Chapter 13—Uncertainty

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1 Acting Under Uncertainty

Logical agents act under *undcertainty* for they do not possess the full truth about their environments. Agents act to maximize *performance measures*, and must construct/choose rules accordingly. A *rational decision*, thus, depends on the relative importance of various goals, and the likelihood and degree to which they will be achieved.

1.1 Encoding Uncertain Knowledge

Knowledge is often expressed using rules and propositions from *first order logic*. Thus, we can express generalizations and instantiations as universal truths. These are, effectively, causal relationships. When knowledge is uncertain, it is impossible to exhaustively enumerate the set of rules, since infinite causes can be attributed to any effect, and vice-versa (this is the problem of **laziness**). There is also the problem of **ignorance**—we may not know all the rules anyway, or have any way of being certain about them. Probability provides a way of summarizing the uncertainty which comes from our laziness and ignorance, allowing us to express a **degree of belief** in the accuracy / completeness of our rule set. It also allows us to update our rule set (set of beliefs about the world) by observing evidence, transforming *prior* notions to *posterior* notions.

2 Probability Notation

The basic element of probabilistic statements is the **random variable**. It refers to a "part" of the world whose "status" is initially unknown. A random

variable is restricted to a domain of possible values: There are **Boolean, Discrete, and Continuous** random variables.

2.1 Atomic Events

An *atomic event* is a complete specification of the world of which the agent is uncertain. The world is modeled by a set of random variables, and thus the *atomic event* is an assignment of values to this entire set.

- atomic events must be mutually exclusive
- The set of all possible atomic events must be exhaustive
- Any particular atomic event entails the truth value of *every* proposition
- A proposition is a disjunction of all atomic events which entail the proposition

2.2 Prior Probability

The *prior probability* of a proposition is the degree of belief that it will be true, in the absence of any other information.