, these probabilities are not equivalent, and such reasoning fails to consider the probability of observing the same evidence if the hypothesis were false (Dahlman, 2023).

The crucial question is not simply whether the evidence is consistent with the hypothesis, but whether the hypothesis provides a better explanation for the evidence than competing alternatives. In other words, the task is to assess whether the evidence is more likely to occur if the hypothesis is true than if it is false. This assessment can only be made once the competing hypotheses and their prior plausibility have been considered. Thus, the evaluation of evidence does not occur in isolation, but directly builds upon the prior reasoning stages presented above.

To showcase this fallacy in practice, we return to the cases of Sally Clark and Lucia de Berk. In the former, the jury was presented with statistical evidence by an expert witness suggesting that the occurrence of two SIDS cases within the same family was extremely unlikely. On this basis, the presence of two such deaths was treated as strong evidence against the defendant. The rarity of the observed event was effectively taken to indicate the unlikelihood of the defendant's innocence, as though the improbability of two natural deaths were equivalent to the improbability that the deaths occurred without foul play. However, these probabilities are not the same. The relevant question was not how unlikely the evidence is in isolation, but whether the competing hypothesis of a double homicide provided a more probable explanation for the deaths than the hypothesis of natural causes. Similarly, in the Lucia de Berk case, the court falsely assumed that the low probability of the deaths occurring by chance was equivalent to the probability that Lucia was innocent.

To reduce the risk of such inversion errors, the checklist explicitly focuses on the explanatory relationship between hypotheses and evidence. Rather than asking whether the evidence appears incriminating itself, the questions are designed to encourage reflection on whether the hypothesis adequately explains the observed evidence and whether the evidence can also reasonably occur if the hypothesis were false.

(9) *For each piece of evidence you wish to take into account, consider:*

(9.1.) *(How much) would you expect to see the observed evidence if the hypothesis were true?*

(9.2.) *(How much) would you expect to see the observed evidence if the hypothesis were false?*

(9.3.) *Is your expectation of seeing the evidence stronger if H is true or if H is false?*

The purpose of these questions is to ensure that (1) both true and false positive rates are considered, thereby aiming to restore the correct evidential balance and (2) reasoning proceeds from H to E, rather than directly from the existence of the evidence to the truth of the hypothesis.

3.5. Evidence Evaluation: Convergent Evidence, Dependencies and their Combination

In many cases, the strength of the prosecution's case rests not on a single piece of evidence, but on the combined effect of multiple items of evidence. Factfinders need to evaluate multiple pieces of evidence supporting the same hypothesis, commonly referred to as convergent evidence. However, integrating such evidence correctly can be challenging and result in various fallacies (Dahlman, 2023).

Evidence is dependent when the probative value of one item of evidence is affected by the existence of another (e.g., two witnesses who have talked to each other), independent evidence retains its probative value regardless of the presence of other evidence (e.g., two witnesses who have not been in contact with each other). A failure to recognise the cumulative effect of independent evidence may lead to underestimation, referred to as 'convergence neglect', while ignoring dependencies may lead to overestimation, this is known as 'dependence neglect' (Dahlman, 2023). For example, where several independent pieces of evidence each have a low probability of occurring if the hypothesis is false, their combined effect may be significantly stronger than any individual piece alone. Conversely, treating dependent evidence as independent can artificially inflate the perceived strength of the case.

Dependence neglect was committed in the Sally Clark case, where the expert witness fallaciously treated the occurrence of two SIDS cases within the same family as independent. If one child suffered from SIDS, the risk of the second child having SIDS increases, therefore the probability of the second infant dying from SIDS is dependent on whether the first child died from SIDS. Documented cases[9] in which the dependency neglect fallacy has been committed commonly reflect fallacious assumptions and reasoning patters within expert analyses: This highlights the need for an additional layer of scrutiny when expert evidence is presented.

Another relevant risk in the evaluation of convergent evidence is the "zero-sum fallacy" (Dahlman, 2023; Pilditch *et al.*, 2019). This fallacy occurs where factfinders incorrectly assume that weakening one side of the evidential balance necessarily strengthens the opposing side to an equal degree. In probabilistic reasoning, however, evidential relationships are often non-linear and asymmetrical. The reduction in probative value of one piece of incriminating evidence does not automatically imply a corresponding increase in the probability of innocence, particularly where other independent evidence remains unaffected. Similarly, exculpatory evidence does not necessarily "cancel out" incriminating evidence of differing strength or reliability. Such reasoning risks distorting the cumulative assessment of evidence and may lead to both over- and underestimation of the overall strength of the case.

To address these issues, the checklist incorporates prompts aimed both at assessing the combination of evidence and at identifying potential dependencies:

(10) *Are any pieces of evidence dependent on one another (i.e., is the probative value of one piece of evidence influenced by the existence of another)?*

(10.1.) *If so, what makes them dependent and how might this relationship affect their probative value?*

(10.2.) *Has statistical expert evidence been presented in the case? If so, are any of the factors or pieces of evidence relied on by the expert potentially dependent?*

(10.3.) *Have any pieces of evidence been left out due to irrelevance or deemed as too small in probative value? Why?*

(10.4.) *Is there any evidence that probative value may have been overestimated or underestimated? Why?*

These questions are particularly important in complex cases involving multiple strands of evidence.

3.6. Indirect Reasoning and Chains of Inference

Finally, the checklist addresses cases in which evidence supports a hypothesis only indirectly, through a chain of inferences[10]. Such reasoning introduces additional opportunities for error, particularly where intermediate assumptions are not made

[9] Here, "cases" refers to cases commonly discussed in the European literature such as Sally Clark and Lucia de Berk. It should be noted that the author did not conduct a thorough systematic or exhaustive review of all relevant cases.

[10] This is often referred to as indirect or circumstantial evidence (Dahlman, 2023).

explicit. This is known as 'link-skipping' (Dahlman, 2023). This fallacy is best explained at hand of an example: Consider a case in which the defendant is accused of burglary. A positive ID is made between blue hoodie fibres found at the crime scene and a blue hoodie owned by the defendant. Claiming that the positive ID provides direct support for the defendant's guilt would be link-skipping, as it neglects the possibility (the sub-hypothesis) that someone else was wearing the defendant's hoodie at the crime scene. Committing this fallacy discounts part of the evidence uncertainty chain, thus causing an underestimation of the probability for a false positive. This can in turn lead to an overestimation of the probative value of the evidence chain.

To address this, the checklist includes prompts such as:

(11) *Does this piece of evidence relate to the hypothesis directly or through one or more inferential steps?*

(11.1.) *What assumptions are required to link this evidence to the hypothesis?*

(11.2.) *How strong or well-supported are these assumptions?*

(11.3.) *Is there an alternative explanation for each step in this chain?*

3.7. Instructions for application in practice

The checklist is intended to function as a flexible reasoning aid rather than a rigid procedural framework. It consists of a series of critical questions organised into thematic subgroups (for example, question 11, followed by questions 11.1., 11.2. and 11.3.). Practitioners should work through the checklist sequentially, reflecting on whether the relevant reasoning issue has been adequately considered within the case.

If a practitioner considers that a question has already been sufficiently discussed or reasoned through, that question may be skipped. Where a primary question has already been sufficiently addressed during reasoning or deliberation, practitioners may skip that question and its corresponding sub-questions. For example, if Question 11 is regarded as adequately considered, Questions 11.1.-11.3. may also be skipped.

The checklist is not intended to require extensive written responses or formal legal analysis under each question. Rather, the questions are designed to re-prompt critical reflections and encourage structured reasoning, drawing attention to potentially problematic probabilistic reasoning patterns that may otherwise go unnoticed. For the full checklist and detailed instructions for practitioners please see Appendix A.

4. CONCLUSION

This paper responds directly to the research agenda identified by Mackor (2026) by developing a structured checklist of critical questions aimed at improving probabilistic reasoning in judicial contexts. Rather than advocating for the direct use of formal Bayesian models, the proposed framework translates key elements of Bayesian reasoning into a sequence of critical questions, thereby offering a practical and accessible tool for structured "self-evaluation".

The checklist is diagnostic in nature: it is designed to make reasoning processes transparent, to expose implicit assumptions, and to highlight potential sources of error. In this sense, it does not function as a decision-making tool and but as a mechanism for disciplined reflection. By enforcing a structured form of reflection in the reasoning process, it aims to reduce the probability that probabilistic fallacies remain unnoticed.

The scope of this approach is deliberately limited. It is not intended to resolve substantive uncertainties, nor to substitute for the expertise required to interpret complex statistical evidence. Such interpretive functions are already performed by forensic experts and advisors. The present framework aims to support judges in critically engaging with the reasoning presented and in recognising when additional expertise is required. Recognising that the probabilistic analysis of a piece of evidence is not understood, or that an assumption does not seem to have been justified, is itself a critical step towards more reliable decision-making.

At this stage, the proposed checklist still requires empirical validation. Future research will therefore focus on testing its effectiveness in practice, through experimental studies using legal scenarios in both third- and first-person formats (inspired by the work of Dahlman, 2025 and Hampson *et al.*, in progress). This dual format allows for the assessment of both the ability to identify reasoning errors and the ability to avoid such errors in one's own judgements.

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APPENDIX A: PROPOSED CHECKLIST

Instructions for use during reasoning process:

Review each checklist item step-by-step, either individually or as a group. For each item, ask whether it has been considered adequately. Answer the questions verbally, cognitively, or through discussion; written responses are not required.

Instructions for use during deliberation:

Use the checklist as a reflective tool during discussions. Review each checklist item step-by-step as a group. Pause on any item that feels uncertain or under-considered and continue once it has been sufficiently addressed. Responses should occur through discussion rather than formal written completion.

Additional guidance:

If you become stuck on a question or are uncertain about the meaning of a term or concept, please refer to the accompanying information sheet for clarification. Examples have also been provided to aid the application.

Checklist

1. What is the main hypothesis under consideration?

2. Have any alternative hypotheses been proposed? What are they?

3. What evidence is available in the case?

4. Before considering any of the evidence, which hypothesis appears more probable?

4.1. Why do you consider this scenario more or less probable?

4.2. Is there a motive? If so, what impact does the presence of this factor have on the probability of the scenario(s)?

4.3. Is there opportunity? If so, what impact does the presence of this factor have on the probability of the scenario(s)

5. Are the competing hypotheses exhaustive (i.e., do they cover all possible outcomes, meaning that at least one must be true)?

6. Are they mutually exclusive (i.e., if one is true does the other have to be false)?

7. Does the evidence increase belief in more than one hypothesis at the same time?

8. Is there an alternative explanation for the evidence?

9. For each piece of evidence you wish to take into account, consider:

9.1. (How much) would you expect to see the observed evidence if the hypothesis were true?

9.2. (How much) would you expect to see the observed evidence if the hypothesis were false?

9.3. Is your expectation of seeing the evidence stronger if H is true or if H is false?

10. Are any pieces of evidence dependent on one another (i.e., is the probative value of one piece of evidence influenced by the existence of another)?

10.1. If so, what makes them dependent and how might this relationship affect their probative value?

10.2. Has statistical expert evidence been presented in the case? If so, are any of the factors or pieces of evidence relied on by the expert potentially dependent?

10.3. Have any pieces of evidence been left out due to irrelevance or deemed as too small in probative value? Why?

10.4. Is there any evidence that probative value may have been overestimated or underestimated? Why?

11. Does this piece of evidence relate to the hypothesis directly or through one or more inferential steps?

11.1. What assumptions are required to link this evidence to the hypothesis?

11.2. How strong or well-supported are these assumptions?

11.3. Is there an alternative explanation for each step in this chain?

APPENDIX B: PROPOSED INFORMATION SHEET

This information sheet is intended to assist you in interpreting and applying the checklist during reasoning and deliberation. The explanations below are illustrative only and are not intended to dictate conclusions.

Section 1: Framing the Hypotheses and Evidence

1. *What is the main hypothesis under consideration?*
2. *Have any alternative hypotheses been proposed? What are they?*
3. *What evidence is available in the case?*

Definitions:

Hypothesis = The main explanation, allegation or scenario being evaluated in light of the evidence.

Alternative hypotheses = Other plausible explanations that may also account for the events or evidence in the case.

Purpose:

These questions are intended to establish a clear structure for reasoning and case overview before the evaluation begins. They encourage the explicit identification of what is being assessed, consider whether competing explanations exist and clarify what evidence is available in the case.

Probabilistic reasoning risks:

Errors may arise where the hypothesis or evidential basis remains implicit or insufficiently specified. Failure to explicitly identify competing hypotheses may result in premature closure or tunnel vision, where evidence is interpreted only in a manner consistent with a preferred explanation. There is also a risk of false dichotomy, where reasoning incorrectly assumes there are only two possible explanations while additional alternatives remain possible.

Example:

Main hypothesis = "The defendant is guilty of murdering X."

Alternative hypothesis = "X died of suicide"

Section 2: Prior Probabilities, Motive and Opportunity

4. Before considering any of the evidence, which hypothesis appears more probable?

4.1. Why do you consider this scenario more or less probable?

4.2. Is there a motive? If so, what impact does the presence of this factor have on the probability of the scenario(s)?

4.3. Is there opportunity? If so, what impact does the presence of this factor have on the probability of the scenario(s)

Definitions:

Prior probability = The probability of a hypothesis before considering any specific evidence in the case.

Purpose:

These questions encourage explicit reflection on the relative plausibility of competing explanations before evaluating the detailed evidence in the case. The framework does not require you to assign precise numerical probabilities. Rather, the purpose is to consider whether one explanation initially appears more probable than another, and why. The questions concerning motive and opportunity are intended to assist you in identifying contextual factors that may influence the plausibility of competing hypotheses.

Probabilistic reasoning risks:

Failure to consider the prior probability of competing explanations constitutes a well-documented probabilistic fallacy commonly referred to as base-rate neglect. Base-rate neglect occurs where attention is focused primarily on striking or emotionally compelling evidence while insufficient consideration is given to how common or uncommon competing explanations are before considering any evidence.

Example:

Consider the hypotheses from above (H1 = Murder, H2 = Suicide). Before considering any of the evidence, H2 appears more probable, as suicide is more common than murder.

If the defendant has a motive to commit murder, e.g. an angry ex-partner, the probability of H1 increases.

If the defendant had opportunity, e.g. they were at the house when the murder was committed, the probability of H1 increases.

SECTION 3: COMPETING HYPOTHESES

5. Are the competing hypotheses exhaustive (i.e., do they cover all possible outcomes, meaning that at least one must be true)?
6. Are they mutually exclusive (i.e., if one is true does the other have to be false)?
7. Does the evidence increase belief in more than one hypothesis at the same time?
8. Is there an alternative explanation for the evidence?

Definitions:

Exhaustive hypotheses = Hypotheses that collectively cover all possible outcomes such that at least one must be true.

Mutually exclusive hypotheses = Hypotheses where, if one is true, the other must be false.

Purpose:

These questions encourage broader consideration of competing explanations and whether evidence may support more than one hypothesis simultaneously. They are intended to prevent reasoning from becoming restricted to a single preferred narrative.

Probabilistic reasoning risks:

These questions are intended to reduce the risk of false dichotomy. False dichotomy occurs where reasoning incorrectly assumes that competing hypotheses are both exhaustive and mutually exclusive. This may result in the mistaken belief that evidence supporting one explanation necessarily undermines all alternatives to the same degree.

Failure to consider alternative explanations may also encourage premature closure and overconfidence in one interpretation of the evidence.

Example:

Consider the hypotheses from above (H1 = Murder, H2 = Suicide). They are not exhaustive. The individual could have died from natural causes (e.g., a terminal illness). They are not exclusive, if H1 is false, i.e., no murder occurred, it does not mean that H2 is true, i.e., tha a suicide occurred.

SECTION 4: EVALUATING EVIDENCE AND INVERSION FALLACIES

9. For each piece of evidence you wish to take into account, consider:

9.1. (How much) would you expect to see the observed evidence if the hypothesis were true?

9.2. (How much) would you expect to see the observed evidence if the hypothesis were false?

9.3. Is your expectation of seeing the evidence stronger if H is true or if H is false?

Purpose:

These questions encourage you to evaluate evidence comparatively rather than in isolation.

The relevant issue is not simply whether evidence is consistent with a hypothesis, but whether the evidence is more expected if the hypothesis is true than if it is false.

These questions therefore encourage consideration of both:

— how well the hypothesis explains the evidence,

— and whether the same evidence could reasonably occur if the hypothesis were false.

Probabilistic reasoning risks:

These questions are intended to reduce the risk of inversion fallacies. An inversion fallacy occurs where the probability of observing the evidence if the hypothesis is true is incorrectly treated as equivalent to the probability that the hypothesis is true because the evidence exists.

This may lead judges to incorrectly assume that rare or unusual evidence necessarily implies a high probability of guilt. The relevant question is not whether the evidence appears incriminating in isolation, but whether the hypothesis provides a better explanation for the evidence than competing alternatives.

Example:

Consider the case above. Suppose DNA evidence is found matching the defendant in the victim's house. The relevant question is not whether the DNA evidence is consistent with the defendant's guilt, but whether it is more likely to see the DNA evidence if the defendant is guilty than innocent. Suppose the defendant was not known to the victim, the probability of seeing the DNA evidence at the crime scene is more likely if the defendant is guilty than innocent. Assuming the defendant also lives in the house, it is equally likely to find DNA evidence independent of whether they are innocent or guilty.

SECTION 5: CONVERGENT EVIDENCE, DEPENDENCIES AND PROBATIVE VALUE

10. Are any pieces of evidence dependent on one another (i.e., is the probative value of one piece of evidence influenced by the existence of another)?

10.1. If so, what makes them dependent and how might this relationship affect their probative value?

10.2. Has statistical expert evidence been presented in the case? If so, are any of the factors or pieces of evidence relied on by the expert potentially dependent?

10.3. Have any pieces of evidence been left out due to irrelevance or deemed as too small in probative value? Why?

10.4. Is there any evidence that probative value may have been overestimated or underestimated? Why?

Definitions:

Dependent evidence = Evidence where the probative value of one item is influenced by another.

Independent evidence = Evidence that retains its probative value regardless of the existence of other evidence.

Probative value = The extent to which evidence assists in proving or disproving a hypothesis.

Purpose:

These questions encourage reflection on how multiple pieces of evidence interact with one another. They are intended to assist judges in identifying whether multiple pieces of evidence genuinely provide separate support for a hypothesis or instead rely on overlapping assumptions, sources, or reasoning chains.

Probabilistic reasoning risks:

These questions are intended to reduce the risks of dependence neglect and convergence neglect. Dependence neglect occurs where dependent evidence is incorrectly treated as independent, artificially inflating the apparent strength of the case. Convergence neglect occurs where the combined strength of genuinely independent evidence is underestimated.

Statistical expert evidence may be particularly vulnerable to hidden assumptions of independence. There is also a risk that evidence may be overestimated or underestimated where its relationship to other evidence is not properly recognised.

Example:

Consider two witnesses who discussed the events together before giving their testimonies, these two witness statements are dependent, lowering their individual probative values. In the case of statistical evidence, forensic analyses may rely on the same underlying source or assumption. For example, in the Sally Clark case, the two infant deaths were initially treated as statistically independent events. However, if one child dies of SIDS, the probability of a second child in the same family also dying of SIDS may increase due to shared genetic or environmental factors. Treating the two deaths as fully independent therefore risked overstating the improbability of the events occurring naturally.

SECTION 6: INFERENTIAL REASONING AND LINK-SKIPPING

11. Does this piece of evidence relate to the hypothesis directly or through one or more inferential steps?

11.1. What assumptions are required to link this evidence to the hypothesis?

11.2. How strong or well-supported are these assumptions?

11.3. Is there an alternative explanation for each step in this chain?

Definition:

Inferential step = A stage of reasoning required to connect evidence to a conclusion.

Assumption = A proposition that must be accepted in order for evidence to support a conclusion.

Chain of inference = A sequence of inferential steps connecting evidence to the hypothesis.

Purpose:

These questions encourage judges to examine how evidence supports a conclusion and whether intermediate assumptions have been made explicit. Some evidence supports a hypothesis directly, while other evidence supports a conclusion only indirectly through multiple inferential steps. These questions encourage reflection on whether each inferential step is adequately supported and whether alternative explanations remain possible.

Probabilistic reasoning risks:

hypothesis directly, while other evidence supports a conclusion only indirectly through multiple inferential steps. These questions encourage reflection on whether each inferential step is adequately supported and whether alternative explanations remain possible.

Probabilistic reasoning risks:

These questions are intended to reduce the risk of link-skipping. Link-skipping occurs where intermediate assumptions or inferential steps are ignored, causing the relationship between evidence and conclusion to appear stronger than it actually is. Failure to recognise inferential gaps may result in overestimation of the probative value of the evidence chain. The more inferential steps required, the greater the possibility that uncertainty or alternative explanations exist at each stage.

Example:

Suppose fibres matching the defendant's hoodie are found at the crime scene. The evidence does not directly establish guilt. Another person could have been wearing the hoodie, therefore this rests on the intermediate assumption: the defendant was the person wearing the hoodie at the crime scene.