EDITORIAL

Artificial Intelligence—The Challenge and the Opportunity

The interdisciplinary studies commonly referred to as "Artificial Intelligence" have resulted in new ways to use computers that are potentially as far-reaching as any previous advance in automatic data processing. The challenge to the meteorological community is to maintain the proper balance between unrealistic expectations and the negativism that has been the usual reaction to exaggerated claims.

The research efforts reported in the following pages provide new insights into the forecast process, and to the role that computers capable of making logical inferences will play in that process in the future. We are beginning to realize which tasks can feasibly be performed by the computer now, which will require more research, and which will never be feasible unless there is a significant advance in the artificial intelligence technology.

This issue of "JTech" contains three papers devoted to the application of artificial intelligence (AI) to the atmospheric sciences. Their existence represents an achievement, and their numbers, a disappointment. At one time it was hoped that enough manuscripts would be submitted on this subject to warrant a special issue of JTech devoted entirely to artificial intelligence. This did not occur. In addition, many of the papers received reported only preliminary results of work in progress, more suitable for presentation at a workshop or conference than as a paper in the professional literature. The inescapable conclusion is that, while there have been many tentative efforts to utilize this new technology, further exploration, including false trails and dead ends, are needed before AI becomes an accepted meteorological tool.

Limited in number as they are, the three AI based papers in this issue demonstrate the variety of applications possible. In their METEOR system, Elio and her associates have followed the traditional AI practice (yes, even AI has developed traditions!), of using the computer to keep track of rapidly changing situations, noting the significance and possible consequences of the changes, and in general performing information processing that would be too time-consuming and tedious for a human assistant, and too complex for a conventional computer. The majority of knowledge-based expert systems are of this type, add-ons to conventional data inputs and computer products, designed to help the human do a more efficient job. The work of Campbell and Olson represents a different potential use of artificial intelligence: to attempt analyses that would not be possible otherwise. Using doppler radar data to recognize and predict microbursts and gust fronts requires the extraction of significant features at different elevation angles, and a merging of the information in a manner and within a time not possible for the human observer. In addition, the use of radar to nowcast wind shear hazards is too new an activity to permit the generation of fixed algorithms suitable for conventional computer programming. The expert systems developed by Campbell and Olson can be rapidly modified and added to, much as a human expert modifies his interpretation of data based on previous experience. This work demonstrates how artificial intelligence systems can be research tools, capable of transference to conventional programs if and when an optimum procedure is found.

The third paper in this group, by McArthur et al., discusses the process of weather forecasting from a knowledge engineering point of view, and outlines the type of framework that might be used in several different future AI programs at a forecast office. Meteorologists who wish to develop expert systems that deal with more than one parameter or phenomenon will have to devote some attention to this facet of AI, known as knowledge representation. A rudimentary knowledge of such purely AI subjects is required for an effective use of the results, much as an understanding

of microwave transmission is needed by meteorologists interpreting radar or satellite data.

A significant characteristic common to all three papers presented here, is that the authors are not meteorologists using artificial intelligence techniques, but engineers, computer scientists and AI experts applying AI to, as it so happens, meteorological subjects. Further meaningful progress in this field will occur only when research meteorologists and forecasters become comfortable with AI techniques and products, using them in cases when they are most appropriate, but not forcing their use in situations when conventional computers (or humans!) can do the job better.

There is no doubt that the study of the atmosphere is inherently a promising field for computer analysis enhanced by artificial intelligence. The explosive increase in data sources, bring with it the problem of quality control, data integration, processing and interpretation, virtually demands a quantum leap in our methods of analysis and display. In addition, the declining numbers of forecasters and the necessity of keeping abreast of rapidly changing technology makes the use of knowledge-based systems an appealing alternative to more time-consuming training programs. Meteorologists who have participated as domain experts in the development of rule-based systems are unanimous in their assertion that reducing their expertise to rules forced them to think objectively about the justification for their standard procedures. This may lead to another, potentially revolutionary, application of AI: an examination of the validity of the process whereby dynamical concepts based on simplifications such as quasi-geostrophic theory are translated from a set of equations to forecasting rules-of-thumb. The AI systems can investigate many more cases than the human forecaster, including hypothetical "what-if" deviations from actual cases. Exercising expert systems in this way may reveal characteristics of the synoptic and meso-scales that were previously undetectable.

Much work is being done, in addition to the efforts described here, but for the most part they are small, isolated projects. As with any new scientific endeavor, there is as yet no standardized, objective method of evaluating these results. That will come only when significant numbers of these efforts are described in the meteorological (as opposed to computer) literature. This issue of JTech represents a first step in that direction.

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