4 Understanding and Learning

In the previous Chapters, the knowledge implementation was defined in the context of both human learning and machine learning. The knowledge implementation is focused on learning of the knowledge and skills by machine (SUS) and is concerned with two main aspects of human learning: learning of the visual knowledge in the context of the categorical structure of the learned categories of the visual objects and learning of the knowledge that is connected with understanding of the content of the text. As it was described in Chapter 3, SUS operates in two main modes, learning and understanding mode. SUS ability to understand depends on the effectiveness of learning process and learning of the new knowledge depends on SUS ability to understand.

It is understanding that sets man above the rest of sensible beings, and gives him all the advantage and dominion which he has over them. Understanding and learning are terms that describe the main human intellectual activities. Understanding of acquired knowledge is the basis for meaningful learning. Machine understanding is the term introduced by authors to relate this term to the term machine learning used to describe the process of acquiring knowledge by machine. Machine understanding is part of the knowledge implementation that stresses dependence of the learning and understanding process. SUS as a machine that is designed to have the ability to think and understand, needs to learn both knowledge and skills. In this Chapter learning is regarded, within framework of the knowledge implementation, as the process of supplying of the material for thought that leads to understanding. As it was described in [1], the main ingredient of thought is a concept. The concepts are part of hierarchical structure of conceptual knowledge that is learned and transformed into the form that is accessible during thinking process. In this book the term category is often used to denote the term concept. The term category is used to denote the class of visual objects that are part of the real world, whereas the term concept is used to denote members of the class with reference to thinking/understanding process. Similarly, in area of philosophical investigations, the term category is used to stress the difference between the concepts that have connection with human mind and the category that is an object that is the result of the generalization process. Understanding appears as the result of the thinking process and is based on abilities called intelligence such as a verbal communication, spatial orientation, memorizing, and reasoning. Understanding that is based on knowledge is often connected with interpretation or disclosing meaning of the language and the concept is the key element of understanding process. Understanding and thought were topics of many philosophical thinkers such as Plato, Aristotle, Locke, Berkeley, Laibnitz or Gadamer to list just
a few (see. e.g. [10], [98], [99], [100], [101], [102], [103]) and were regarded in the context of the origins of human knowledge.

Visual perception was often thought of as the ‘introduction’ to understanding of the real world phenomena. For example, Locke claimed that perception is made up of sensations (input) and reflections, Wittgenstein underlined the role of the knowledge and Arnheim and Rock [104] suggested that perception is intelligent in that it is based on operations similar to those that characterize thought. According to the inference theory, knowledge is acquired solely by sensory experience and association ideas and that the mind at birth is a tabula rasa upon which experience records sensations. The Gestalt view was far from being a tabula rasa and refers to the laws of association: items will become connected when they have frequently appeared together [105]. The Gibson theory [15] claims that sensory input is enough to explain our perceptions. Marr [16] developed a primal sketch paradigm for early processing of visual information. SUS understand of the visual object by transforming it into the symbolic name and next during naming process the name is assigned to the perceived object. The processes connected with naming of the object are related in some aspects to human perception. Understanding of the visual object or phenomena is different from understanding a general concept, or abstract concepts such as mathematical objects and the visual concept and mental images play a key role in visual understanding.

Learned knowledge is used during understanding of the visual or sensory object and during understanding and interpretation of the text object. Understanding of the object, which belongs to the category of visual objects, require engaging different skills and knowledge. For example, objects from the different structural categories such as the element category, the pattern category or the picture category, require application of different skills and knowledge for processing, for visual reasoning and for visual understanding. Understanding of the complex visual object is to know which part it consists of, what material is it made of, what for is it used for/by, how to make it, how to use it and how does it work. An object, which belongs to the category of visual objects, can be named (recognized) based on its shape. In the case of members of the category of symbolic signs or visual symbols, visual understanding plays a key role in naming of these objects. In contrast, naming of objects that are members of the category of text involves only a small part of visual knowledge but at the same time requires a vast amount of non-visual knowledge during understanding process. Also members of the pattern category, derived from the category of visual symbols such as the category of mathematical expressions, the category of texts, the category of musical texts or the category of engineering schemas, need to be interpreted by using very complex methods requiring huge amount of non-visual knowledge. The symbolic name and visual concept can explain the way in which the pictorial information can be represented, however in this book these issues will not be discussed.

Understanding of the sensory objects, similarly to the visual objects, requires accurate naming of the object. Understanding both the visual and the sensory objects begins with the naming of the object. When an examined object is named correctly (recognized) all previously acquired knowledge can be used during the understanding process. In the case of naming an object from the mineral-category,