AUTOMATIC LEARNING OF SUM-PRODUCT NETWORKS

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Objective

Sum-product networks (SPNs) are probabilistic graphical models capable of representing probability distributions containing a great number of variables. SPNs have shown impressive results in various domains. Despite that, there are very few SPN inference and learning libraries currently available. Additionaly, there hasn't been a comparative study on different SPN learning methods yet. This project seeks to develop a free, open-source inference and learning SPN library, and to compare three different SPN learning algorithms in the domain of image completion and classification.

Materials and Methods

The algorithms were implemented as part of the GoSPN[1] library, written in the Go programming language. The three learning algorithms implemented were Poon-Domingos [3], Dennis-Ventura [1] and Gens-Domingos [2]. Tests were then applied in order to compare the performances of the three methods on the DigitsX, MNIST, Caltech-101 and Olivetti Faces datasets.

Results

The two methods that achieved the best performances were the Gens-Domingos and Dennis-Ventura algorithms. Poon-Domingos either exceeded the time or memory limit, or had unsatisfactory results. Table 1 shows the accuracy of the two best algorithms. Tests were done by using 50% of the dataset as training set and the rest as test set.

Table 1. Classification accuracy (in %).

	Dennis-Ventura	Gens-Domingos
DigitsX	99.42	97.14
Caltech	81.38	88.66
Olivetti	89.93	95.50
MNIST	77.85	81.55

[1]Available at: `https://github.com/RenatoGeh/gospn`

For the image completion task, half of the image was given as evidence to the model (represented by the grayscale half in Figure 1) and the other half (shown in green in Figure 1) was generated by the SPN by querying for the most probable variable valuations given the evidence. The left-hand image was generated by the Gens-Domingos algorithm, whilst the Dennis-Ventura algorithm generated the image on the right.

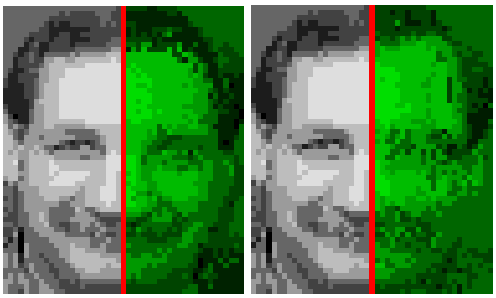

Figure 1. Image completion.

Conclusions

We achieved good classification results in different applications, such as handwritten digit classification, object identification and face recognition. On the completion task, the algorithms were able to identify key features, such as nose, eyes and mouth on the Olivetti dataset. The code was documented and made available as part of the free open-source GoSPN library.

References

[1] A. Dennis and D. Ventura. "Learning the Architecture of Sum-Product Networks Using Clustering on Variables". In: *NIPS* 25 (2012).

[2] R. Gens and P. Domingos. "Learning the Structure of Sum-Product Networks". In: *ICML* 30 (2013).

[3] H. Poon and P. Domingos. "Sum-Product Networks: A New Deep Architecture". In: *UAI* 27 (2011).