Inductive Logic Programming (ILP) vs Deep Learning DL)

Simon Jacquet

June 23rd 2022

UNIVERSITÉ DE NAMUR

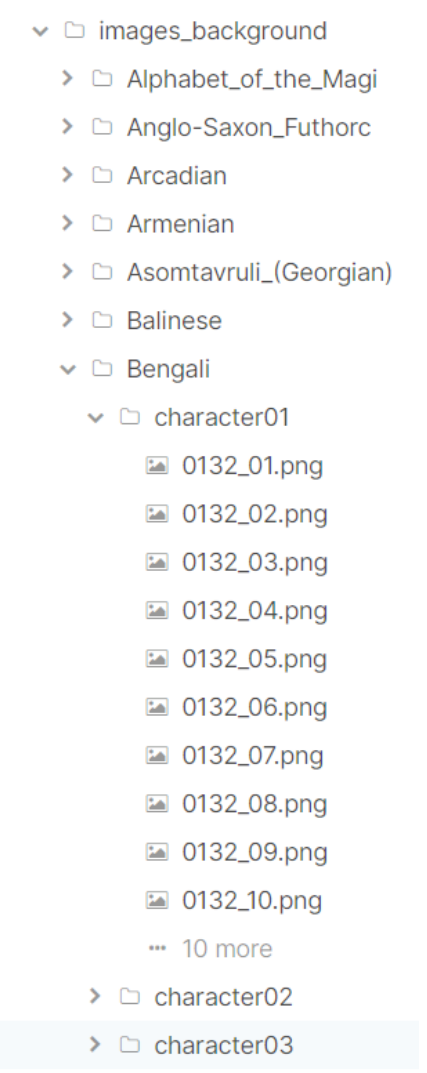
Paper 1: ILP vs DL in One-Shot Learning

- Title: "Human-like rule learning from images using one-shot hypothesis derivation"
- Author: Muggleton
- Content: ILP vs Deep Learning in One Shot Learning
- Databases:
  - Omniglot dataset: character recognition
  - UK Biobank: neurodegenerative disease identification
- Link: `https://www.researchgate.net/publication/355875180_Human-like_rule_learning_from_images_using_one-shot_hypothesis_derivation`

UNIVERSITÉ DE NAMUR

Omniglot Dataset

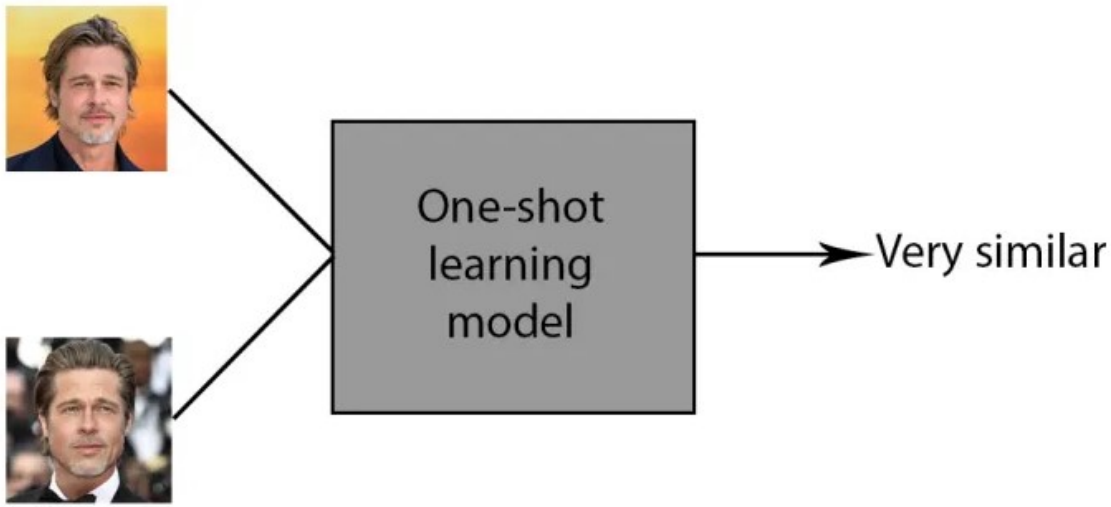
- Character recognition
- 1623 different handwritten characters from 50 different alphabets
- Each character is a different class
- Each character has 20 examples
  - ☞ Written by 20 different people



UNIVERSITÉ DE NAMUR

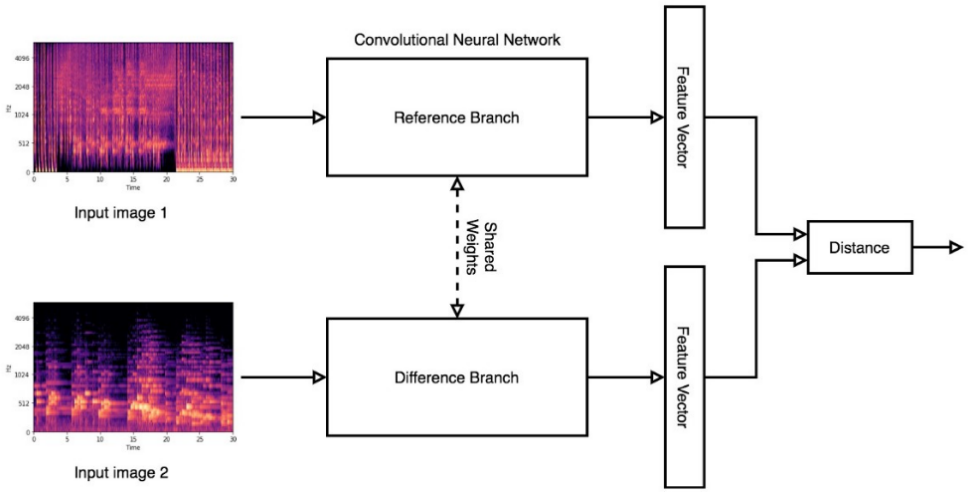
One Shot Learning

- Classification task in which one is provided with 1 (or few) example of each class
- Deep learning usually needs thousands of examples to learn a new class
- Human only need to see a picture of a giraffe once to be able to recognise another one
- Most well known use case: Facial recognition



Siamese Neural Networks

- Model trained to differentiate between images of different classes
- `https://www.cs.cmu.edu/~rsalakhu/papers/oneshot1.pdf`



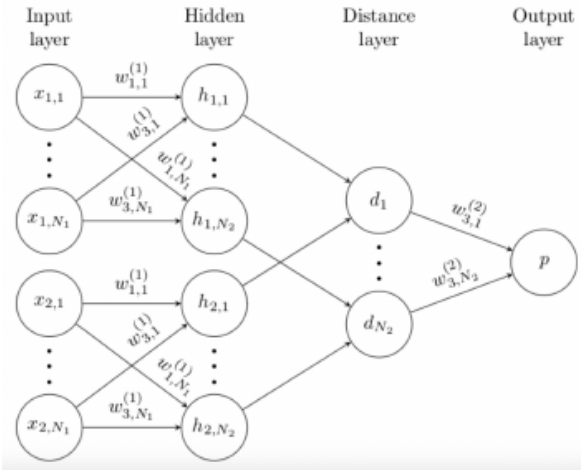
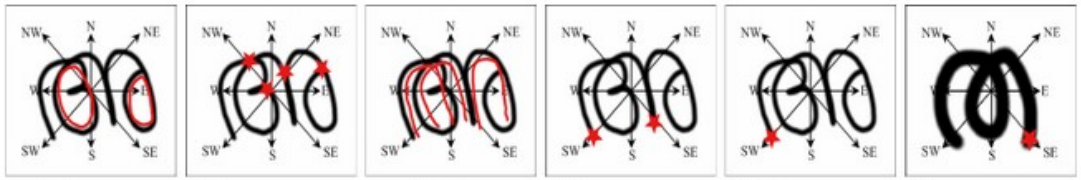


Figure: Architectures of a Siamese NN

ILP approach

- One-Shot Hypothesis Derivation (OSHD) based on
- Implemented in Toplog
- Background knowledge:



(a) Loop (b) Junction (c) Arc (d) Terminals (e) Start Point (f) End Point

Fig. 3: Human-like feature extraction criteria

Table 1: Geometrical and Directional Properties

Character ID	Geometrical Properties				Directional Properties	
	No. Loops	No. Junctions	No. Arcs	No. Terminals	Starting Point	Ending Point
1	2	4	3	2	sw	null
2	3	4	3	2	sw	null
3	3	4	3	2	sw	null
4	1	2	3	2	null	se
5	1	3	3	2	nw	se

- Modes:

```
:- modeh(1,alphabet(+character)).
:- modeb(*,has_gemproperties(+character,-properties)).
:- modeb(*,has_gemproperties_count(+properties,
                                   #geo_feature_name,#int)).
:- modeb(*,has_dirproperties(+character,-properties)).
:- modeb(*,has_dirproperties_feature(+properties,
                                     #dir_feature_name,#featurevalue)).
```

ILP vs DL

Background
- ILP:
  - Modes
  - Table of Geometrical and Directional Properties
- DL:
  - Many examples to train the model
  - 40 (of 50) alphabets used as background

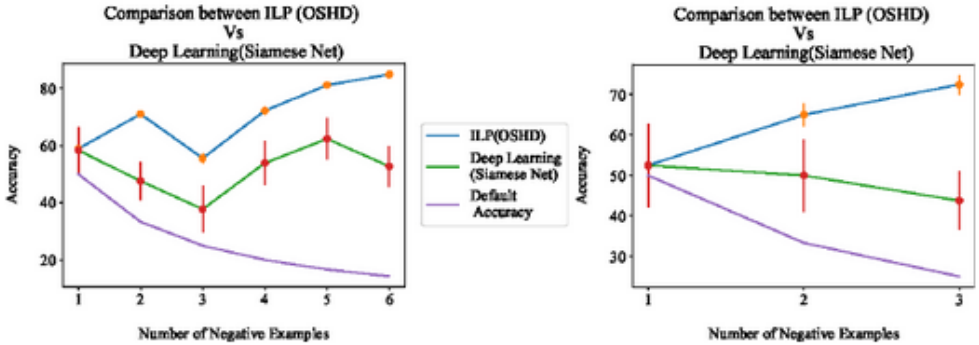
Training
- ILP:
  - The 1 example generates a new rule
- DL:
  - The 1 example is kept in memory

Testing
- ILP:
  - The new example is verified against the new rule
- DL:
  - The new example, with the training example are compared to see whether they belong to the same class

UNIVERSITÉ DE NAMUR

Results

- Results provided by Muggleton are not consistent with those provided by the original Siamese paper



(a) Character Recognition (b) Neurological Diagnosis

Fig. 6: Average Predictive accuracy of ILP (OSHD) vs Deep Learning (Siamese Net)

Table 1. Accuracy on Omniglot verification task (siamese convolutional neural net)

Method	Test
30k training	
no distortions	90.61
affine distortions x8	91.90
90k training	
no distortions	91.54
affine distortions x8	93.15
150k training	
no distortions	91.63
affine distortions x8	**93.42**

Figure: Comparison of the two models by Muggleton (left) and accuracy in the Siamese paper (right)

UNIVERSITÉ DE NAMUR

Approach 2: DeepProbLog

- Title: "From Statistical Relational AI to Neural Symbolic Computation: DeepProbLog"
- Author: Luc De Raedt
- Content: Adding a ProbLog brick at the end of Neural Networks
- Databases:
  - MNIST dataset: digit recognition
- Link: `https://www.i-aida.org/wp-content/uploads/2022/03/Luc-De-Raedt_compressed.pdf`

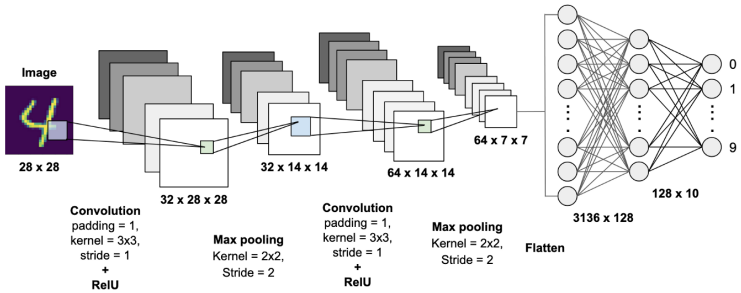
UNIVERSITÉ DE NAMUR

DeepMNIST addition

- Set of examples:

  addition( ,  ,8), addition( ,  ,4), addition( , ,11), …

- Model:
  - Neural network:



  - ProbLog brick:

```
nn(mnist_net, [X], Y, [0 ... 9] ) :: digit(X,Y).

addition(X,Y,Z) :- digit(X,N1), digit(Y,N2), Z is N1+N2.
```

- Execution:

addition(, ,8) :- digit(,N1), digit(,N2), 8 is N1 + N2.

Frame Title

UNIVERSITÉ DE NAMUR