the photo-transduction cascade are especially useful. In addition, the author's love of morphology and of the retina can be savored through his fabulous original illustrations. The descriptions of these illustrations are woven into the text so that each drawing or diagram can be appreciated as the story is read. Finally, the topical chapters at the end of the text provide useful information on the biochemical cascades, as well as quantitative descriptions that involve radiometry and photometry.

Those readers, however, who are looking for a detailed discussion of how vision will be/disappear. The book is idiosyncratic in its selection of topics, coverage, emphasis, and presentation. For example, although the dynamic nature of vision is emphasized and the importance of vestibular and other extra-retinal signals is discussed, no mention is made about the well-known brain-stem circuitry or cortical brain areas (for example, the middle temporal visual area or frontal eye fields) that control saccadic eye movements. Instead, the book digresses to the tangentially related topic of directionally selective rabbit retinal ganglion cells. In fairness to the author, the former issues are really beyond the first steps in seeing. Although other central brain areas, such as the primary visual cortex, are mentioned, no details are provided about dynamic organization of this area or the existence of other important visual cortical areas to which the primary visual cortex connects. Overall, the rationale for selection of topics to be included in the book is unclear. Even at the level of the retina, coverage is uneven and many important topics are either not discussed or current views are not included. For example, important aspects of retinal adaptation are not considered, and the views of ganglion-cell physiology and receptive-field function are dated. Most issues are explained as if the ideas presented were established facts, rather than simply a favored perspective. The chapters 'Looking' and 'Seeing' are especially disappointing as one never learns much about how visual signals are processed. The serious reader will be frustrated by the lack of references; citations are mostly relegated to the very end of the book under 'Notes'. Side bars discuss the Latin or Greek origins of words used, but mention nothing about leading figures in the field or alternative hypotheses for the views discussed. Unorthodox exposition of familiar information also is confusing for example, the use of frequency instead of wavelength to represent the visible spectrum. Topics such as ganglion-cell classes and organization of the lateral geniculate nucleus, among others, are presented in dogmatic frameworks, which miss the ongoing debates that characterize current understanding. The epilogue entitled 'Ignorance' is limited and inappropriate, given that some of the ideas mentioned are not covered adequately earlier in the book.

In summary, this is a beautifully illustrated work that provides a detailed overview of the photoreceptors and morphology of the retina. Although the book omits what universe and emphasizes structure over function, what is covered is presented in a rather than simply a favored perspective. I would recommend this book to scientists and lay persons alike with an interest in the organization and the anatomy of the primate retina.

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Reference

Biophysics of Computation: Information Processing in Single Neurons
by Christof Koch, Oxford University Press, 1998. £59.95 (xx + 562 pages) ISBN 0 19 510491 9

Marr and Poggio have proposed that for any computational machine there are three levels at which processing must be understood: computation, algorithm and implementation. At the top level, computational theory formally characterizes the problem to be solved. At the bottom level is the question of implementation: for the brain this means the neuronal ‘wetware’ that perfoms the computation, including neuron biophysics and circuits, synapses, etc. The link between these two levels is given by the algorithms used to compute the solution. At the level is only constrained by fundamental principles indirectly, the rules that must be followed and determination of an algorithm are, in a sense, an emergent property from both top-down (for example, computational theory) and bottom-up (for example, element physics) considerations. As a result, finding the appropriate algorithms for information processing (useful in the case of machines prototyped on or in the case of brain) requires an understanding of the formal nature of the computation, as well as the nature of the hardware.

In neuroscience, the relationship between observation and interpretation is explicitly emphasized what has come to be called ‘computational neuroscience’. For example, using this approach, the modeling of specific and defined biophysical mechanisms provides the conceptual basis for data interpretation. There has been a huge increase in quantitative data in neuroscience and, increasingly, these data are gathered in the context of explicit mechanistic theories. The constraints imposed by complex system behavior underlie one axiom of computational neuroscience: explicit modeling of these theories is not important, it is necessary, despite the dubious reputation of computer models. As someone said, ‘Give me four parameters, and I will build you a dog. Give me one more, and I can make it tail wag.’ In other words, so what! In his ambitious new text, Christof Koch demonstrates convincingly that ‘so what?’ can be counted by the fact that the constraints implied by data mean that neuron models can (and should) demonstrate more than just tail wagging by virtue of many parameters. While it is fair to say that the literature includes a surfet of ill-posed computer simulations, fortunately the quality of this research is improving markedly. Biophysics of Computation will reinforce that welcome trend.

Koch combines two strategies: he covers a great deal of what is known about neuron biophysics (and anatomy, at least at the single-cell level), in all cases indicating potential computational relevance; and he also covers a wide variety of computational questions, always choosing those that are tightly coupled to experiments. Koch presents what can be now considered to be ‘classical’ computational neuroscience, for example, kinetic models of axon excitability and the work of Hodgkin and Huxley, or linear cable theory and the work of Rall. He also provides a comprehensive survey of current work, for example, the functional consequences of non-linear synaptic integration, stochastic properties of channels and spikes trains, and intracellular diffusion of second messengers. Finally, he throws in a few tidbits of recent research, for example, in the chapter ‘Unconventional Computing’, including the molecular basis for memory and the generation of the very crowded extracellular space in the brain. It will be interesting to see which of the subjects presented here will make it into the conventional computational category.

Discussion of so-called ‘neuromorphic’ computation through the retina is another matter, since the relationship to biology is clearer. With respect to neural network theory, which, conversely, might very well provide productive strategies for
Methods in Neuronal Modeling (2nd edn)

edited by Christof Koch and Ian Segev, The MIT Press, 1999. £47.95 (xiii + 671 pages)
ISBN 0 262 11231 0

Methods in Neuronal Modeling concentrates on the type of modeling approach formulated by Willard Rudy in the 1960s to simulate a single neuron behavior on a computer by slicing the neuron's continuous membrane into compartments. The substantial difference between this edition and the first edition is reflected by the inclusion of seven completely new chapters, which is appropriate for the compartmental approach. The rest of the book, it would have been interesting if some complementary approaches, such as tapered dendritic representations, and the equivalent cables, which are based on the Lanczos method, had been included. One of the limitations of the compartmental model, the discussion of which forms the cornerstone of this book, is that it suffers from too many degrees of freedom and in most instances requires an 'educated guess' for the many unknown parameters required to model the neuron with sufficient accuracy. Another limitation that is not addressed is clearly evident from Fig. 3.3, it is not enough for accurately investigating alternative effects, such as potential field interactions, spatial coverage and mapping of receptive fields. The book also includes the membrane biophysics of a space-clamped neuron but the topic remains similar to that discussed in the first edition with some additional references. It would have been more useful to include data at the beginning of the book or to combine it with the chapter on Ca2+ dynamics in single neurons. As little is known about Ca2+ channels and their dynamic properties, these two subjects represent some of the most interesting and important contributions to the whole book.

The use of the compartmental model to simulate pyramidal neurons with active dendritic ion channels is dealt with in Chapter 5. This is a 'hot' topic in neuroscience but is covered relatively scantily using a measure of four equations. Although the authors continue to argue that a method must be sought for constraining the parameters by matching simulations to experimental recordings, and then proceed to propose a trial-and-error approach, it would have been more interesting to use data on conduction velocities that are now available through optical recording and the application of a pharmacological agent to determine the optimum density of specific ion channels on the basis of Hodgkin's approach to Na+ channels. Another limitation is left relatively untouched from the first edition, although there is an expanded section on bursting, which focuses on a hybrid between the FitzHugh-Nagumo and Hodgkin-Huxley models known as the Morris-Lecar model. This chapter seems to set the pace for biologically realistic neural networks and, hence, biological cybernetics. Indeed, a completely new chapter is devoted to the possibility of using very large-scale integration (VLSI) technology for implementing more realistic silicon neurons that incorporate various biophysical features, based on the Hodgkin-Huxley model and complementary metal oxide silicon VLSI technology. The book also provides a wide and relevant issue of neural spike-train analysis. After motivating the subject in terms of the temporal coding

References


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