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ADAPTIVE PROBLEM SOLVING

-Partie 1-

Adaptive Problem Solving (**APS**) represents a class of Articial Intelligence (**AI**) systems which are capable of automatically modifying their internal parameters to solve the target problem. Adaptive systems come into their own when the problem search space is very large, when the necessary information is difficult or impossible to collect, when available data are disorganized, fragmented, or corrupted by noise, or when the problem has unknown dynamics. In other words, they suit most real-world situations where we do not have a complete model of the problem domain. In these circumstances, the traditional AI approach based on problem analysis, functional decomposition, and knowledge-based programming either fails or generates brittle solutions requiring extensive computation and memory resources.

Consider the programming of a robot for simple navigation in a partially known environment, devising a tool to predict its motion and behaviour.

In both cases, it is difficult to list all possible conditions which the system is expected to match and, even if possible, the combinatorics of the variables that might affect the solution is computationally intractable. An alternative strategy consists in letting the system observe the incoming data, and automatically extract invariant rules that can be applied to novel situations.

This is how human beings learn to drive a car or children learn to read.

An adaptive system is a program that recursively looks at the available data and gradually builds an estimate of the underlying model. Depending on how the system has been set up, the acquired model can be used to obtain missing information (data completion), predict the future course of temporal series (data forecast), categorize new data (data classi.cation), or cluster available data in meaningful ensembles (data representation).

Most adaptive techniques are inspired by biological principles of self-organization. Biological organisms are systems that successfully cope with a dynamic, partially unknown, and noisy environment. Given their limited resources and physical constraints, they gradually acquire their knowledge and adapt behavioural abilities by learning from experience and through natural evolution. It should come as no surprise that some of the most successful adaptive techniques have names such as : *Artificial Neural Networks*, *Neuro-fuzzy logic*, *Artificial Immunized Systems*, etc....

Each is inspired by a particular style of biological problem solving, but all attempt to capture the .exibility, ef.ciency, robustness, and simplicity of natural adaptive solutions. All such systems adaptively search the possible solution space by looking at available data and gradually modifying their internal estimate of the problem domain.

Compared to traditional knowledge-based systems, adaptive systems are based on the recursive application of very simple and local computations. These programs are functionally simple, quite compact, and are suitable for parallel implementations if desired. Their power resides in the adaptive principles driving solution estimation, not in system complexity. Adaptive systems are mainly data driven, implying that the solution quality depends on the type of data that the system is allowed to see.

Much current research focuses on understanding the influences of biases in the data set and the stability conditions of the adaptation process.

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