THE POON-DOMINGOS PARAMETER LEARNING ALGORITHM FOR IMAGE COMPLETION AND CLASSIFICATION ON SUM-PRODUCT NETWORKS

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Abstract. In this document we describe the Poon-Domingos [PD11] parameter learning algorithm for image classification and completion.

1. Structure

The Poon-Domingos algorithm uses a fixed structure and then learns the weights through generative learning. We first give an overview on how to build the structure given an image and then provide a pseudo-code algorithm for building such structure.

1.1. Overview

As described in [DV12]:

> The Poon architecture is suited for modeling probability distributions over images, or other domains with local dependencies among variables. It is constructed as follows. For every possible axis aligned rectangular region in the image, the Poon architecture includes a set of m sum nodes, all of whose scope is the set of variables associated with the pixels in that region. Each of these (nonsingle-pixel) regions are conceptually split vertically and horizontally in all possible ways to form pairs of rectangular subregions. For each pair of subregions, and for every possible pairing of sum nodes (one taken from each subregion), a product node is introduced and made the parent of the pair of sum nodes. The product node is also added as a child to all of the top region's sum nodes. Figure 3 shows a fragment of a Poon architecture SPN modeling a 2×3 image patch.

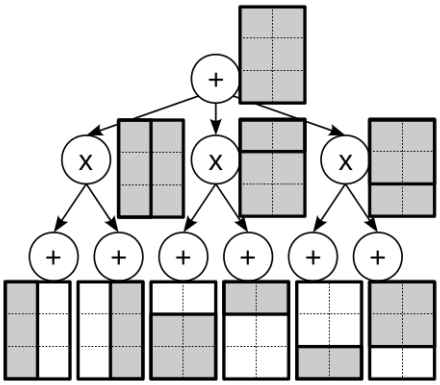

FIGURE 1. "The Poon architecture with $m = 1$ sum nodes per region. Three product nodes are introduced because the 2×3-pixel image patch can be split vertically and horizontally in three different ways. In general the Poon architecture has number-of-splits times m^2 product nodes per region" [DV12].

1.2. Algorithm

Let us organize in a clearer way what we have extracted from [DV12].

Definition 1.1 (Region)**.** *A region is a product node. Graphically, it represents an axis-aligned rectangular region of the image.*

Definition 1.2 (Subregion)**.** *A subregion is a sum node. Given a region R, the children of R are the two possible rectangles that compose R.*

REFERENCES

[DV12] Aaron Dennis and Dan Ventura. "Learning the Architecture of Sum-Product Networks Using Clustering on Variables". In: *Advances in Neural Information Processing Systems* 25 (2012).

[PD11] Hoifung Poon and Pedro Domingos. "Sum-Product Networks: A New Deep Architecture". In: *Uncertainty in Artificial Intelligence* 27 (2011).