

Title

Marcello Di Bello and Rafal Urbaniak

2021-01-20



# Contents

<b>I</b>	<b>What is legal probabilism?</b>	<b>7</b>
1	Some history (Legal probabilism and its history)	9
2	Common objections	11
2.1	Naked statistical evidence . . . . .	11
2.2	The difficulty about conjunction . . . . .	11
2.3	Cohen's other objections . . . . .	11
2.4	The problem of priors . . . . .	11
2.5	The reference class problem . . . . .	11
2.6	The complexity objection . . . . .	11
2.7	Where do the numbers comes from? . . . . .	11
<b>II</b>	<b>Assessing Evidence</b>	<b>13</b>
3	Spotting Fallacies with Bayes' Theorem	17
3.1	Assuming independence . . . . .	18
3.2	The prosecutor's fallacy . . . . .	18
3.3	Base rate fallacy . . . . .	18
3.4	Defense attorney's fallacy . . . . .	18
3.5	Uniqueness fallacy . . . . .	18
3.6	Case studies . . . . .	18
4	Complications	19
4.1	Where do the numbers come from? . . . . .	20
4.2	The puzzle about corroboration . . . . .	20
4.3	Source, activity and offense level hypotheses . . . . .	20
4.4	Complex hypotheses and complex bodies of evidence . . . . .	20
4.5	Stories, explanations and coherence . . . . .	20
5	Likelihood Ratios	21
5.1	Odds version of Bayes' theorem . . . . .	21
5.2	Bayesian factor v. likelihood ratio . . . . .	21
5.3	Choosing competing hypotheses . . . . .	21

5.4 Case studies . . . . .	21
<b>6 Bayesian Networks</b>	<b>23</b>
6.1 Multiple pieces of evidence and complex hypotheses . . . . .	23
6.2 Bayesian networks to the rescue . . . . .	23
6.3 Legal evidence idioms . . . . .	23
6.4 Scenario idioms . . . . .	23
6.5 Case studies . . . . .	23
6.6 Modeling relevance . . . . .	23
<b>7 Corroboration</b>	<b>25</b>
<b>8 Coherence</b>	<b>27</b>
<b>9 Completeness</b>	<b>29</b>
<b>10 Philosophical objections</b>	<b>31</b>
<b>III Trial Decisions</b>	<b>33</b>
<b>11 Standards of proof</b>	<b>37</b>
<b>12 Expected utility</b>	<b>39</b>
<b>13 The risk of error</b>	<b>41</b>
<b>14 Fairness</b>	<b>43</b>
<b>IV Probabilistic approach to narrations</b>	<b>45</b>
<b>15 The Dutch school and its challenges</b>	<b>47</b>
<b>16 Merging/aggregation/selection issues</b>	<b>49</b>
<b>17 Conditions on narration</b>	<b>51</b>
<b>18 Formal representation and programmatic deployment</b>	<b>53</b>
<b>V Trial Institutions</b>	<b>55</b>
<b>19 Rules of Evidence</b>	<b>59</b>
<b>20 Cross-examination</b>	<b>61</b>

<i>CONTENTS</i>	5
<b>VI Conclusion</b>	<b>63</b>
<b>21 Pros</b>	<b>67</b>
<b>22 Cons</b>	<b>69</b>
<b>Preface</b>	<b>71</b>
<b>23 Introduction</b>	<b>73</b>



## Part I

# What is legal probabilism?





## Chapter 1

# Some history (Legal probabilism and its history)

This chapter will introduce legal probabilism and contain a historical discussion of legal probabilism, how it came about, when, major contributions, etc. I see essentially two moments in the history of legal probabilism: the early days when probability theory was invented (Bernoulli, Laplace, Condorcet, etc.), and then the second half of the 20th century with the emergence of the New Evidence Scholarship (Lempert) and law and economics. But the history might be more complicated.



## Chapter 2

# Common objections

This chapter would discuss puzzles and hypothetical scenarios, mostly the debate about naked statistical evidence. This is a discussion of the most compelling objections that have been raised against legal probabilism. Most of these objections trace back to Cohen, although other pivotal players are Laurence Tribe and Ronald Allen. I think this chapter could also have a historical flavor or perhaps it could be more systematic. Not sure about the best presentation format.

what do we do with  
Haack, Moss etc.?

### 2.1 Naked statistical evidence

### 2.2 The difficulty about conjunction

### 2.3 Cohen's other objections

### 2.4 The problem of priors

### 2.5 The reference class problem

### 2.6 The complexity objection

### 2.7 Where do the numbers comes from?



## Part II

# Assessing Evidence



After the first part, the rest of the book will be a deep dive into what probability theory can do for us when it is applied to trial proceedings.

Instead of addressing the common objections upfront, the strategy of the book would be to set the objections aside – keep them on the back burner as it were – and return to them once we have a clearer sense of legal probabilism and its limits.

---

This part of the book is devoted to how probability theory can help—or not help—in assessing trial evidence. I think it is important that we start very simple and then we progressively get more complex.

We need to clearly set the limit of discussion of objections in the first part





## Chapter 3

# Spotting Fallacies with Bayes' Theorem

This chapter shows how we can use probability theory and Bayes' theory to spot common probabilistic fallacies, prosecutor's fallacy, base rate fallacy, etc. This is the simple stuff.

I think this chapter should also show the limitation of this approach. That is, we should make clear that these are probabilistic fallacies. They are fallacies only insofar as the trier of facts aim to determine the posterior probability of guilt. Which they might not.

careful here, some come up without explicit calculations

The chapter will also be accompanied by case studies.

**3.1   Assuming independence**

**3.2   The prosecutor's fallacy**

**3.3   Base rate fallacy**

**3.4   Defense attorney's fallacy**

**3.5   Uniqueness fallacy**

**3.6   Case studies**

**3.6.1   Collins**

**3.6.2   Sally Clark**

## Chapter 4

# Complications

not sure if this isn't too early

Here we examine a number of complications that emerge from the simple Bayes' theorem approach described in the earlier chapter. Here are some of the common difficulties:

- How do we determine the priors?
- More generally, how do we determine the numerical values of any of the probabilities involved? It might work for DNA matches, but what about nonnumerical evidence such as eyewitnesses?
- How do we combine different pieces of evidence?
- How we we formulate complex hypotheses, say narratives, stories or explanations?
- How do we take into account things like the coherence of one's story or the explanatory power of one's hypothesis? (evidence-to-hypothesis reasoning versus hypothesis-to-evidence reasoning).
- Ronald Allen's objections and Susan Haack's objections.

- 4.1 Where do the numbers come from?
- 4.2 The puzzle about corroboration
- 4.3 Source, activity and offense level hypotheses
- 4.4 Complex hypotheses and complex bodies of evidence
- 4.5 Stories, explanations and coherence

## Chapter 5

# Likelihood Ratios

Here we present likelihood ratios as a possible answer to some of the complications. Pros and cons of this approach. It addresses the problems of priors to some extent, but it leaves a lot of the other complications essentially unresolved. The likelihood approach raises complication of its own.

### 5.1 Odds version of Bayes' theorem

### 5.2 Bayesian factor v. likelihood ratio

### 5.3 Choosing competing hypotheses

### 5.4 Case studies

#### 5.4.1 Cold-hit DNA matches

#### 5.4.2 The two-stain problem

#### 5.4.3 Guidelines from the European Forensic Institute



## Chapter 6

# Bayesian Networks

Here we present Bayesian networks as the best answer that legal probabilists can offer. We illustrate Bayesian networks with examples and show how they can answer some of the complications. We try to be as honest as possible. We want to be a reliable and trustworthy source of discussion, not partisan. We also discuss how Bayesian networks can help address certain puzzles about relevance.

### 6.1 Multiple pieces of evidence and complex hypotheses

### 6.2 Bayesian networks to the rescue

### 6.3 Legal evidence idioms

### 6.4 Scenario idioms

### 6.5 Case studies

#### 6.5.1 Sally Clark

#### 6.5.2 DNA evidence

### 6.6 Modeling relevance





## Chapter 7

# Corroboration

Here we zoom into a particular topic. This should be a place to review the literature on corroboration and for Rafal to present his own probabilistic solution to the corroboration puzzle.



## Chapter 8

# Coherence

Looks like coherence (cohesiveness and related ideas) plays an important role in assessing evidence at trial. Here it would be place to review the literature on coherence and for Rafal to preset his own probabilistic solution to the coherence puzzle, emphasizing legal applications.



## Chapter 9

# Completeness



## Chapter 10

# Philosophical objections

---

perhaps Allen, Haack &  
Moss here?





## Part III

# Trial Decisions



We turn from assessing evidence to trial decisions. The question is this, when is the evidence strong enough to meet the governing burden of proof?



## Chapter 11

# Standards of proof

Discuss various probabilistic explications and their challenges (Rafal's paper on this?)



## Chapter 12

# Expected utility

This chapter reviews the literature that describes how expected utility can be used to define rules for trial decisions.





## Chapter 13

# The risk of error

This chapter introduces different ways to think about the risk of error at trial. One dimension of the risk of error flows from the posterior probabilities  $P(\textit{Guilt}|\textit{Evidence})$ . The other dimension flows from the conditional probabilities  $P(\textit{Conviction}|\textit{Innocence})$ . This an opportunity for Marcello to present the arguments in his Mind paper, which however Rafal has criticized. So hopefully this chapter will be a very balanced account of the topic!



## Chapter 14

# Fairness

This chapter discusses how decisions can be fair and to what extent probability theory can help us think about the fairness of decisions. One important notion of fairness that probability theory can capture is that of equal distribution of the risk of error. This draws on some of Marcello's argument in the Ethics paper.

---

talk about incompatibility of definitions, Hedden's argument against measures of fairness etc.



## Part IV

# Probabilistic approach to narrations



## Chapter 15

# The Dutch school and its challenges





## Chapter 16

# Merging/aggregation/selection issues



## Chapter 17

# Conditions on narration



## Chapter 18

# Formal representation and programmatically deployment



## Part V

# Trial Institutions





Finally, this part of the book should assess some institutions of the trial system using probability theory and cognate theories. I am not sure if this is too much, but I am putting it here just in case.

---

Are we competent to discuss this?



## Chapter 19

# Rules of Evidence



## Chapter 20

# Cross-examination



## Part VI

# Conclusion





I'd like this conclusion to be a very careful and nuanced discussion of the good and bad things about legal probabilism. What difficulties can in principle be overcome and what other difficulties are instead inherent to legal probabilism and thus inescapable?



## Chapter 21

### Pros



## Chapter 22

### Cons



# Preface

testing again

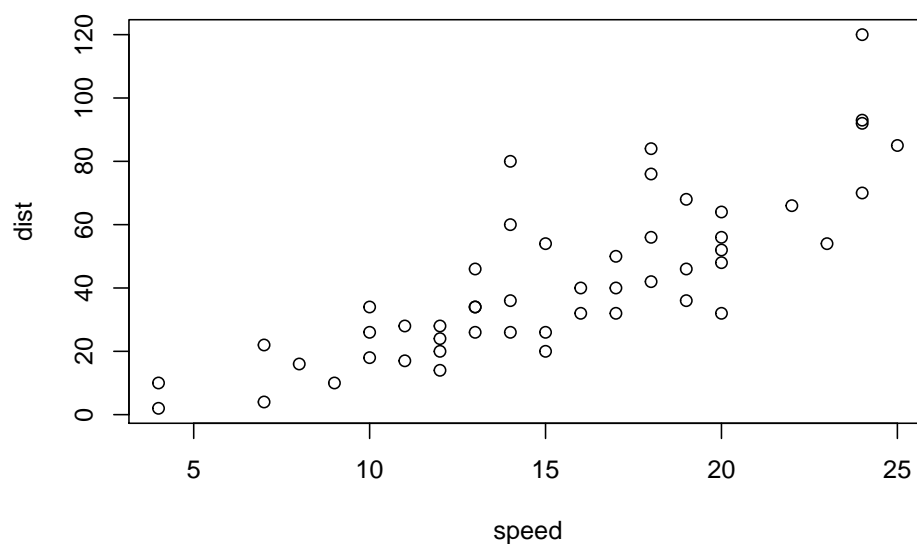
$$f(k) = \binom{n}{k} p^k (1-p)^{n-k} \quad (22.1)$$

This is a citation (Diamond, 1990) which uses keys from the bib file listed in the preamble.

Equation (22.1)<sup>1</sup>

Note that chapter files are found and compiled automatically, but the file names have to contain chapter numbers first. For instance, we used `01-intro.Rmd`, placed in the same folder. Observe how we included r code inline.

```
plot(cars)
```



<sup>1</sup>This is a footnote containing a double citation (Dahlman, 2020; Diamond, 1990).





# Chapter 23

## Introduction

You can label chapter and section titles using `{#label}` after them, e.g., we can reference Chapter 23. Let's use chapter labels starting with “ch:”.

Figures and tables with captions will be placed in `figure` and `table` environments, respectively.

```
par(mar = c(4, 4, .1, .1))  
plot(pressure, type = 'b', pch = 19)
```

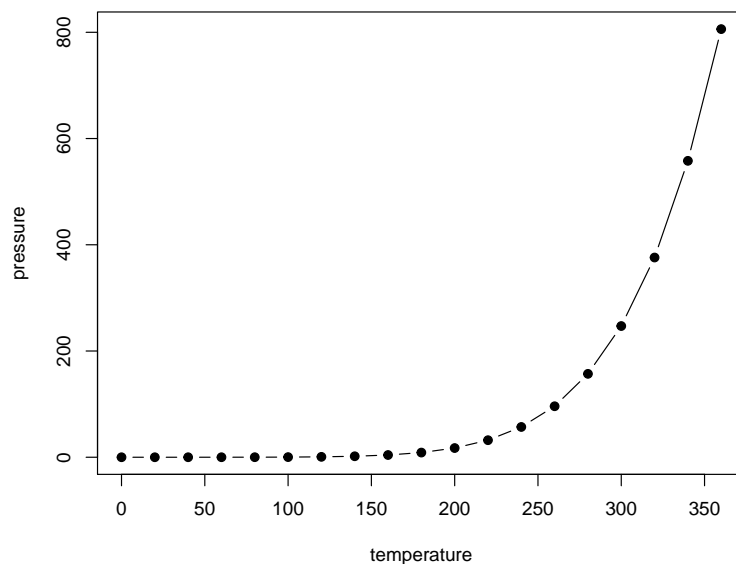


Figure 23.1: Here is a nice figure!

Reference a figure by its code chunk label with the `fig:` prefix, e.g., see Figure

Table 23.1: Here is a nice table!

Sepal.Length	Sepal.Width	Petal.Length	Petal.Width	Species
5.1	3.5	1.4	0.2	setosa
4.9	3.0	1.4	0.2	setosa
4.7	3.2	1.3	0.2	setosa
4.6	3.1	1.5	0.2	setosa
5.0	3.6	1.4	0.2	setosa
5.4	3.9	1.7	0.4	setosa
4.6	3.4	1.4	0.3	setosa
5.0	3.4	1.5	0.2	setosa
4.4	2.9	1.4	0.2	setosa
4.9	3.1	1.5	0.1	setosa
5.4	3.7	1.5	0.2	setosa
4.8	3.4	1.6	0.2	setosa
4.8	3.0	1.4	0.1	setosa
4.3	3.0	1.1	0.1	setosa
5.8	4.0	1.2	0.2	setosa
5.7	4.4	1.5	0.4	setosa
5.4	3.9	1.3	0.4	setosa
5.1	3.5	1.4	0.3	setosa
5.7	3.8	1.7	0.3	setosa
5.1	3.8	1.5	0.3	setosa

23.1. Similarly, you can reference tables generated from `knitr::kable()`, e.g., see Table 23.1.

```
knitr::kable(
  head(iris, 20), caption = 'Here is a nice table!',
  booktabs = TRUE
)
```

Dahlman, C. (2020). Naked statistical evidence and incentives for lawful conduct. *International Journal of Evidence and Proof*, 24(2), 162–179.

Diamond, H. A. (1990). Reasonable doubt: To define, or not to define. *Columbia Law Review*, 90(6), 1716–1736.