ADAPTIVE PROCESSES AND INTELLIGENT MACHINES

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1. Introduction

The extraordinary development of the digital computer has induced a growing concern with the difficult domain of neurophysiology and the very much more inchoate study of thinking and thought processes. Many mathematicians, and others, have been attracted by the challenge of constructing computer programs which will carry out activities ordinarily requiring human intelligence. Here we have in mind such processes as pattern recognition, musical composition, chess playing, and theorem proving.

It is of interest and importance then to see if it is possible to define in precise terms what we mean, or even the many different things we could mean, by the term intelligent machine. Perhaps even more important is to examine in fine detail what is involved in an attempt to introduce such concepts as levels of intelligence, learning, instinct, in such a way as to facilitate reasoned scientific discourse in this area. As we shall see, there are considerable difficulties, and as the reader will soon note, we raise more questions than we answer. These questions do not appear to be insurmountable, but it would appear that their answers require a level of mathematical sophistication and analysis equivalent to that required for the theory of sets, the mathematical theory of logic, and perhaps most closely related to that used in the Liouville theory of the integration of elementary functions in terms of elementary functions [1].

Our basic approach is to imbed the concept of intelligence within the concept of decision making. We then consider various classes of multistage decision processes to which we attach certain familiar names. Admittedly, this is a narrow approach, but perhaps precisely for this reason we may be able to obtain some precision.

2. Multistage decision processes

Let p be a point in a space S, with q a point in a space D, and $T(p, q)$ a transformation with the property that $T(p, q) \in S$ whenever $p \in S$, $q \in D$. Call p the state vector, and q the decision vector (see [2]). Consider a sequence of points in S generated in the following fashion

$$p_1 = T(p, q_1), \qquad p_2 = T(p_1, q_2), \cdots, \qquad p_n = T(p_{n-1}, q_n), \cdots . \tag{2.1}$$