# Neurosymbolic Program Induction

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## Motivation

NeSy combines sub-symbols, symbols and knowledge

- Formal Logic  $\rightarrow$  Human knowledge
- Neural Networks  $\rightarrow$  Powerful feature learner

### In prior works



- Structures derived by formal logic
- Learning NN parameters through structures

### The Question

• Can we learn structure and parameters simultaneously?

Formal Logic is converted into fully-differentiable structures which can be used to train NNs.

# NeSy Program Induction

- Constructs NeSy logic programs given labeled samples consisting of
  - Symbolic input
  - Unlabeled sub-symbolic input (e.g. images, sensory data, ...)
- NN parameters are trained while inducing the program:
  - Trained through distant supervision
- In contrast to related works, we make fewer assumptions:
  - No pre-trained NNs are needed



– No assumptions about features

• Neurosymbolic (NeSy) combines Logic and Deep Learning

# UCI Experiment



#### Data

- 15+ binarized UCI datasets
- 0s and 1s replaced by  $\square$ s and  $\square$ s
- wide variety in number of attributes and samples

#### Task

- Verification
- Learning meaning of  $\square$  and  $\blacksquare$
- Learning how to connect those features

#### **Results: 10-fold Crossvalidation**

# More Experiments in the coming Paper

- We can learn relationships between different sub-symbols
- used to learn new ones!
- knowledge sup-• Background ports NeSy program induction
- Already learned rules can be Paper is being submitted coming weeks





### Future Directives

- Propositional Logic  $\rightarrow$  First- Exploring datasets with sym-Order Logic
- brary
- bolic and sub-symbolic features
- Publication of a Python Li- Scaling up to real-world Problems

