trees in a purely binary form, claiming that this approach makes parsing easier. However, I found that, as a result, his algorithms were complicated and not intuitively convincing. He then discusses different parsing methods, treating, in sequence, the top-down parse, the bottom-up parse, the general left-to-right parse (using Earley's nodal span method), and parsing based on restricted grammars, specifically, $LR(k)$ grammars, bounded-context grammars, and precedence grammars. Unfortunately, the interesting special case of operator precedence is not treated.

The author has a clear and engaging expository style; but he is unfortunately fighting an uphill battle against a poor choice of algorithms and data representations. For instance, the discussion of the top-down parse occupies two chapters and requires about five pages of flow-charts; with proper choice of representation and algorithm, the top-down parse becomes exceedingly simple—in fact, the simplest of all methods. Furthermore, there are numerous minor errors which make the discussion hard to follow. After several hours of attempting to understand the discussion of the nodal span parse, I realized that my difficulties were due to a number of different misplaced or missing arrows in one diagram (figure 8.6)! Among other errors that I noticed were the use of $\bar{y}$ rather than $\bar{x}$ on line 10, page 47, the use of $\underline{m}$ rather than $\underline{i}$ on the last line of page 114, and the omission of $\bar{z}$ following ξ in the statement of the first part of the closure rule on the same page.

The advantages of this book are its excellent organization and fine expository style. I found these outweighed, however, by the disadvantages of cumbersome algorithms and confusing errors. The restriction of the subject matter to parsing is a mistake, from my point of view; but that is a matter of taste.

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37 [13, 25].—H. MELVIN LIEBERSTEIN, *Mathematical Physiology, Blood Flow and Electrically Active Cells,* American Elsevier Publishing Co., Inc., 1973, New York, xiv + 377 pp., 24 cm. Price $19.50

This book is a collection of the specific contributions of its author to the growing field of mathematical physiology, and the reader would be well advised not to form an overall impression of this field on the basis of this book.

The section on blood flow is based on a power series expansion for the velocity profile in pulsatile blood flow. The first term of this series is the parabolic profile of steady flow, and the subsequent terms contain successively higher time derivatives of the driving force. One would expect this series to converge rapidly only in the smaller arteries where the flow is, in fact, quasi-steady.

The section on electrophysiology is based on a modification of the Hodgkin-Huxley equations, which is referred to by the author as a "reformulation." The equations for nerve conduction, as stated by Hodgkin and Huxley [1], have the form:

$$ri = -v_x, \tag{1}$$

$$cv_t + I = -i_x, \tag{2}$$

where $I = I(v, s_1 \cdots s_N)$ is the ionic current through the membrane, and where the membrane parameters s_k obey ordinary differential equations of the form

$$ds_k/dt = f_k(s_k, v).$$

Traveling wave solutions of this system with velocity θ obey the ordinary differential equation

$$cv_t + I = (1/r\theta^2)v_{tt} \qquad (3)$$

with I defined as above.

Unless the parameter θ is chosen correctly, the solutions to (3) are unbounded, and this fact can be used to determine θ.

Lieberstein attempts to avoid the difficulty of unbounded solutions as follows. First, he introduces in equation (1) the term li_t which arises from line inductance. This in itself cannot be wrong, since there is always some line inductance, and the Hodgkin-Huxley equations can be regarded as a limit as $l \longrightarrow 0$. Thus, Lieberstein obtains the equations

$$li_t + ri = -v_x, \qquad (1)'$$

$$cv_t + I = -i_x, \qquad (2)'$$

with I as above. The signal velocity for this hyperbolic system is given by $\theta^2 = 1/lc$, and Lieberstein determines the value of θ from the experimental propagation speed of a nerve impulse. The fact that equations of the Hodgkin-Huxley type with $l = 0$ exhibit stable traveling wave solutions with finite velocity (see for example [2]) shows that this procedure is not justified. Under Lieberstein's assumption, the ordinary differential equation for traveling waves is

$$cv_t + I = (1/rc\theta^2)I_t. \qquad (3)'$$

Equations (3) and (3)′ are different, though of course they coincide in the case $\theta \longrightarrow \infty$ which corresponds to a "membrane" or "space-clamped" action potential [1].

Lieberstein's assumption that the nerve impulse travels at the velocity given by $\theta^2 = 1/lc$ is almost certainly incorrect. First, it is doubtful whether one could produce a field theory for transmission line conduction in nerves which would give such a low signal velocity as the observed propagation rate in nerves (20 m/sec in squid giant axon) Second, $\theta^2 = 1/lc$ yields a velocity which is uninfluenced by the active properties of the membrane and should therefore be independent of temperature, for example, but this is not the case. Finally, it is well known that electrical stimulation of a nerve at one point yields a stimulus artifact at distant points which arrives essentially instantaneously, long before the nerve impulse. This observation strongly suggests that the nerve impulse itself travels at a velocity far lower than the maximum possible signal velocity of the nerve cable.

If the term li_t is included in the formulation, and one looks for solutions which are traveling waves with velocity $\theta^2 < 1/lc$, then the ordinary differential equation to be satisfied by these waves is second order in time, like (3), and tends to (3) in the limit $l \longrightarrow 0$, θ fixed. This would appear to be the correct procedure.

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1. A. L. HODGKIN & A. F. HUXLEY, "A quantitative description of membrane current and its application to conduction and excitation in nerve," *J. Physiology* (*London*), v. 117, 1952, pp. 500–544.

2. J. RINZEL & J. B. KELLER, "Travelling wave solutions of a nerve conduction equation," *Biophysical J.*, v. 13, 1973, pp. 1313–1337.