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RESEARCH STATEMENT

CONTENTS

1 DISSERTATION: Statistics and Probability in Criminal Trials
The Good, the Bad, and the Ugly

Is a high probability of guilt, in and of itself, enough to convict? There are *prima facie* arguments for both a positive and a negative answer. Since the certainty of guilt is unattainable, one can argue, a high probability should be enough to convict. For if it isn't, what else would be enough except full certainty (which is unattainable)? The correct answer to our initial question, then, seems to be Yes. On the other hand, a thought experiment suggests that the correct answer is No. Imagine a prison yard with one hundred prisoners and only one prison guard. One day ninety-nine prisoners collectively murder the guard. After the crime, one prisoner is picked at random and tried. His probability of guilt is very high, but it seems unacceptable to convict him on mere high probability.

I, too, maintain that the correct answer is No. I argue that there are at least four problematic uncertainties in a criminal trial: uncertainty about guilt; uncertainty about whether the evidence presented at trial is all the evidence one can reasonably expect; uncertainty about whether objections or counter-arguments might possibly change one's conclusions about guilt or innocence; uncertainty about what events preceded or followed the act of the crime. Further, I argue that the function of the criminal standard of proof 'beyond a reasonable doubt' is to reduce all these uncertainties, not only the uncertainty about guilt. In other words, my contention is that a warranted conviction should meet a four-pronged test: (i) the defendant's probability of guilt is sufficiently high; (ii) the evidence presented is reasonably complete; (iii) the case for guilt has proven to be resilient enough against objections and counter-arguments; and finally, (iv) the prosecutor's narrative of the crime is reasonably complete and specific.

The four pronged-test illuminates issues in epistemology about the nature of epistemic warrant and issues in law about the use of statistical evidence. Many epistemologists hold that the high probability of a proposition, in and of itself, is not sufficient for us to be warranted in believing the proposition. Lottery propositions are a prominent example of this. I draw attention to two features of epistemic warrant that bear a close relation to condition (iii) above. The first feature is the stability of one's belief against future, and possibly contradictory, evidence; the second is the burdensomeness associated with withholding judgment. I argue that we are not warranted in believing a highly probable proposition whenever the latter is not stable and so long as withholding judgment about it is not unduly burdensome.

The four-pronged test, and in particular condition (iv) about narrativity, can also help us explain some of the nuances of using statistical evidence in criminal trials. We have seen a steady rise in the use of statistics in criminal cases, especially as a result of the discovery of DNA fingerprinting in the eighties. Also, the phenomenon of "big data" has made it easier to recover statistics for trial purposes. Against this background, a question naturally arises. Are statistics alone enough

to convict? For one, we do feel uneasy about statistical evidence: it seems to lack "specificity" because it places the defendant in a group with others, and we do not want to be convicted because of what others did. But this does not explain why it is—at times—acceptable to convict on just DNA evidence, whose probative value, after all, rests on statistical estimates. We should therefore be careful with wholesale dismissals of statistics. I argue that, in some cases, a conviction *may* justifiably rest on statistical evidence alone, and in other cases, it *may not*. The deciding criterion remains the four-pronged test above, and in particular the narrativity condition. Taking DNA evidence as a case study, I show that statistical evidence can be particularly problematic whenever it fails to support a well-specified narrative of the crime. This conclusion, while still leaving room for statistical evidence in courts, refines the earlier worry that statistical evidence lacks specificity. The feature of specificity, however, should be understood as a feature of narratives, not of individual pieces of evidence. This is how it should be. We cannot isolate pieces of evidence; we are better off considering the evidence more holistically and in relation to a narrative.

My dissertation consists of nine chapters. Chapters 1 and 2—"Probabilists and Traditionalists" and "Sharpening Things up"—formulate the driving questions and reconstruct the dialectic between probabilists ad traditionalists. Chapter 3—"A Debate that Began Forty Years Ago"—reviews the literature on probability and statistics in criminal trials which appeared in the last forty years. Chapter 4—"How Statistics Get Used in Criminal Trials"—details how different types of statistical evidence have been used in criminal trials. Chapter 5—"Bayes in the Courtroom"—offers an introduction to the mathematics and the philosophy of probability. It also gives a probabilistic, Bayesian analysis of the types of statistical evidence discussed in the preceding chapter, with a focus on DNA evidence. The last four chapters make the original contribution. Chapter 6—"The Burdens of Stable Judgment"—addresses the epistemological question of whether high probability alone suffices for knowledge. Chapter 7—"What is a Reasonable Doubt?"—situates this epistemological question in the context of criminal trials. In so doing, it offers an account of the criminal standard of proof 'beyond a reasonable doubt' in terms of the four-pronged test. Chapter 8—"When is DNA Evidence Enough to Convict?"—contrasts DNA evidence with traditional forms of evidence, such as eyewitness evidence and fingerprints; it also tackles the question of whether DNA evidence alone is enough to convict. Finally, Chapter 9—"Looking back"—draws some morals on the role of evidence, probability, and epistemic luck in criminal trials.

2 RESEARCH PLANS

My dissertation is part of a research agenda on the role of uncertainty, probability, and evidence in legal and common-sense reasoning. Within this agenda, I have a few long-term projects at the intersection of epistemology and philosophy of law:

A. RELEVANCE AND NARRATIVES. The starting point for any theory of legal fact-finding is a definition of relevant evidence. Evidence introduced during a trial for the purpose of reconstructing what happened has to be relevant, otherwise trial proceedings would become needlessly confused. Yet, despite the intuitiveness of this requirement, a plausible account of relevant evidence is hard to find.

One view is that relevant evidence is that which has any tendency to increase the probability of a proposition that bears on the question of guilt. This characterization is "piecemeal" insofar as it considers pieces of evidence in isolation from one another. My working hypothesis, by contrast, is that each piece of evidence must fit in a larger narrative of what happened, and it is in relation to a narrative that the evidence can be judged to be relevant or irrelevant. I began to formulate a narrative-based account of relevant evidence in my dissertation. In this project, I plan to develop this account in more detail and test it against some case studies, including eyewitness testimony, fingerprint evidence, statistical and expert evidence.

B. JUDICIAL AND FACTUAL DISAGREEMENTS. The distinction between "law" and "facts" is pervasive. Legal scholars in mainstream philosophy of law have been debating why judges disagree about the law; call this *legal disagreement*. Scholars of evidence law have been examining why legal-fact finders can arrive at different interpretations of the evidence and disagree about whether or not the evidence supports certain facts; call this *factual disagreement*. As it turns out, scholars interested in legal disagreements have had little interaction with those interested in factual disagreements. This is unfortunate. I think that by bringing together these two lines of research, we can arrive at a fuller understanding of legal reasoning.

I have a two-stage approach here. The first stage will be to read legal disagreements through factual disagreements. Legal positivists *à la* Hart hold that legal disagreements can be adequately explained as disagreements about social facts. If Hart is right, legal disagreements would be factual, and consequently, they could be looked at with the concepts and methods which evidence law scholars have adopted in examining factual disagreements proper. Conversely, the other stage will be to read factual disagreements through legal disagreements. Richard Dworkin argued that legal disagreements are rooted in disagreements about theoretical principles, not merely in disagreements about social facts. I want to explore the extent to which factual disagreements can be informed by theoretical principles, just like legal disagreements are (at least according to Dworkin). All in all, this research project will probe the law-fact distinction, offer a broader picture of legal reasoning, and contribute to a dialogue between two separate traditions of research.

C. THREE UNCERTAINTIES. In my dissertation I argue that there are different issues about which there is problematic uncertainty in criminal trials. In this project I want to explore more closely three such issues with the tools of probability, logic, and game theory. (1) The first, and most fundamental, issue is whether the defendant is guilty or not. (2) The second issue concerns the evidence presented at trial, e.g. whether the evidence is complete or incomplete and the extent to which its availability depends on uncontrollable factors. (3) Finally, there is uncertainty about the behaviour of the trial actors. What will the prosecutor's strategy be? How will the defense respond?

The law of evidence and the law of procedure can be understood as a set of "devices" for coping with the three uncertainties just described. My first goal in this project is to analyze more closely how existent evidentiary rules can tame and control the three uncertainties. Here are some tentative ideas. The formula 'guilt beyond a reasonable doubt' aims to reduce the uncertainty about guilt as much as possible; the compulsory process which gives the defense the power to subpoena a witness restrains the uncertainty about the evidence; the right to an effective assistance of counsel restrains the uncertainty about the trial actors by setting a minimum standard of professional conduct. My second goal is to understand how the uncertainty about the evidence and the uncertainty about the trial actors affect the uncertainty about guilt. Does reducing the uncertainty about the evidence help us reduce uncertainty about guilt? Does leaving the trial actors free to pursue their own strategies increase the uncertainty about guilt? Probability, game theory, argumentation theory, and multi-agent logics are likely to prove useful here.

D. PROBABILITY, MODELS, AND CAUSALITY IN REASONING. If statistical decision theory is correct, a rational agent would choose the action that maximizes expected utility, yet experiments have shown that we perform poorly at calculating probabilities and often do not maximize expected utility. Some take these experiments to demonstrate that we are bad reasoners and bad decision makers. Some cognitivist scientists, however, have argued that the picture should be more nuanced. Gerd Gigerenzer suggested that we use "rough and ready heuristics" which are overall quite effective; Keith Stenning and Michiel van Lambalgen suggested that we construct "inertial causal models" and that probability and utility estimates make sense only within these models.

I would like to connect these suggestions with topics in epistemology. For instance, it is well-known that lottery propositions indicate that we refrain from drawing conclusions even if their truth is highly probable. Why? My hypothesis is that we do so because we construct and rely on inertial, non-probabilistic models of reality. At a later stage, I hope to consider the legal implications of the findings, which will be relevant to questions regarding the role of statistics and probability in legal proceedings.