

# Neural Semirings

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**Algebraic Model Counting** [1] formulates AI problems as **semiring computations**, for example: probabilistic inference or neuro-symbolic AI.

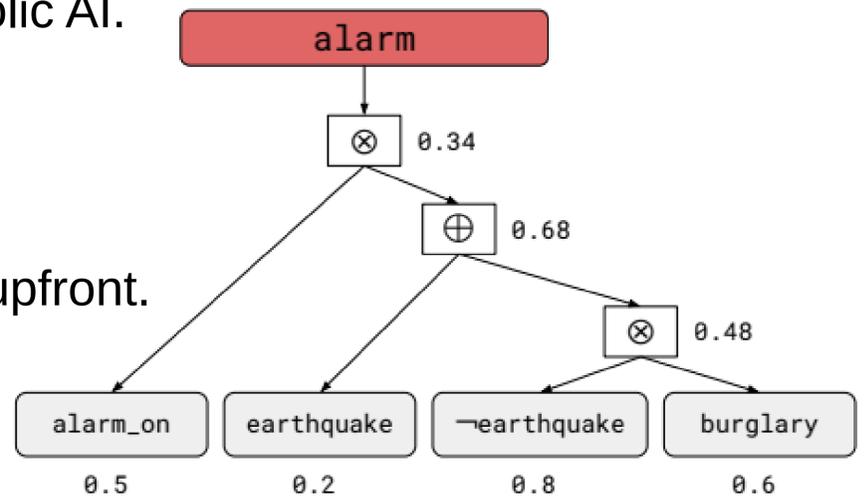
→ **Generalization of sum-product algorithm**

## Current Limitation:

The operators of the semiring algebra are defined upfront.

## Goal:

Make semiring operators subject to learning.



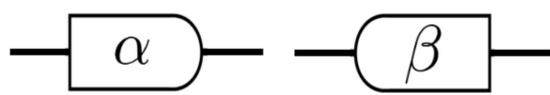
## Build neural **nets that adhere** to semiring **properties**.

→ extend Deep Sets [2] with a second operation (multiplication)

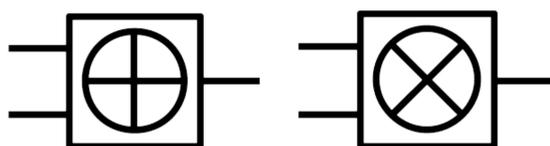
→ extend equivariant neural networks [3] from groups to semirings

→ build algebraic circuits [4] where circuit operators are learnable

## Trainable Circuit Gates:

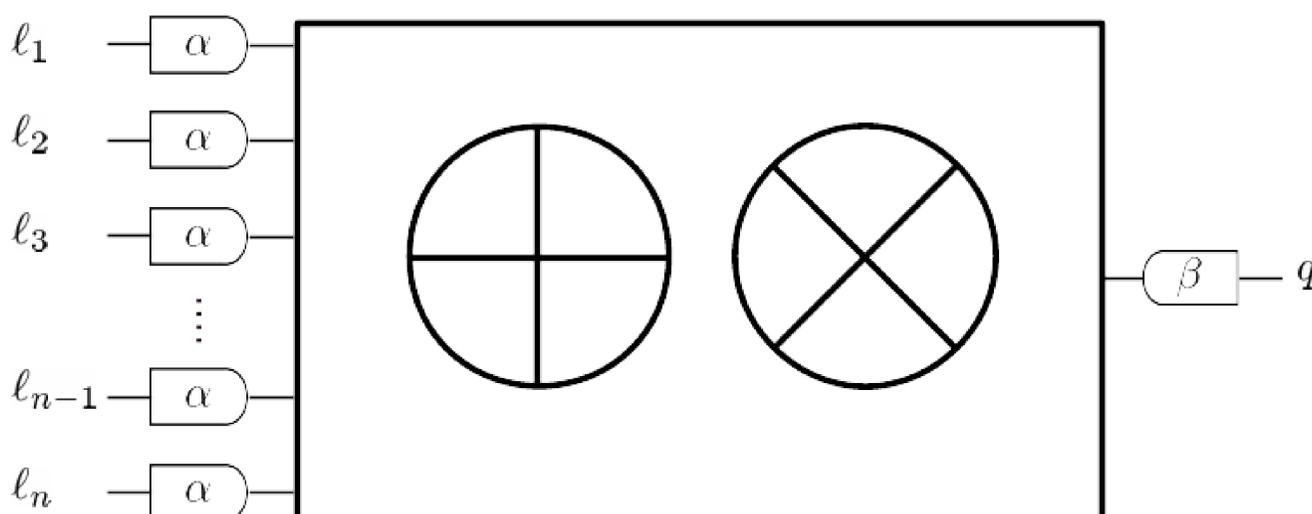


**α**: encodes literal as elements of semiring  
**β**: decodes semiring element into symbol/literal



addition and multiplication gates that adhere to semiring properties

## Schematic Overview Neural Semiring Circuit:



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[1] Kimmig, Angelika, Guy Van den Broeck, and Luc De Raedt. "Algebraic model counting." Journal of Applied Logic 22 (2017): .

[2] Zaheer, Manzil, et al. "Deep Sets." Advances in Neural Information Processing Systems 30 (2017).

[3] Cohen, Taco, and Max Welling. "Group equivariant convolutional networks." ICML, 2016.

[4] Zuidberg Dos Martires, Pedro Miguel, et al. "Transforming Probabilistic Programs into Algebraic Circuits for Inference and Learning." Program Transformations for Machine Learning, NeurIPS 2019, Location: Vancouver. 2019.