MACHINE LEARNING AND VISION: RESEARCH ISSUES AND PROMISING DIRECTIONS

by

R. S. Michalski
P. W. Pachowicz
A. Rosenfeld
Y. Aloimonos

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NSF/DARPA Workshop on Machine Learning and Vision: A Summary

Ryszard S. Michalski
Peter W. Pachowicz
Center for Artificial Intelligence
George Mason University

Azriel Rosenfeld
Yiannis Aloimonos
Center for Automation Research
University of Maryland

This report gives a brief account of the NSF/DARPA Workshop on Machine Learning and Vision, organized by George Mason University in collaboration with the University of Maryland, October 15-17, 1991 in Harpers Ferry, WV. The purpose of the workshop was to bring together researchers in vision and learning to discuss the possibilities of cross-fertilizing the two fields, and implementing learning capabilities in vision systems.

The workshop was attended by about 40 participants representing universities, industrial and governmental laboratories, and several sponsoring agencies. The workshop started with two general presentations, one on machine vision (A. Rosenfeld), and the second on machine learning (R.S. Michalski). Subsequent discussions were conducted in three sessions: 1) Learning in object recognition (organized by J. Shavlik and T. Poggio), 2) Learning in navigation (organized by T. Dean and T. Kanade), and 3) Learning in sensory-motor control (organized by R. Bajcsy and T. Mitchell).

The session on object recognition discussed issues related to types of tasks and important subtasks in object recognition. Two basic types were distinguished: learning shape descriptions and learning surface (texture) descriptions. The shape learning subtasks were classified according to their difficulty: isolated object recognition, recognition of specific objects in a scene, and recognition of objects that fulfill a functional goal (e.g., an object that could be used as a chair). The following issues were considered as important for learning in vision: relationship between 2D and 3D vision, number of training examples needed, use of prior knowledge, discovery of good representations, attribute selection, variability of the environment, and occlusion.

The session on learning in navigation classified the problems that require learning along such dimensions as: constrained vs. unconstrained navigation, static vs. dynamic navigation, and structured vs. unstructured environment. Navigation tasks incorporating learning functions were analyzed according to shallow vs. deep inference, resource consideration, availability of supplementary knowledge, and complexity of behavior. Issues for machine learning include (i) learning in a constrained spatio-temporal context, (ii) building representations to facilitate planning in a spatio-temporal context, (iii) memory management during learning, (iv) combining sensor information, and (v) optimal feedback control.

The session on learning in sensory-motor control identified several bottleneck problems. The major goal of machine learning is viewed as automatic combining of specific vision and action modules in a task-independent way. This includes (i) learning efficient visual search, (ii) learning invariances that facilitate object identification under different imaging transformations and occlusions, (iii) learning module configuration and coordination for sensory-motor tasks, and (iv) learning calibration between sensing and action.

In summary, researchers agreed that many crucial elements of machine vision cannot be considered in isolation from machine learning. However, to be successful in the integration of learning and vision, researchers should pick a particular vision problem, apply acceptable restrictions on the problem, simplify the data, find solutions by applying learning technology, and then improve the solutions by gradually relaxing restrictions on the problem. It would be desirable to sponsor several long-term projects focused on both industrial and military applications. The creation of sharable testbeds is recommended for evaluation of results.

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Reference

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