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14. ABSTRACT

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Plans Next Period:

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I certify that the information in the report is complete and accurate:

Signature:

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ICREA/Universitat Pompeu Fabra & Imperial College

Project Title

Network Science and Intelligent Systems - Wireless
Communications and Information Networks: Security
Policy Migrants in Dynamic Collaborative IT Environments

Proposal 75529-NS

Contract #W911NF1910432

Objective

- To find general-purpose principles and methods to address a problem that so far has only been informally identified and only a patchwork of ad-hoc solutions exists:

The Reuse and Migration of Security Policies

- The ARL is particularly interested in this area of research to ensure the confidentiality, integrity and availability needed for next-generations of distributed dynamic coalition operations

Approach

- The use of the well-understood observation that many security and privacy policies can be enforced by Mealy automata to develop approaches to migration and reuse of policies under a unique computational framework
- To frame the solutions in terms of a Machine Learning (ML) problem: to learn automata

Accomplishments

- A formal framework to characterize migrations
- Two extensions to our earlier work on learning automata: (1) integration of task-specific semantics during learning through scoring functions (e.g., too much generalization is detrimental for security policies); (2) learned automata may have tens of thousands rules - unprecedented in the field of symbolic learning
- A hybrid symbolic/statical ML system to learn Access Control Policies that outperforms direct applications of standard ML

Conclusions

- It became clear to us that combinations of symbolic and statistical ML will support very general methods for migration
- Integration of Symbolic and Statistical learning is an open issue that goes beyond migrations. We're directing our efforts toward this goal

Scientific Barriers

- The scientific challenge arises from the fact that migrations may only be able to provide policy approximations because
 1. Computational resources can be different in the systems hosting the migrated policies
 2. Conditions at the hosting sites might be very different and unknown or partially known at migration time

Significance

- Stateless policy enforcement can be interpreted as a classifier to be learned. The project will show how off-the-shelf ML techniques can be used in migration (technology driven result)
- Reinforcement Learning algorithms output probabilistic automata that can be used for migration of stateful policies (technology driven result)
- We are close to having practical symbolic learners able to learn very expressive automata, hence, they can be adapted to learn interpretable stateful policies (scientific advance)

Collaborations, Partnerships, and Leveraged Funding

- The work has been done with support and direct collaboration with members of the International Technology Alliance in Distributed Analytics and Information Sciences, funded by the ARL and the UK Defence Science & Technology Laboratory
- Prof. Lobo was partially supported by grants from the Spanish Ministry of Economy and Competitiveness.

Future Plans

To address the integration of neuro symbolic computation with:

- Integration of semantic information in the form of logic constrains during the learning stages of neural networks
- End-to-end neuro-symbolic systems to integrate continuous spaces of differential learning and Inductive logic programming
- Solidifying early collaboration with neuroscientist to work with more plausible biological neural models of computation

Final year of funding, informal discussion of follow-on award, but interest in writing full proposal for foundational work.

Technology transfer

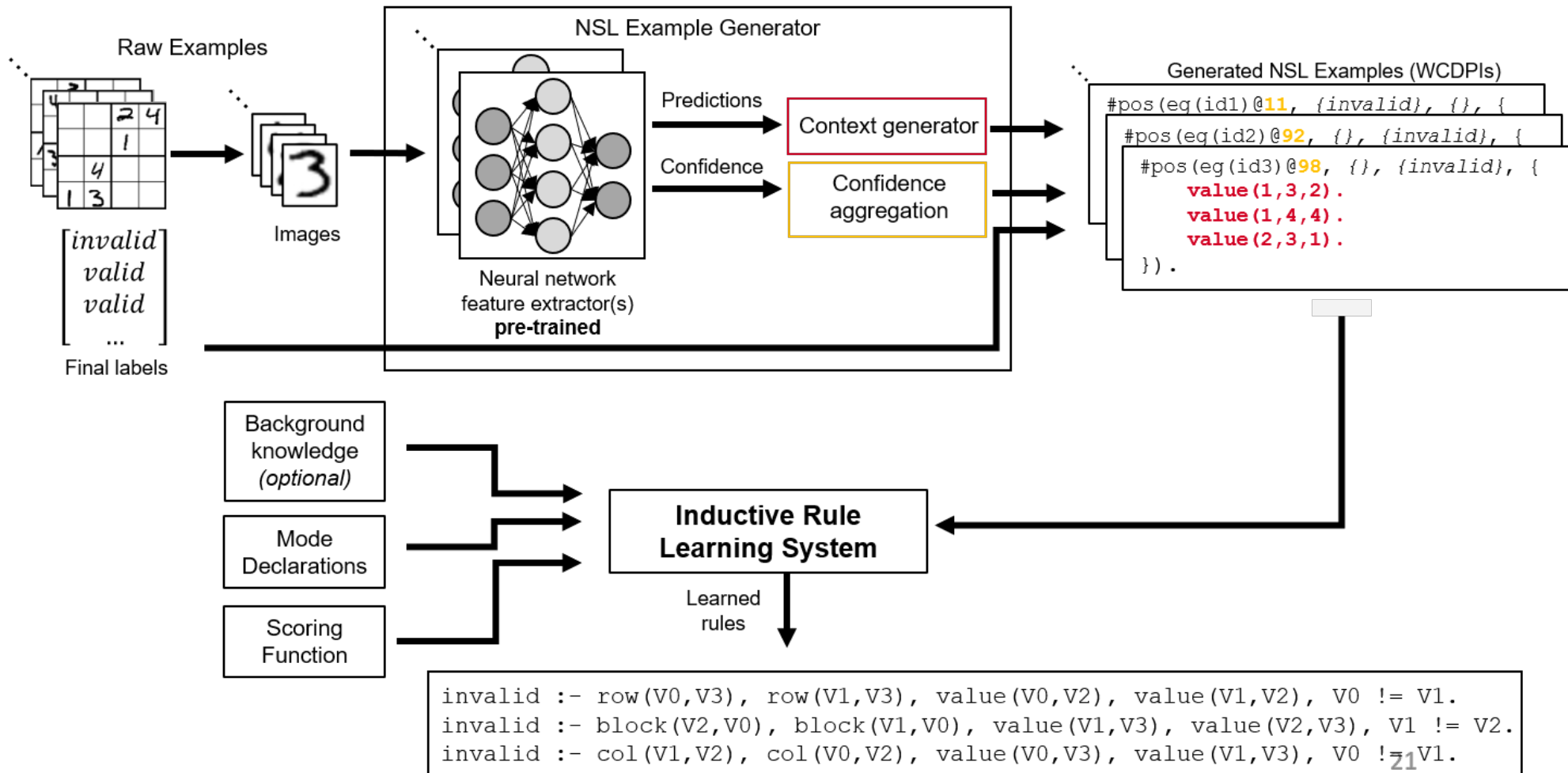
- Both PIs attended in February the DAIS-ITA Winter Bootcamp meeting in New York – these meetings consist of research discussion sessions where ARL researchers participate
- Five papers related to the work were presented in the DAIS-ITA Virtual Fall meeting – This year's meeting was also the peer annual review of the program. ARL researchers participate and other Army personnel attended this meeting

Publications

- Lobo J, Bertino E, Russos A. On Security Policy Migrations. In Proc. of the 25th ACM Symposium on Access Control Models and Technologies, SACMAT2020 (pp. 179-188).
- Law M, Russo A, Bertino E, Broda K, Lobo J. FastLAS: Scalable Inductive Logic Programming Incorporating Domain-Specific Optimisation Criteria. In Proc. of the 34th AAI Conference on Artificial Intelligence, AAI2020 (pp. 2877-2885).
- Jabal AA, Bertino E, Lobo J, Law M, Russo A, Calo S, Verma D. Polisma-A Framework for Learning Attribute-based Access Control Policies. In Proc. of the 25th European Symposium on Research in Computer Security, ESORICS2020 (Vol. 2020).
- Aspis Y, Broda K, Russo A, Lobo J. Stable and Supported Semantics in Continuous Vector Spaces. In Proc. of the 17th International Conference on Principles of Knowledge Representation and Reasoning, KR2020 (pp 59-68)
- Invited speaker (Jorge Lobo): AI for Privacy (AI4P) Workshop@ECAI 2020

Full-time equivalents

- The award partially supported a 11 months visit of Jorge Lobo to Imperial College (52%)



Nuero-Symbolic Learning (NSL) of a classifier for correct hand-written Sudoku boards: Forward Propagation Architecture

Learning Events from Video Streams



From annotated frames of video streams a system can learn to recognize conditions that determine the beginning and the end of an event – **Left panel:** a meeting occurs when 2 people get closer to each other, stay close and don't move for an amount of time. It ends when they move away. **Right panel:** people walk together, when they get close, and keep moving in the same direction.