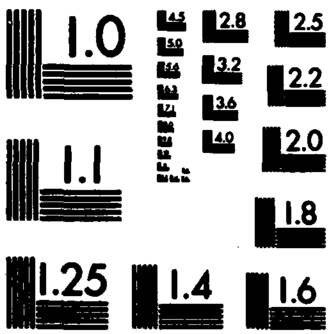
AD-A133 945 STUDY ON EXTREMIZING ADAPTIVE SYSTEMS AND APPLICATIONS TO SYNTHETIC APERT..(U) ENVIRONMENTAL RESEARCH INST OF MICHIGAN ANN ARBOR D POLITIS MAY 83 AFOSR-TR-83-0852 1/1

UNCLASSIFIED F49620-82-C-0097 F/G 6/4 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

AD-A133945

(3)

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AFOSR-TR- 83-0852	2. GOVT ACCESSION NO. AD-A133945	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Study on Extremizing Adaptive Systems and Applications to Synthetic Aperture Radars		5. TYPE OF REPORT & PERIOD COVERED ~~Interim~~ Report 10 Sep 82 - 09 Sep 83
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Dr. Demetrios Politis		8. CONTRACT OR GRANT NUMBER(s) F49620-82-C-0097
9. PERFORMING ORGANIZATION NAME AND ADDRESS Environmental Research Institute of Michigan P.O. Box 8618 Ann Arbor, Michigan 48107		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2312/A1 61102F
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Office of Scientific Research/NL Bolling AFB, DC 20332		12. REPORT DATE May 1983
		13. NUMBER OF PAGES 5
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

OCT 24 1983

A

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Learning; Neuron; Synthetic Aperture Radars

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Klopf's work on the functioning of the neuron was studied and critically examined for engineering application possibilities. Similarly, Barto's work on the implementation of Klopf's ideas in computer simulated nets/systems was studied to determine if it could provide suitable models for physical systems. The latest learning system investigated by Barto, described as "Learning with an Adaptive Critic" was considered as the most promising for for engineering applications. The dynamic behavior of this system is currently

DD FORM 1473 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DTIC FILE COPY

83 10 17 165

being investigated in order to improve our understanding of the system operation and potential applications. In parallel with this study possible application of such learning systems in synthetic aperture radars (SAR) and data exploitation were examined. Several potential applications have already been suggested. These suggestions will be further explored and the most promising will be proposed for full investigation and possible implementation.

Contract F49620-82-C-0097
Annual Scientific Report
May 1983

STUDY ON EXTREMIZING ADAPTIVE SYSTEMS AND APPLICATIONS TO SYNTHETIC APERTURE RADARS

Environmental Research Institute
of Michigan
P.O. Box 8618
Ann Arbor, MI 48107

Dr. Demetrios Politis

Controlling Office: Air Force Office of Scientific Research/NL
Bolling Air Force Base, DC 20332

STUDY ON EXTREMIZING ADAPTIVE SYSTEMS AND APPLICATIONS TO SYNTHETIC APERTURE RADARS

Brief Interim Report

ABSTRACT

Klopf's work [1] on the functioning of the neuron was studied and critically examined for engineering application possibilities. Similarly, Barto's work [2] on the implementation of Klopf's ideas in computer simulated nets/systems was studied to determine if it could provide suitable models for physical systems. The latest learning system investigated by Barto, described as "Learning with an Adaptive Critic" [3] was considered as the most promising for engineering applications. A functional engineering model of that system has been developed and its dynamic behavior of this system is currently being investigated in order to improve our understanding of the system operation and potential applications. In parallel with this study we are looking for possible application of such learning systems in synthetic aperture radars (SAR) and data exploitation. Several potential applications have already been suggested. These suggestions will be further explored and the most promising will be proposed for full investigation and possible implementation in FY84.

This project was motivated by A. H. Klopf's insightful observation and proposition on the functioning of the neuron cell and the nervous system in general, and the work done by Professor A. Barto and his associates at the University of Massachusetts in an effort to design and computer simulate networks, and systems of networks, operating on the principles proposed by Klopf. We believe, and hope to show eventually that physical systems can be built, and applications in physical systems can be found for such systems that will yield superior performance.

Task 1 of the project required that first we study carefully Klopf's work clearly presented in Ref [1] in order to fully understand and appreciate its implications and then do the same with Barto's work

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFSC)
NOTICE OF TRANSMITTAL TO DTIC
This technical report has been reviewed and is
approved for public release IAW AFR 190-12.
Distribution is unlimited.
MATTHEW J. KERPER
Chief, Technical Information Division

[2]. The purpose there is to understand the various implementation models developed and select the most promising one for application to synthetic aperture radars.

We believe that Klopf's fascinating work described in Ref. 1 opens up new ways of thinking for designing physical systems which challenge our imagination, but may take a little time until we learn how and where to best implement them.

Barto's work [2] is an excellent study on adaptation and learning problems and learning rules, with special emphasis given to Klopf's heterostat. In a system operating in accordance with this reinforcement learning rule, the weighting function at the i-th input, $W_i(t)$, is enhanced if excitation of the i-th input at t leads to excitation at the i-th input τ seconds later, the enhancing function $e(\tau)$ decaying exponentially with τ. Thus τ is a cause-effect measure, a small τ indicating a strong "link" between the i-th input and the output it produces.

Several goal-seeking systems of goal-seeking components were developed and studied by Barto. Of these systems, those described as "learning with a critic" are judged to be potentially more applicable to our engineering world.

Systems described as "learning with a teacher" require that the controller "knows the answers to a set of questions", i.e., knows what the response to a set of inputs should be and provides the system with appropriate corrective signals. In most engineering systems, this operation requires more information than is usually available. Learning with a critic, on the other hand, requires only that an observation be made as to whether the output is changing in the right direction. One could reasonably expect that such information should be available in many engineering applications.

It seems to us that learning with a critic encompasses the class of problems where the desired goal is to reduce a measured error signal without identifying contributing factors and system dynamics. This covers indeed a large class of problems.

Investigation of Dynamics of Adaptive Nets

The most promising system for engineering applications developed by Barto was judged to be the one containing an adaptive critic in the feedback path and reported in Ref. [3].

The controlled dynamic system, again, is the cart-pole system, except that the controller action is adaptive with its weighting function adjusted by the Adaptive Critic Element and system output, plus an eligibility function mechanism resident in the controller. Because this system has shown a much improved learning capability, we chose it as the model to investigate its dynamic behavior. Later the system may be modified to bring it into closer agreement with engineering applications in general and synthetic aperture radar system requirements in particular.

It was decided to carry out the analysis of the above system in the following sequence of steps:

a) First analyze the system with the Adaptive Search Element only,i.e., without the Adaptive Critic Element in the loop. Develop a block diagram which shows the feedback structure of the ASE and any nonlinearity, nonstationarity and sampling;

b) study the control nature of the ASE and alternate forms of the ASE feedback;

c) define what is meant by stability for this type of system;

d) reduce the ASE to a linear stationary control problem and analyze stability;

e) add sampling to the system discussed previously and investigate the inpact on stability;

f) add nonlinearities to the system and investigate the impact on stability; draw conclusions;

g) verify conclusions by using a computer simulation of ASE, and

h) add the ACE and investigate its effect on stability.

The above work is proceeding and we hope it will be concluded by the end of the first year effort.

Task 3 calls for identifying potential SAR applications of adaptive goal-seeking systems.

In order to generate as many ideas as possible, a presentation of the Adaptive System was made to a select group of the Radar Division technical staff. As a result of this meeting, several ideas were proposed for possible application. These ideas will be further explored and the most promising will be proposed for investigation and implementation in the next year.

References

1. A. H. Klopf, The Hedonistic Neuron, Hemisphere Publishing Corp., Washington, 1982.

2. Andrew Barto, "Goal Seeking Components for Adaptive Intelligence: An Initial Assessment", Technical Report AFWAL-TR-81-1070, CIS Dept., University of Massachusetts, April 1981.

3. A. Barto, R. Sutton, C. Anderson, "Neuron-Like Adaptive Elements that Can Solve Difficult Learning Control Problems", CIS Dept., University of Massachusetts, Report No. 82-20.

END

FILMED

11-83

DTIC