Università degli Studi di Bari
Dipartimento di Informatica

LACAM Laboratory
Machine Learning

Towards Representation Learning with Tractable Probabilistic Models

Antonio Vergari, Nicola Di Mauro and Floriana Esposito

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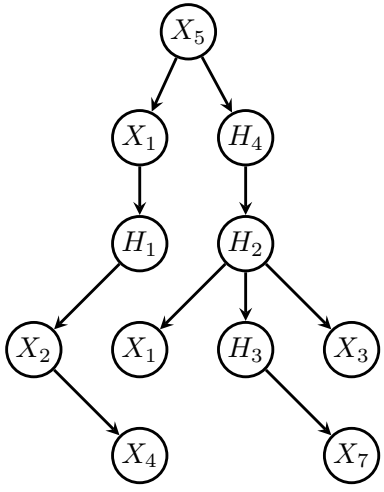
Tractable Probabilistic Models (TPMs)

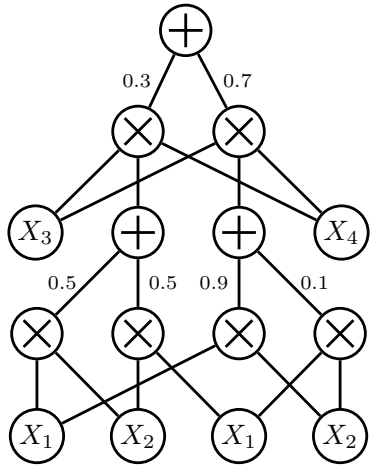
Many Machine Learning problems can be reframed as probabilitic inference

Plenty of Probabilistic Models learned as density estimators

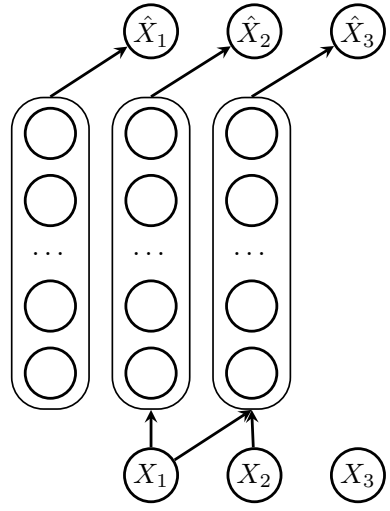
Inference is hard.



Low treewidth PGMs



Computational Graphs



Autoregressive NNs

$\rightarrow$ TPMs allow **exact** inference to be computed in polynomial time!

Representation learning with TPMs

Given a set of i.i.d samples $\{\mathbf{x}^i\}_{i=1}^m \sim \mathbf{X}$, a TPM θ, a dataset $\{\mathbf{x}^i\}_{i=1}^m$, we want to generate an embedding for each sample i such as:

$$\mathbf{e}^i = f_{p,\theta}(\mathbf{x}^i), \quad \mathbf{e}^i \in \mathbb{R}^d$$

with f being the transformation by θ encoding $p(\mathbf{X})$.

Idea: evaluate θ ***several*** times by constructing ***random queries*** (e.g. sample $\mathbf{Q}_j \subseteq \mathbf{X}, j = 1 \ldots, d$), then use the probability value of each query as an embedding component:

$$e^i_j = p_\theta(\mathbf{Q}_j = \mathbf{x}^i_{\mathbf{Q}_j})$$

$\rightarrow$ reuse previously learned models, as *black boxes*
$\rightarrow$ exploit embeddings for clustering, classification,...

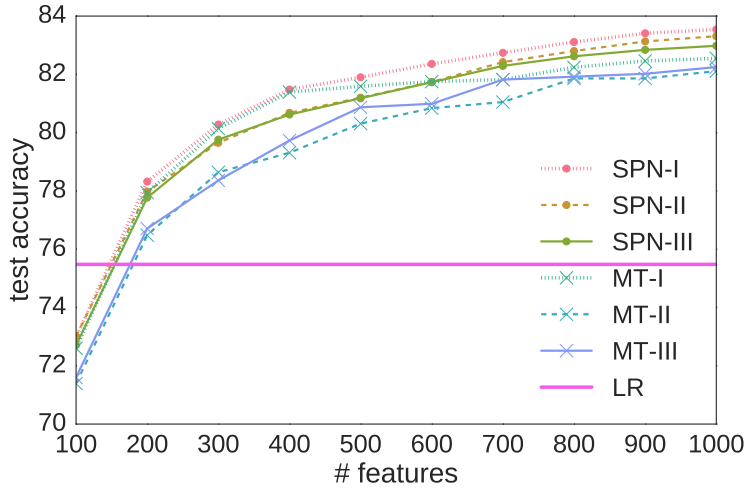
Experimental evaluation

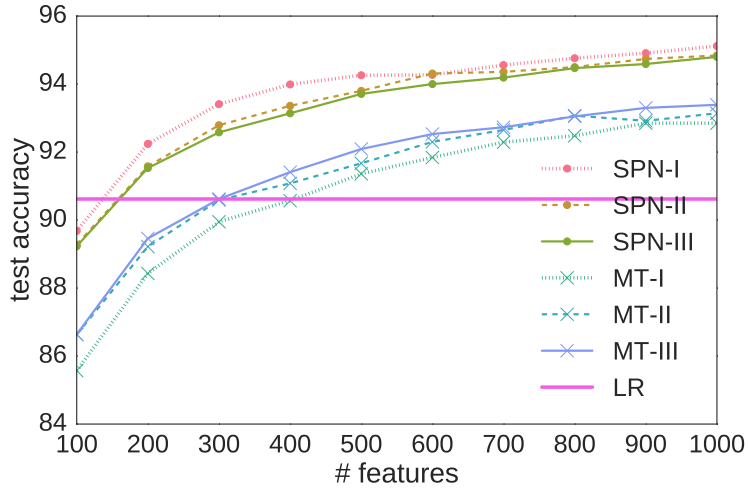
I Learning SPNs and MTs unsupervisedly on five binary image datasets

II extract embeddings from 1000 random marginal queries

III train a supervised linear classifier on them

$\rightarrow$ ***meaningful representations*** *if better accuracy scores*





$\rightarrow$ trade-off between likelihood over $\mathbf{X}$ and accuracy over Y