



**Università degli Studi di Bari**  
Dipartimento di Informatica



**LACAM**  
Machine Learning

# Learning Sum-Product Networks

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*August 2, 2016*

# The need for SPNs

*Why should you work on SPNs?*

- ▶ exact tractable inference
- ▶ NN for which structure learning is easy

# Representation

# Density estimation

## **(Different kinds of) Inference**

# Tractable Probabilistic Models

# Sum-Product Networks

# Scopes

- **Global Scope** (outside of any function or class)
- **Local Scope** (inside a function or class)
- **Module Scope** (inside a module)
- **Class Scope** (inside a class)
- **Function Scope** (inside a function)

- **Global Scope** is the outermost scope and is accessible from anywhere in the program.
- **Local Scope** is the innermost scope and is only accessible within the function or class it is defined in.
- **Module Scope** is the scope of a module and is accessible from anywhere within the module.
- **Class Scope** is the scope of a class and is accessible from anywhere within the class.
- **Function Scope** is the scope of a function and is accessible from anywhere within the function.

- **Global Scope** is the default scope for all variables and functions.
- **Local Scope** is created when a function or class is defined and is destroyed when the function or class is finished executing.
- **Module Scope** is created when a module is imported and is destroyed when the module is unloaded.
- **Class Scope** is created when a class is instantiated and is destroyed when the class is garbage collected.
- **Function Scope** is created when a function is called and is destroyed when the function returns.

- **Global Scope** is the scope of the entire program.
- **Local Scope** is the scope of a single function or class.
- **Module Scope** is the scope of a single module.
- **Class Scope** is the scope of a single class.
- **Function Scope** is the scope of a single function.

- **Global Scope** is the scope of the entire program.
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# Structural Properties

# Inference

# Complete evidence

# Marginal inference

# MPE inference

# Interpretation

# Interpretation

- ▶ probabilistic model
- ▶ deep feedforward neural network

# Network Polynomials



# Arithmetic Circuits

Differences with ACs:

- ▶ probabilistic semantics
  - ▶ learning
  - ▶ sampling
- ▶ no shared weights

# SPNs as BNs I

Zhao

# SPNs as BNs II

Peharz

# Learning

# Structure Learning

# LearnSPN

LearnSPN: A Self-Supervised

Learning Framework for

Learning SPN

Learning SPN

Learning SPN

Learning SPN

Learning SPN

Learning SPN

Learning SPN

Learning SPN

Learning SPN

Learning SPN

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Learning SPN

## LearnSPN-b

# **New Structure Learning Tendencies**



# Parameter Learning

# Hard/Soft Parameter Learning

# Bayesian Parameter Learning

# Parameter Learning VS LearnSPN

Collapsed Variational Inference is useless : D

# Representation Learning

# Extracting Embeddings

# Classification

# Filtering Embeddings



# Random Marginal Queries

# Encoding/Decoding Embeddings

MPN as autoencoders.

## **Applications**

# **Applications I: computer vision**

## **Applications II: language modeling**

## **Applications III: activity recognition**

## **Applications IV: speech**

## **Trends & What to do next**



## References

# awesome-spn

A curated and structured list of resources about SPNs<sup>1</sup>.

<https://github.com/arranger1044/awesome-spn>

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<sup>1</sup> Inspired by the <http://spn.cs.washington.edu/> at the Washington University

