Politecnico di Torino
Dipartimento di Automatica e Informatica

PhD in Computer and Control Engineering
XXXVI cycle

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Robust Machine learning models for high dimensional data interpretation

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1. Introduction

Deep neural networks (DNNs) have reached important milestones in the computer vision field. However, these models lack transparency and interpretability, and inability to estimate the uncertainty associated to their predictions.

My research involves the development of combined architectures composed of a convolutional model and a **neuro-symbolic component**.

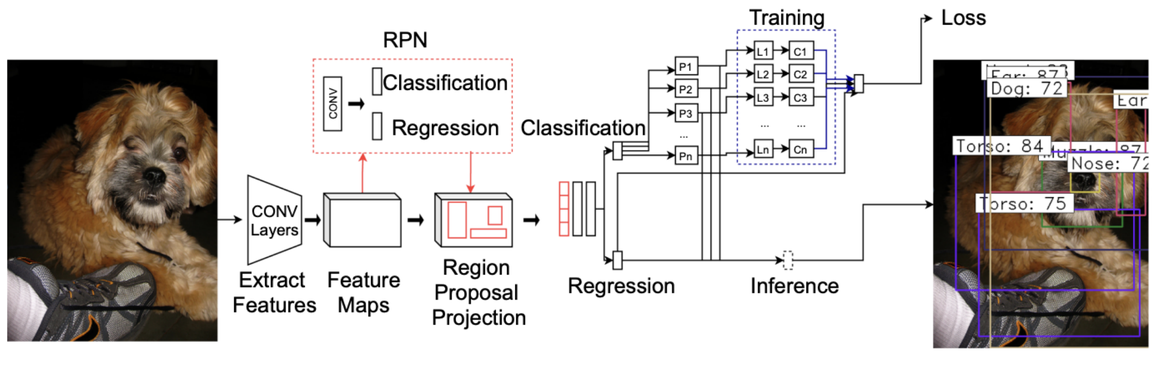
This approach allows to encode a prior information as a set of logical constraints to compensate for the lack of data in the training set through knowledge sharing between the two components.

2. Faster-LTN[1]

Faster – Logic Tensor Network (FasterLTN) is an object detector composed of a convolutional backbone and an LTN.

We propose a novel approach consisting of the following steps:

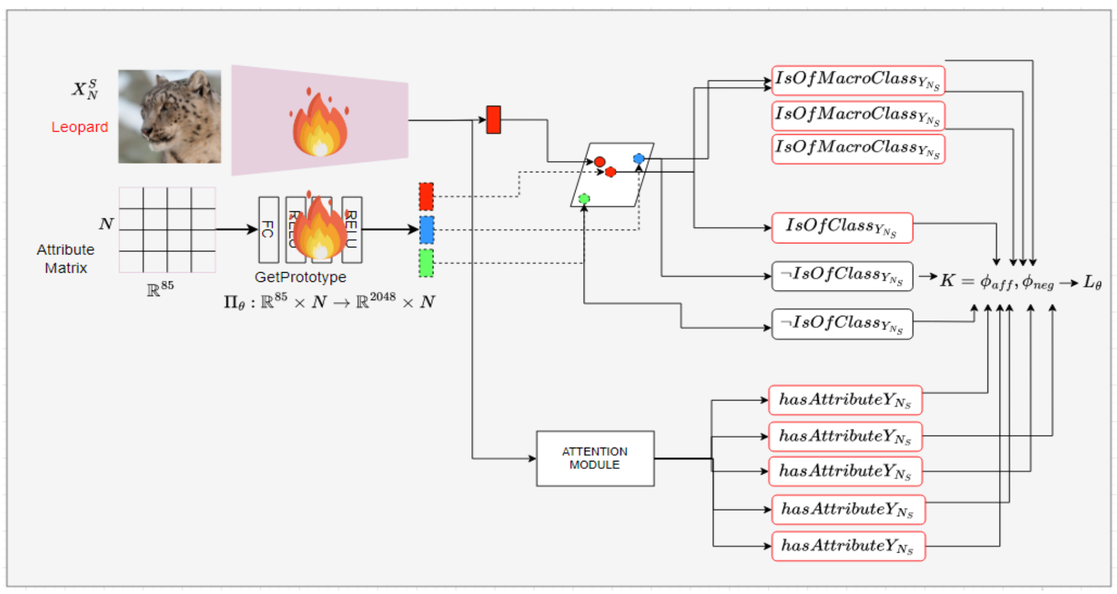
- **Faster R-CNN**: two-stage object detector
- **LTN** - head: The logical constraints imposed by the LTN can thus shape the training of the convolutional layers, that are no longer purely data-driven.



3. Proto-LTN[2]

Starting from our previous work [2], we proposed a new methodology aimed ad adapting a Logic Tensor Network to a zero-shot learning task .

Using a set of prototypes, it was possible to formulate "**isofclass**" predicates based on a measure of distance between images and prototype classes.



4. Robust Machine Learning Model

Applications such as medical image analysis would benefit greatly from greater transparency and uncertainty estimation in neural network inference.

We propose methods for incorporating prediction uncertainty into convolutional models to **reduce uncertain cases** and improve model performance.

5. References

1. Faster-LTN: a neuro-symbolic, end-to-end object detection architecture / Manigrasso, Francesco; Davide Miro, Filomeno; Morra, Lia; Lamberti, Fabrizio. 30th International Conference on Artificial Neural Networks (ICANN 2021).

2. PROTOtypical Logic Tensor Networks (PROTO-LTN) for Zero Shot Learning / Martone, Simone; Manigrasso, Francesco; Lamberti, Fabrizio; Morra, Lia(ICPR 2022) at Montreal nel 21-25 Agosto 2022.