Shape Understanding Systems

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The First Steps toward the Visual Thinking Machines

With 330 Figures

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This book is dedicated to our Patron St. Jadwiga Queen of Poland

Contents

Preface

This book presents the results of the research in one of the most complex and difficult areas of research such as research in the areas of thinking and understanding. This research that is carried out in the newly founded Queen Jadwiga Research Institute of Understanding www.qjfpl.org/QJRIU/Eng/Eng_QJRIU_PO_O.htm is focused on research on the problem of visual understanding and visual thinking. Visual understanding is part of the general understanding problem and it is not possible to carry out the research in visual understanding without reference to the nonvisual understanding problems. Understanding appears as the result of the thinking processes, and doing research in the area of understanding there is a need to include thinking process as one of the research problems that should be solved in the context of understanding investigations. According to our knowledge, this book is the first attempt to investigate the complexity of the visual thinking problems in the context of building the thinking machine. The aim of our research is to build the machine that can have capabilities to solve visual problems during thinking process. We are aware how complex this problem is and we are aware that the results of our research are only the first steps in building the thinking machine being able to solve complex visual problems. However, we believe that the results of our research will pave the way into the new way of thinking about designing the thinking machines and, especially, will supply the new scientific arguments about our human nature.

Until now, the problem of understanding and thinking was the topic of research in the area of philosophy, psychology, or cognitive science. Philosophical investigations of many thinkers such as Plato, Aristotle, Locke, Berkeley, or contemporary thinkers contributed into progress of understanding and thinking processes. Although there are some research on this topic in the area of artificial intelligence (AI), researchers in AI do not pay sufficient attention into understanding/thinking problems. It was probably for that reason that they tried to tailor the problem of what they called "artificial intelligence" to the abilities of the existing computing machines.

Another reason was that until now, there was no proper representation that could capture visual aspects of the world and represent them in the form that could be compatible with other representations of the nonvisual knowledge.

When existing systems are built based on the results of the scientific discoveries in the domain of psychology, cognitive science, computer science, or AI, our approach is based on the results of philosophical investigations of such thinkers as Aristotle, Locke, or Berkeley. In Chap. 1 of this book, the brief description of the results of main philosophical investigations concerning thinking and understanding is presented. In this chapter, shape that is regarded as the main perceptual category of thinking process and the important visual feature of the perceived world is briefly described. In the following sections of this chapter, the different problems connected with understanding are briefly presented. The relation between understanding and thinking is discussed in the following sections of this chapter. The last section includes the short description of the shape understanding system (SUS). In this book, the problems connected with the implementation issues of the SUS are not presented. The reason for that is that the theoretical issues connected with thinking and understanding are very complex, and inclusion of the extended description of implementation issues could cause that the contents of this book would be less understandable. In Chap. 2, concepts of shape classes that are understood as the basic perceptual categories are explained. The classes are represented by their symbolic names. Each class is related to each other and based on these classes there is relatively easy to establish the "perceptual similarity" among perceived objects. In Chap. 3, the description of the reasoning process that leads to assigning the perceived object to one of the shape classes is given. Each class possesses its characteristic reasoning process. The result of the reasoning process is the assignment of the examined object to one of the shape classes represented by the symbolic names. The symbolic name is used to find the visual concept and next to assign the perceived object into one of the ontological categories. Ontological categories are part of the new hierarchical categorical structure of the SUS. The new hierarchical categorical structure is explained in Chap. 4. The categorical chains that represent the categories of visual objects and knowledge categories are applied to interpret the perceived object as the symbol, the letter, or the real world object. In Chap. 5, examples of the visual reasoning processes that can be considered as the thinking process are presented. The thinking process is regarded as the continuous computational activity that is triggered by perception of a new object, by perception of an "inner object," or by the task given by the user. Thinking can lead to solving a problem where there is only one solution (e.g., the visual intelligence test) or solving a problem where there are many possible solutions

(e.g., designing the tools). In this book, the focus is on thinking that leads to solving a problem that has only one solution.

We are aware that this book could be written in a different way where some issues could be explained in more details or presented in the different ways. We would like to explain that this book was written in very "difficult" conditions. During the most crucial part of writing of this book, we were notoriously expelled from our own flat where most work connected with preparation of this book was carried out. We think that for most of the readers, it would be difficult to understand how it could happen that in twenty-first century someone could be expelled from his home. We believe that it could happen only in country such as Australia where for more than 15 years, we Polish scientists are subjected to psychological terror from some Australian people and institution. The details of our persecution in Australia are described on our Web site (www.qjfpl.org\Przesladowanie\Eng\). We would like to take this opportunity and ask the Australian Government in Canberra to take responsibility for all damage that we suffered from Australian people and institutions.