Chapter XYZ: Weight of Evidence

The aim of legal-fact finding is, quite literally, to find out the facts, for example, whether or not the defendant embezzled USD 500,000 as the prosecution claims. To find out what the facts are—whether the prosecution's theory is true—it is necessary to gather, scrutinize and assess evidence from a variety of sources. One side will present evidence against the defendant, and the other side, the defense, will present evidence in favor of the defendant.

This adversarial process of presenting, scrutinizing and assessing evidence must come to an end. A decision about the facts must be made at some point based on the evidence presented up to that point. So, in trial proceedings, two decisions must be made: a decision about what the facts are, based on the evidence presented so far; and a decision about whether the process of presenting, scrutinizing and assessing evidence must come to an end. In principle, more evidence could always be presented about a disputed factual issue. Where was the defendant at 4 pm on Oct 13, 2024? Witnesses; forensic experts; telephone conversations; camera recordings—these are some of the types of evidence that could help to answer the question. But, at some point, gathering more evidence will no longer help to better answer the question than what the evidence already gathered could do. The costs of seeking more evidence may become greater than the epistemic value it adds.

New evidence can be epistemically valuable in at least two ways. First, it provides novel information that existing evidence did not provide, where this novel information can be consistent or inconsistent with the existing evidence. Second, new evidence may not provide novel information but simply agree with other evidence, for example, when two witnesses report having seen the same thing. So, new evidence is epistemically valuable if it adds new information or strengthens the credibility of existing evidence. But, at some point, seeking more evidence will become less and less epistemically valuable.

The epistemic value of new evidence need not be the same as its decision-theoretic value. A new piece of evidence is decision-theoretic valuable if, when added to the existing body of evidence, it would change the trial decision, given whatever decision criterion is used. A new piece of evidence can be epistemically valuable without being decision-theoretic valuable but not the other way around. Perhaps a new piece of evidence can add novel information or strengthen the credibility of other evidence, but these changes might not be significant enough to affect what the decision would be.

Besides epistemic and decision-theoretic value of new evidence, a third concept of worth singling out: the overall value of new evidence. New evidence is valuable, all things considered, whenever it is worth seeking it and postponing the trial decision. New evidence is not valuable, all things considered, whenever it is not worth postponing the trial decision and seeking it. The question of whether to stop seeking more evidence is ultimately a practical question, moral or political. It is a practical question because it requires balancing the costs of seeking more evidence with the epistemic and decision-theoretic value of new evidence. These costs can be monetary, but also in terms of time and delayed trial decisions. Before performing this balancing act, however, we need an account of when additional evidence is epistemically valuable or not. We aim to provide an account of the epistemic value of new evidence here.

The question of the epistemic value of new evidence need not be confined to evidence that has not yet been obtained. It could also concern evidence that was obtained and plays some role in the case. Or it could be about evidence that is missing and could no longer be obtained. So, the question about the value of evidence can be both prospective and retrospective. The prospective question should inform what investigators, prosecutors or defense do as they seek more evidence. The retrospective question assumes that seeking more evidence is impossible, but can still guide the trial decision about finding the defendant liable or not.

A stylized legal case will help fix ideas. A more detailed discussion of realistic legal cases is to be found at the end of this chapter. The defendant confessed to having killed the victim when he burglarized the victim's apartment and stole cash and other valuables kept in a tin box. The confession is the key incriminating evidence, but at trial, the defense raises the doubt that the defendant is covering up for his son. This doubt is corroborated by the fact that the defendant was rather short and it would take a tall person to kill the victim. And the defendant's son is much taller. But, on the other hand, the defendant confessed and provided abundant details all consistent with the findings of the investigators. One piece of evidence is missing: because the defendant confessed right away, the investigators did not examine the tin box for fingerprints. Had they found the son's fingerprints on it, that would be clear evidence the defendant was innocent. Absent this evidence, the defendant's confession remains the key piece of incriminating evidence.

This case raises several questions. Retrospectively—knowing what we know now—what is the value of the missing fingerprint evidence? Prospectively—knowing what the investigators knew back them—what is the value of the fingerprint evidence? Prospectively or retrospectively, what should the investigators have done? Should the defendant be acquitted because of the missing fingerprint evidence?

Section 1

1 Weighted Probability Difference

Formally, the epistemic value of new evidence E_n, against the background of other evidence E_b, can be measured by the probability change the new evidence brings about relative to a hypothesis H of interest. So the epistemic value of E_n given background evidence E_b relative to hypothesis H is the absolute difference $|P(H|E_b) - P(H|E_b \wedge E_n)|$. The greater this difference, whether positive or negative, the greater the epistemic value of the new evidence. The smaller the difference, the lesser the value of the new evidence.

This account, however, is not completely satisfactory, as it may regard additional evidence as worthless, while it is instead quite valuable. Suppose two witnesses testify one in favor and another against the defendant, one says they were with the defendant when the crime occurred away from the crime scene, while the other says they saw the defendant around the crime scene at the relevant time. Absent any reason to believe one witness more than the other, assume the chances are 50/50, that is $P(G|W1 \wedge W2) = .5$ Next, we consult two other witnesses, and again we find one favoring the defendant and the other incriminating the defendant. So, again, $P(G|W1 \wedge W2 \wedge W2 \wedge W5) = .5$. Are the testimonies of the two additional witnesses completely worthless? It seems not.

But here is a quick fix. There is an ambiguity. True, after listening to the two additional witnesses, we realize their input is worthless. But *before* listening to them, we did not know what they could have said. They could have spoken both against (or in favor) of the defendant, and in that case, the probability of G would have changed quite dramatically, either upwards or downwards. So, there are three possible scenarios: they both speak against the defendant; they both speak in favor; they speak one in favor and the other against. If each scenario is 1/3 likely, there is a 2/3 chance the new evidence would be epistemically valuable and only a 1/3 chance it would not be. So, overall, the new evidence is valuable.

So, the proposal here would be this: the epistemic value of new evidence E_n given E_b and relative to H is the weighted sum of the difference $P(H|E_b) - P(H|E_b \wedge E_n)$, whether the weights are the probabilities of the scenarios that could materialize.

$$P(M_r|\neg S) = P(M_r|M_t \wedge \neg S) \times P(M_t|\neg S) + P(M_r|\neg M_t \wedge \neg S) \times P(\neg M_t|\neg S).$$

TP probability $\times$ genotype probability + FP probability $\times$ (1-genotype probability)