



Tree Densities

1 Why

We extend the definition of tree distributions to densities.

2 Definition

2.1 Rooted Definition

Let $f : \mathbf{R}^d \rightarrow \mathbf{R}$ be a density. f *factors according to the rooted tree* on $\{1, \dots, d\}$ rooted at a vertex k if it can be written as a product of f_k and the conditionals of $f_{i|j}$ for $i, j = 1, \dots, d$ and $i \neq j$ and $i \neq k$ where j is the parent of i in the rooted tree.

2.2 Defining Result

Proposition 1. *If a density factors according to a tree rooted at a vertex it factors according to that tree rooted at any vertex.*

2.3 Undirected Definition

A density f *factors according to the tree* T if it factors according to the T rooted at any vertex.

3 Existence and Uniqueness

Trees are not a property of distributions, since there is no one-to-one correspondence, as demonstrated by the following propositions.

3.1 Existence

A distribution f need not factor according to a tree.

3.2 Uniqueness

A distribution f may factor according to multiple trees.