

INTERNATIONAL CENTRE FOR MECHANICAL SCIENCES

COURSES AND LECTURES - No. 85



JULIUSZ KULIKOWSKI  
ACADEMY OF SCIENCES - WARSAW

# ALGEBRAIC METHODS IN PATTERN RECOGNITION

COURSE HELD AT THE DEPARTMENT  
OF AUTOMATION AND INFORMATION  
JULY 1971



Springer-Verlag Wien GmbH 1971

**This work is subject to copyright.**

**All rights are reserved,**

**whether the whole or part of the material is concerned  
specifically those of translation, reprinting, re-use of illustrations,  
broadcasting, reproduction by photocopying machine  
or similar means, and storage in data banks.**

**© 1972 by Springer-Verlag Wien  
Originally published by Springer-Verlag Wien-New York in 1972**

ISBN 978-3-211-81128-3

ISBN 978-3-7091-2884-8 (eBook)

DOI 10.1007/978-3-7091-2884-8

## P R E F A C E

*During the last years electronic computation and data processing methods have reached a comparatively high level of maturity. More and more complicated forms of input data: numerical, alpha-numerical, textual can be handled automatically and processed by electronic computers. Last time a growing attention is paid to the picture processing. Graphical and pictorial forms of information play an important role anywhere a human individuum is linked on an informational system as its element. This is a consequence of the fact that a human visual tract is distinguished by its possibility to parallel information processing and by its flexibility to changing circumstances. That is why the problem of immediate visual information exchange between man and computer arises as a very actual one. The recognition of patterns by specialized automata or by electronic computers is a first step toward the solution of this problem. The pictures being of interest in many practical applications are not only typewritten or handwritten texts, but also graphics, electronic schemas, graphs, fingerprints, meteorological charts, microphotos etc. Under certain assumptions they can be divided into less or more formalized classes to be discriminated automatically. It seems to us reasonable to consider the pic-*

tures as some expressions of a "planar" language, subjected to a certain number of morphological and syntactical rules. An identification of the sets of grammatical rules corresponding to the given classes of patterns is a problem of interest if a pattern recognition algorithm is to be chosen. No universal "planar" language seems to exist and no universal pattern recognition algorithm for a computer seems to be possible, as well. Nevertheless, the linguistic approach turns out as a more effective one when composite patterns are dealt with. The other methods based on geometrical, statistical or functional models of patterns recognition can be included as fragmentary ones in the structural-linguistic analysis of a composite pattern. A need of an universal meta-language for the description and theoretical investigation of "planar" languages that are used in particular situations arises. In our opinion, this can be reached on the basis of a general approach offered by a general theory of relations. This last can be specified in such a way that any simple or composite picture is considered as a realization of a generalized relation described on an ordered family of sets of local input signal values. This idea developed in the below given lectures. It will be shown that a kind of Boolean algebra can be defined on the set of possible relations. The well known methods of Boolean functions minimization thus can be used in order to minimize the length of an expression formally describing a pattern.

*The considerations will be illustrated by numerical examples. However, they could not be considered as recommendations for the solutions of practical problems.*

*This is my duty and a great pleasure to express here my best thanks to Professor Luigi Sobrero and to Professor Angelo Marzollo for their initiative of including the lectures being given below to the program of CISM Summer School in June, 1971.*



*Udine, June 1971*