A LOGIC FOR UNKNOWN OUTCOMES

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1 *Introduction* In computer question answering and problem solving programs many of the questions of modal and tense logics appear as practical design problems. One problem of particular interest appears when we allow events to have the truth value "unknown", a natural value to assign to some events which occur at other times than the present. However, allowing a third value is not as simple as it seems. Suppose that statements P and Q each have the truth value "unknown". What values should be assigned to $(P \wedge Q)$? If $(P \vee Q)$ is necessary, it should have the value "true", otherwise it has the value "unknown". The "modal" composition of truth values cannot be achieved in a three ("true", "unknown", "false") valued truth functional logic. In fact, as shown by Dugundji [1], no finite valued truth functional logic can be given the modal interpretation. Consequently, semantic analysis of most modal systems must be quasi-truth-functional or involve infinite matrices or both. For example, Kripke [2] introduces the concept of a set of "possible worlds" with a model which assigns to each well formed formula (wff) a set of truth values, one for each world. If the set of worlds is infinite then each wff will have an infinite sequence for its value. Furthermore, the composition of truth values is not strictly truth-functional since it depends on the "possibility" relation between worlds. Another example is the infinite product logic, πC_2, where C_2 is the classical two-valued propositional calculus [5]. In this logic wffs again have sequence for their values. These sequences can be viewed as the value a wff takes over time [3] and thus provide a link between modal logic and tense logic. A final example, out of many others, is the probabilistic approach as discussed by Rescher [4], [5]. He shows that assigning a probability to each wff and applying certain minimal features of a probability calculus yields a set of tautologies equivalent to the theorems of S5. Here again the logic is infinite valued and quasi-truth-functional in the compositions.

    With a concern for computer applications such as question answering it seems appropriate to discuss yet another approach, which appears to have a simpler (though non-truth functional) decision procedure while requiring