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Preview of Award 2152454 - Annual Project Report

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Cover

Federal Agency and Organization Element to Which Report is Submitted:	4900
Federal Award or Other Identifying Number Assigned by Agency:	2152454
Project Title:	EAGER: Robust Reasoning using a Geometric Approach to SAT and PSAT
PD/PI Name:	Thomas C Henderson, Principal Investigator
Recipient Organization:	University of Utah
Project/Grant Period:	04/01/2022 - 09/30/2023
Reporting Period:	04/01/2022 - 03/31/2023
Submitting Official (if other than PD\PI):	N/A
Submission Date:	N/A
Signature of Submitting Official (signature shall be submitted in accordance with agency specific instructions)	N/A

Accomplishments

* What are the major goals of the project?

To evaluate the geometric approach to SAT and PSAT in terms of:

- 1. Solving PSAT inference problems,
- 2. Policy Optimization as part of reinforcement learning, and
- 3. LTL probability assignment in complex stochastic environments.

* What was accomplished under these goals and objectives (you must provide information for at least one of the 4 categories below)?

Major Activities:	Chop-SAT was demonstrated effective in probabilistic agent decision making based on inferences produced from a priori knowledge combined with information obtained from perception of the specific environment. Linear programming methods have been studied in terms of the usefulness of solution finding using projections, as well as feasible region reduction using zero-measure subspace analysis.
Specific Objectives:	Determine (1) whether Chop-SAT allows effective PSAT inference for agent decision making; (2) whether geometric methods can be used to expose SAT solutions in an efficient manner.
Significant Results:	(1) Chop-SAT has been shown to be effective in probabilistic inference for agents; (2) the efficient discovery of SAT solutions is achieved in lower dimensional spaces, but less successful above 10-D.
Key outcomes or Other achievements:	(1) Chop-SAT provides an effective method to determine the atom probabilities in a probabilistic knowledge base; (2) theoretical results have been developed concerning the geometric properties of feasible regions arising from unsatisfiable CNF sentences.

* What opportunities for training and professional development has the project provided?

A number of students have worked as Research Assistants on the project and learned a great deal about performing research. In addition, aspects of the research have been incorporated into classroom materials and assignments (e.g., in CS3100 – Models of Computation). Two students are doing their undergraduate thesis on this topic.

* Have the results been disseminated to communities of interest? If so, please provide details.

Publications in an appropriate conference (International Conference on Agents and Artificial Intelligence; Lisbon, Portugal; Feb 2023)

* What do you plan to do during the next reporting period to accomplish the goals?

Continue work on policy optimization and probabilistic LTL.

Products

Books

Book Chapters

Inventions

Journals or Juried Conference Papers View all journal publications currently available in the <u>NSF Public Access Repository</u> for this award.

The results in the NSF Public Access Repository will include a comprehensive listing of all journal publications recorded to date that are associated with this award.

"A New Approach to Probabilistic Knowledge-Based Decision Making," T. Henderson, T. Nishida, A. Lessen, N. Wernecke, K. Eken and D. Sacharny, International Conference on Agents and Artificial Intelligence, Lisbon, Portugal, Feb. 2023.. Status = ACCEPTED.

"Chop-SAT: A New Approach to Solving SAT and Probabilistic SAT for Agent Knowledge Bases," T. Henderson, D. Sacharny, A. Mitiche, X. Fan, A. Lessen, I. Rajan and T. Nishida, International Conference on Agents and Artificial Intelligence, Lisbon, Portugal, Feb. 2023.. Status = ACCEPTED.

Licenses

Other Conference Presentations / Papers

Other Products

Other Publications

Patent Applications

Technologies or Techniques

Thesis/Dissertations

Websites or Other Internet Sites Supporting Files

Filename	Description	Uploaded By	Uploaded On
ICAART_2023_6_CR.pdf	âA New Approach to Probabilistic Knowledge-Based Decision Making,â T. Henderson, T. Nishida, A. Lessen, N. Wernecke, K. Eken and D. Sacharny, International Conference on Agents and Artificial Intelligence, Lisbon, Portugal, Feb. 2023.	Thomas Henderson	12/31/2022
ICAART_2023_15_CR.pdf	âChop-SAT: A New Approach to Solving SAT and Probabilistic SAT for Agent Knowledge Bases,â T. Henderson, D. Sacharny, A. Mitiche, X. Fan, A. Lessen, I. Rajan and T. Nishida, International Conference on Agents and Artificial Intelligence, Lisbon, Portugal, Feb. 2023.	Thomas Henderson	12/31/2022

Participants/Organizations

What individuals have worked on the project?

Name	Most Senior Project Role	Nearest Person Month Worked
Henderson, Thomas	PD/PI	1
Wernecke, Nicola	Graduate Student (research assistant)	3
Lessen, Amelia	Undergraduate Student	5
Nishida, Tessa	Undergraduate Student	5

Full details of individuals who have worked on the project:

Thomas C Henderson Email: tch@cs.utah.edu Most Senior Project Role: PD/PI Nearest Person Month Worked: 1

Contribution to the Project: responsible for the scientific or technical direction of the project

Funding Support: N/A

Change in active other support: No

International Collaboration: No International Travel: No

Nicola Wernecke Email: u1369785@utah.edu Most Senior Project Role: Graduate Student (research assistant) Nearest Person Month Worked: 3

Contribution to the Project: research assistant; probabilistic inference for agent decision making

Funding Support: N/A

International Collaboration: No International Travel: No

Amelia Lessen Email: u1149219@utah.edu Most Senior Project Role: Undergraduate Student Nearest Person Month Worked: 5

Contribution to the Project: research assistant; linear programming projections of feasible region; PSAT inference

Funding Support: University of Utah UROP program

International Collaboration: No International Travel: No

Tessa Nishida Email: tessa.nishida@utah.edu Most Senior Project Role: Undergraduate Student Nearest Person Month Worked: 5

Contribution to the Project: research assistant; probabilistic inference; maximal inscribed ellipsoid studies

Funding Support: N/A

International Collaboration: No International Travel: No

What other organizations have been involved as partners? Nothing to report.

Were other collaborators or contacts involved? If so, please provide details.

Prof. Amar Mitiche; INRS; Montreal, Canada

Prof. Xiuyi Fan; Nanyang Technological University, Singapore

Impacts

What is the impact on the development of the principal discipline(s) of the project?

The PSAT method provides an efficient method to approximate atom probabilities in probabilistic knowledge bases, and where the logical variables are independent provides a way to approximate a PSAT solution.

What is the impact on other disciplines?

Wherever a knowledge base exists for a large number of logical variables, a probabilistic analysis can be provided in order to facilitate the decision-making process.

What is the impact on the development of human resources?

A number of students have developed the skills necessary to conduct research in this area.

What was the impact on teaching and educational experiences?

Aspects of this work have been incorporated into the teaching materials and problem assignments for the undergraduate CS class Models of Computation.

What is the impact on physical resources that form infrastructure?

Nothing to report.

What is the impact on institutional resources that form infrastructure? Nothing to report.

What is the impact on information resources that form infrastructure?

Nothing to report.

What is the impact on technology transfer?

Nothing to report.

What is the impact on society beyond science and technology?

The method has application to any domain with a large number of logical variables whose probabilities must be determined (e.g., medical diagnosis, economics, military, etc.).

What percentage of the award's budget was spent in a foreign country?

Nothing to report.

Changes/Problems

Changes in approach and reason for change Nothing to report.

Actual or Anticipated problems or delays and actions or plans to resolve them Nothing to report.

Changes that have a significant impact on expenditures

Nothing to report.

Significant changes in use or care of human subjects Nothing to report.

Significant changes in use or care of vertebrate animals Nothing to report.

Significant changes in use or care of biohazards Nothing to report.

Change in primary performance site location Nothing to report.