

The emphasis on values gives Bayesian Decision Theory another dimension that is especially valuable in an assessment of the synergy of information. Not only can new information be included in the decision-maker's updated probabilities, but also the costs of the information can be included in the values. Thus it is possible to represent a rational decision about whether to seek the information in the first place. Taking into account the cost and the expected value of the data to be received, can the decision-maker expect to be better or worse off by accessing it?

Thus, application of Bayesian Decision Theory to the Basic Verification Decision Problem provides, first of all, a model for integrating information from new sources into the decision process. But, more important, it also determines the level of costs the decision-maker should be prepared to accept in return for the information. Consequently, information which is so imprecise as to be not worth accessing even if free can be identified, and optimal rules about when to stop looking for additional information can be generated.

**The Model**

The Basic Verification Decision Problem described in Figure 1 will be analyzed using the cost parameters shown in Figure 2. Below the Bayesian rational decision-maker will be called "Decision-maker." Note that Decision-maker's costs, rather than values, are used for convenience. Decision-maker's value for any particular outcome should be taken to be the negative

of the cost. Technically, these values should be measured in units of von Neumann-Morgenstern utility.

In Figure 2, the Accepted Compliance outcome is shown as having cost zero. This is not intended to suggest that Accepted Compliance has neither cost nor value; it indicates only that the other cost parameters, *F*, *L*, and *M*, measure the costs associated with the other outcomes relative to that of Accepted Compliance. Formally, the cost parameters are

- F* = RELATIVE COST OF { FALSE ALARM }
- L* = RELATIVE COST OF { SUCCESSFUL VIOLATION }
- M* = RELATIVE COST OF { DETECTED VIOLATION }.

The only assumptions made on these cost parameters are

$$F > 0; \quad L > 0; \quad L > M.$$

These assumptions reflect only Decision-maker's preference for Accepted Compliance over False Alarm when the true state is Green, and for Detected Violation over Successful Violation when the true state is Red. Note, in particular, that no assumption is made about the value of Detected Violation relative to Accepted Compliance; Decision-maker may prefer either Accepted Compliance ( $M > 0$ ) or Detected Violation ( $M < 0$ ).

Later, some assumptions concerning the cost of additional information will be introduced. For now, however, it is important to analyse how well Decision-maker can do without it.

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Figure 2:

**Basic Verification Decision Problem – Cost Parameters**

		True Status	
		<i>Green</i>	<i>Red</i>
Accept	<i>0</i>	<i>L</i>	
Alarm	<i>F</i>	<i>M</i>	

