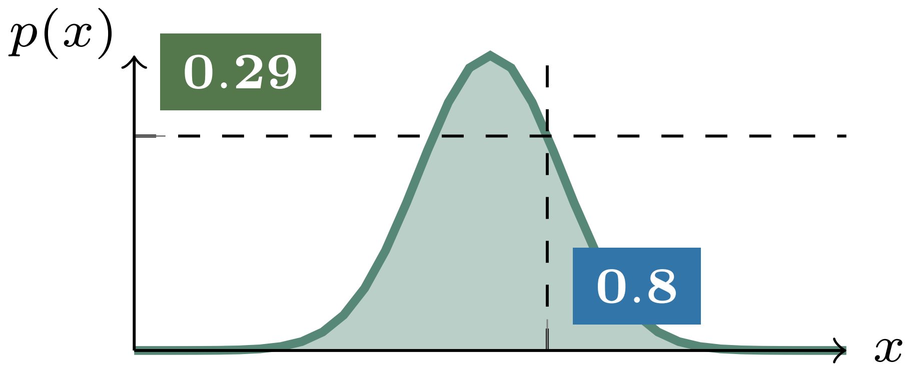
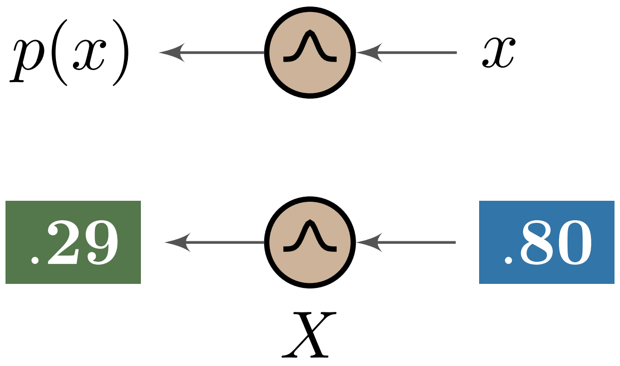
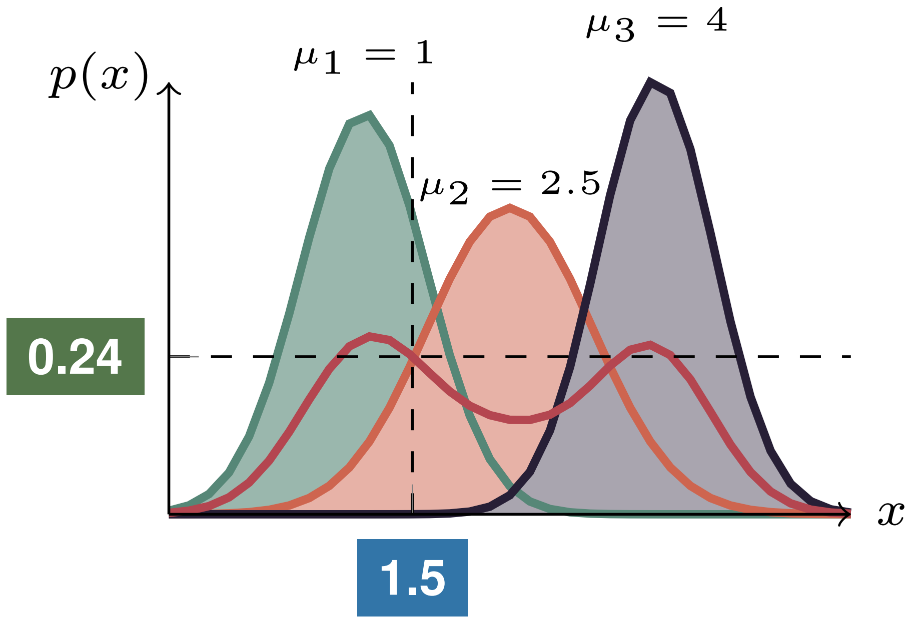
Scalable Learning of Probabilistic Circuits

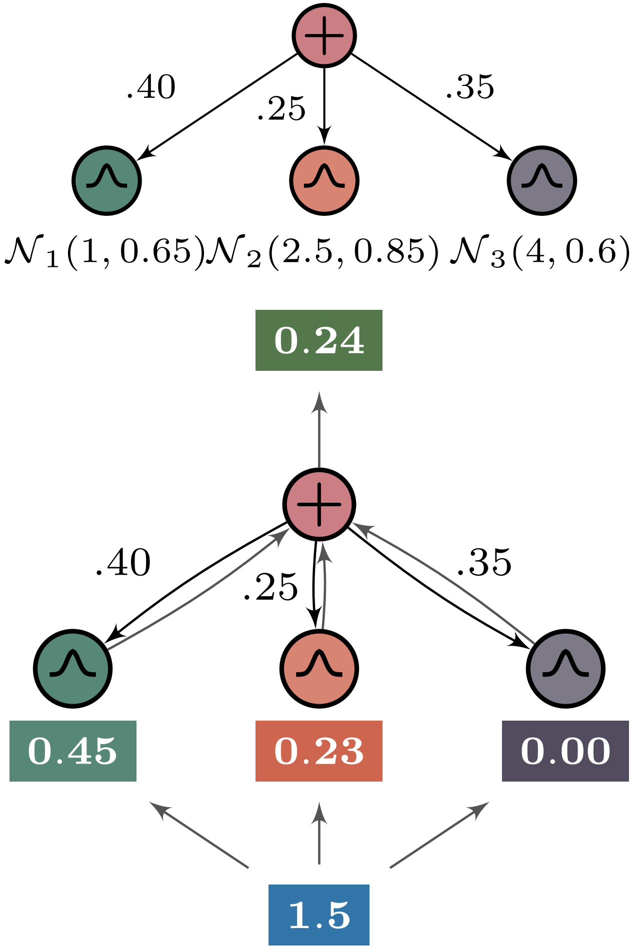
Probabilistic Circuits – Inputs



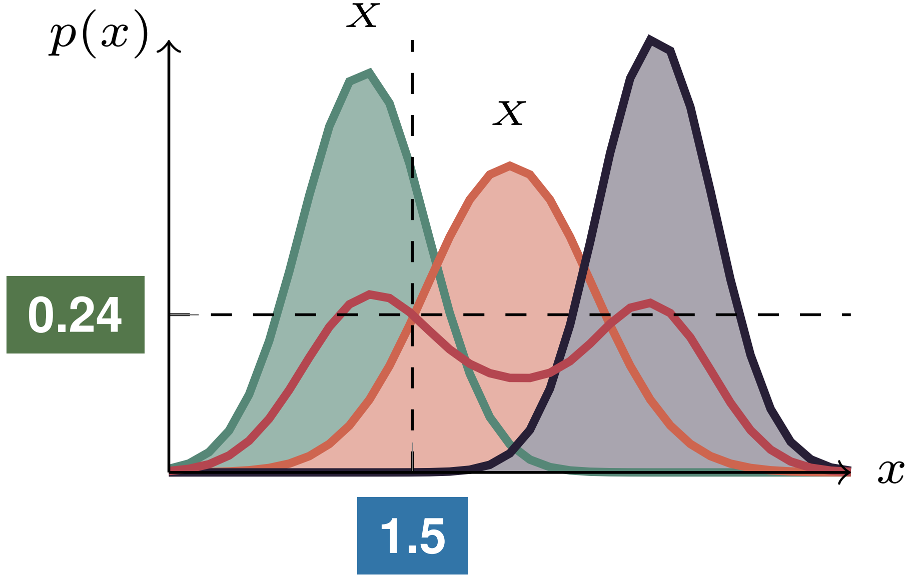


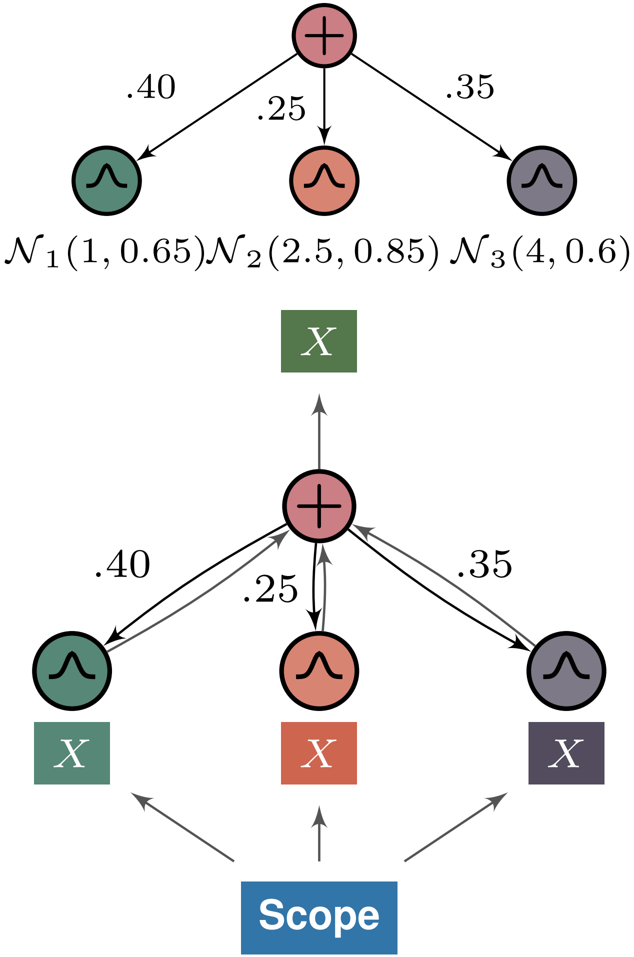
Probabilistic Circuits – Sums





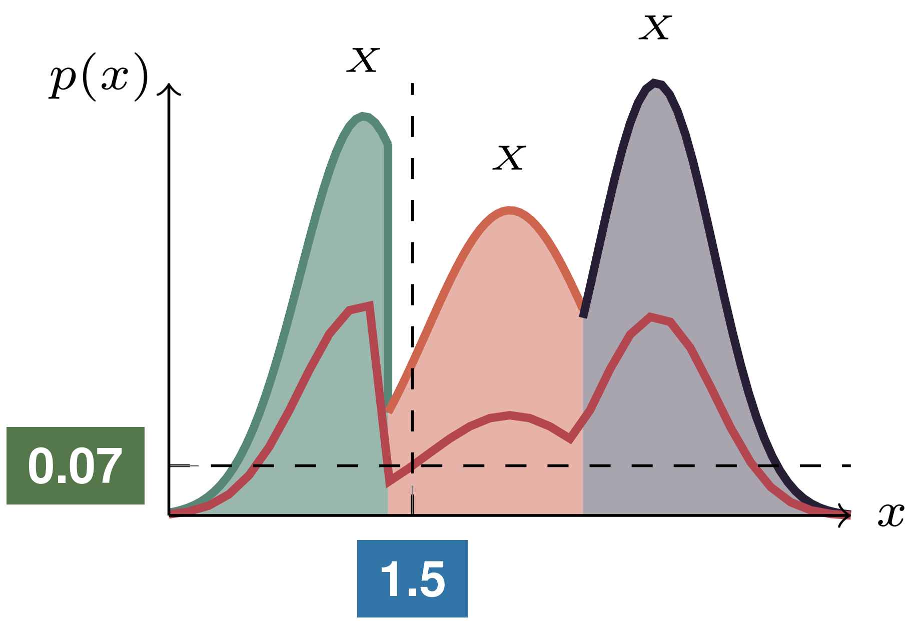
Probabilistic Circuits – Smoothness

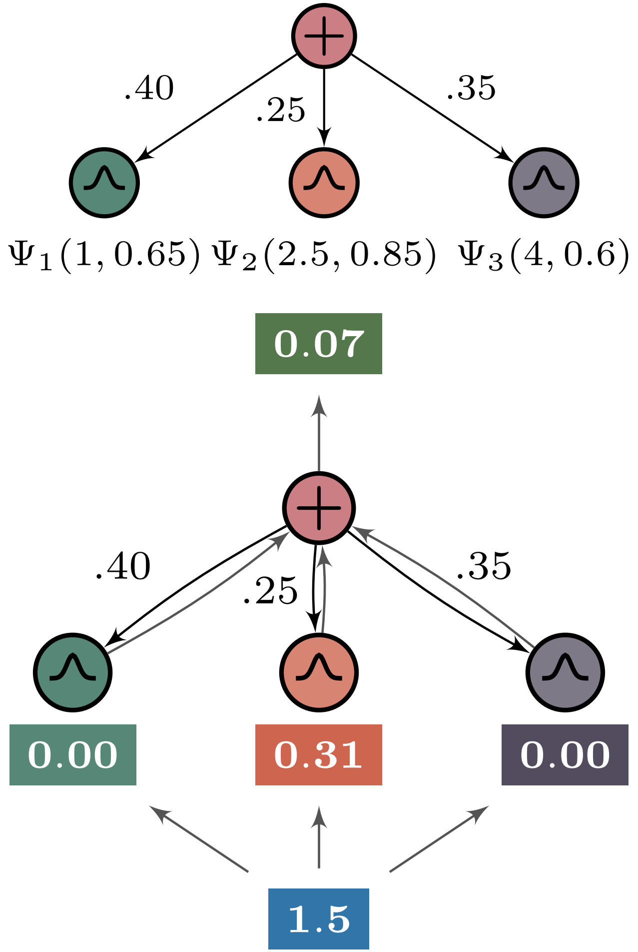




Definition 1 (Smoothness)**.**
Every sum node child mentions the <u>same</u> variables.

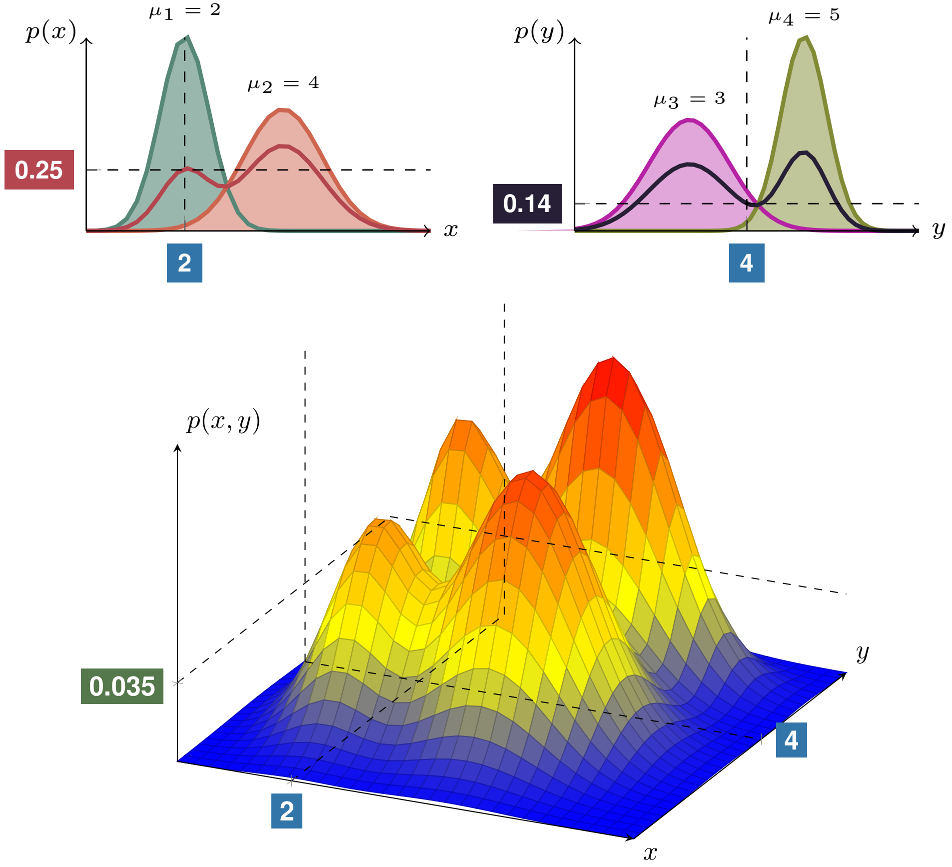
Probabilistic Circuits – Determinism

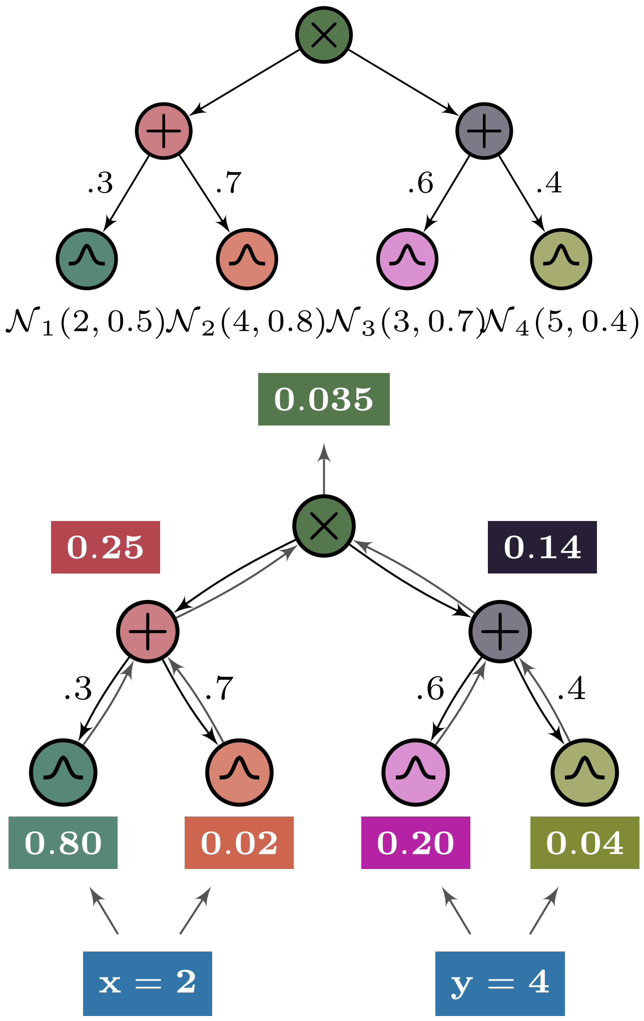




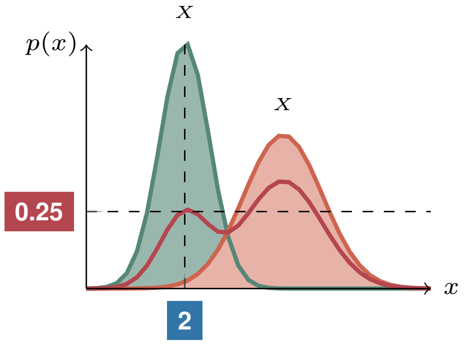
Definition 2 (Determinism)**.**
<u>At most one</u> sum node child has a positive value.

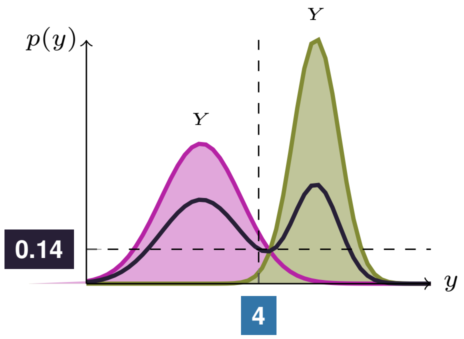
Probabilistic Circuits – Products



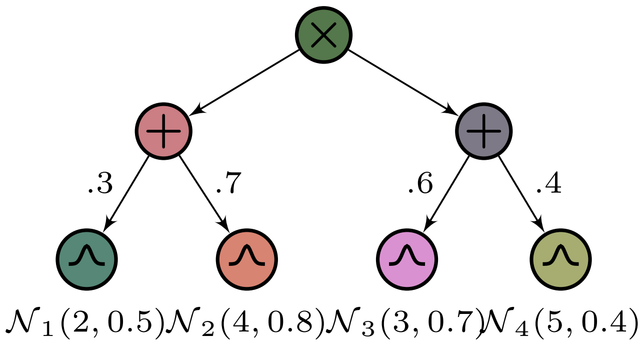


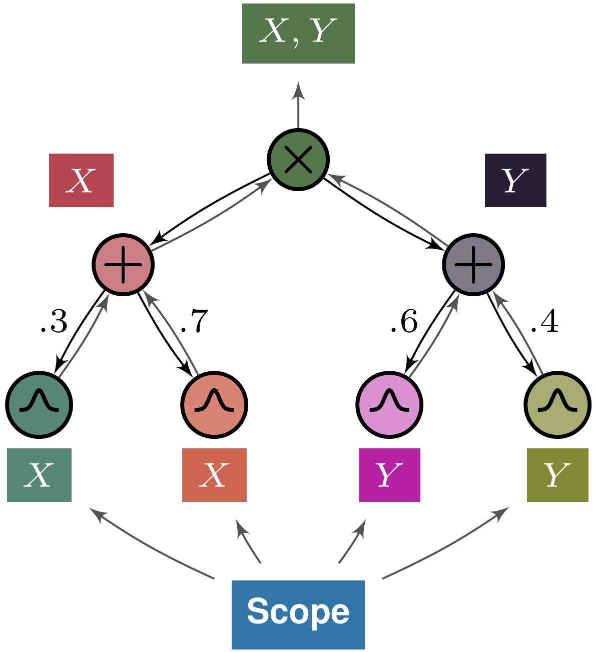
Probabilistic Circuits – Decomposability



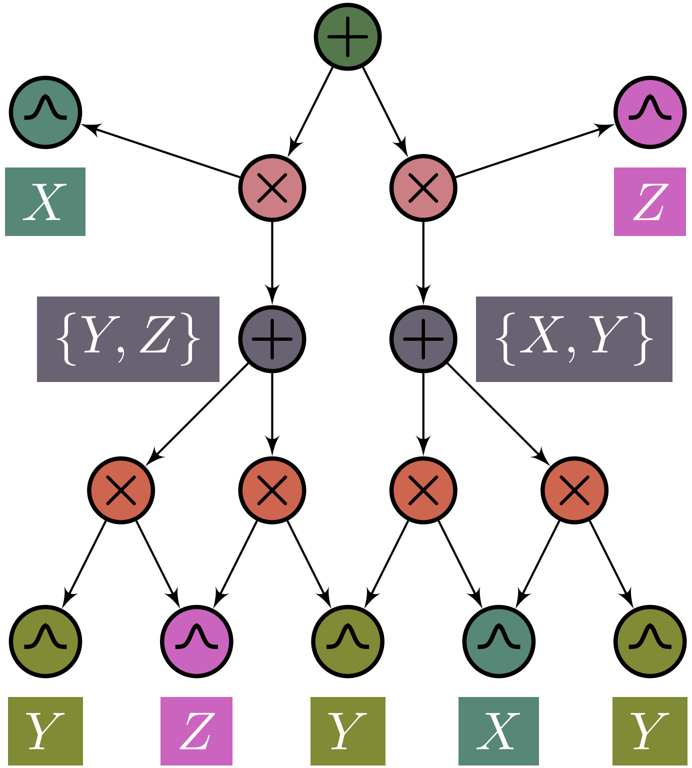


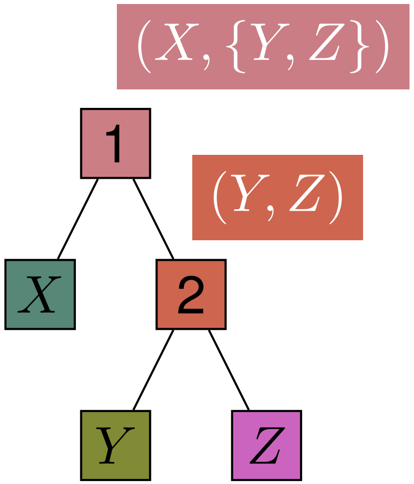
Definition 3 (Decomposability)**.**
Every product node child mentions <u>different</u> variables.



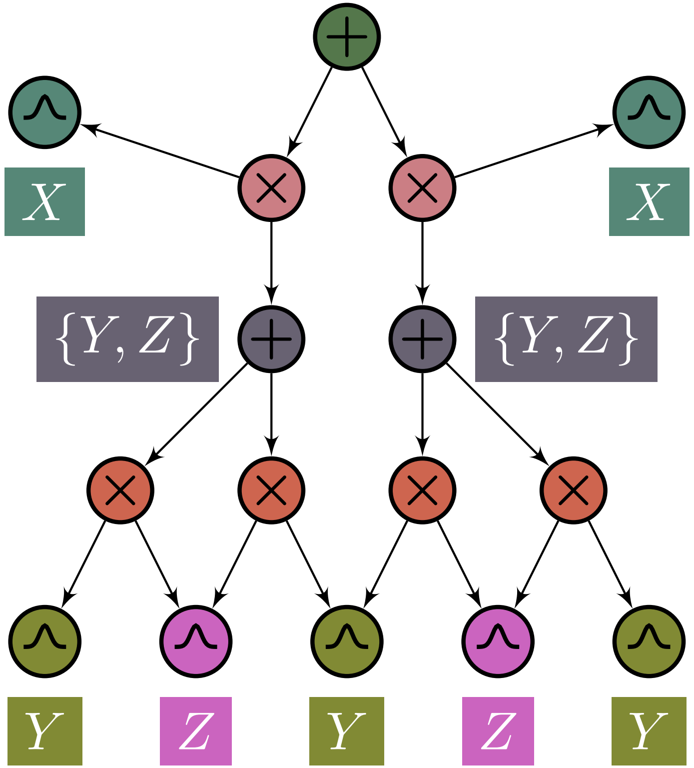


Probabilistic Circuits – Structured Decomposability





vtree

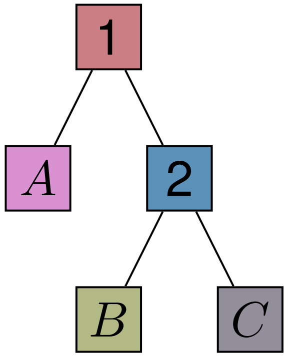


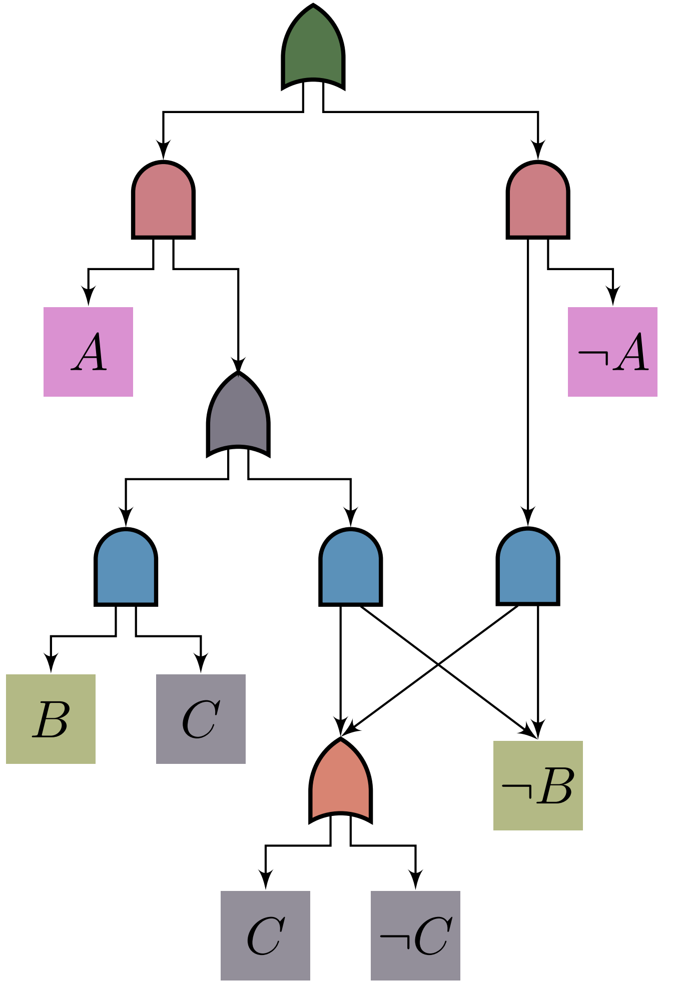
Definition 4 (Structured decomposability). *Every product node follows a vtree decomposition.*

Probabilistic Circuits – Logic Circuits

A	B	C	$\phi(\mathbf{x})$
0	0	0	1
1	0	0	1
0	1	0	0
1	1	0	0
0	0	1	1
1	0	1	1
0	1	1	0
1	1	1	1

$$\phi(A, B, C) = (A \vee B) \wedge (\neg B \vee C)$$

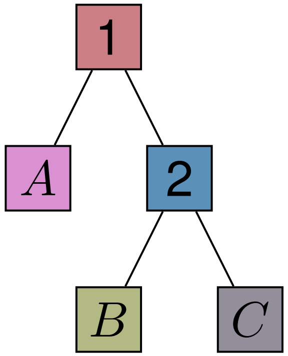


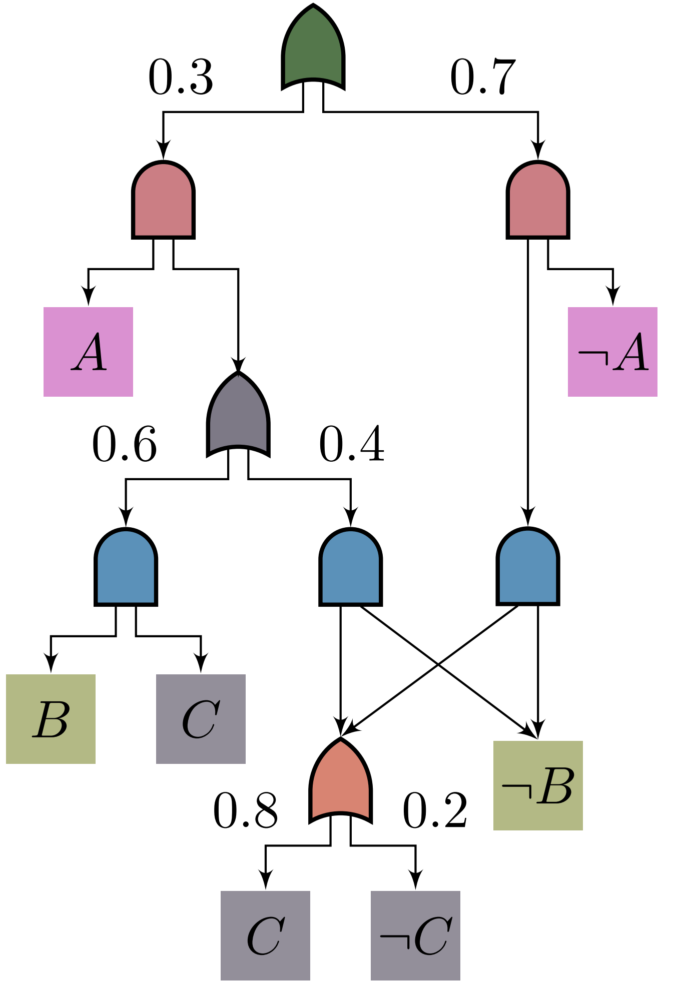


Probabilistic Circuits – Support

A	B	C	$\phi(\mathbf{x})$	$p(\mathbf{x})$
0	0	0	1	0.140
1	0	0	1	0.024
0	1	0	0	0.000
1	1	0	0	0.000
0	0	1	1	0.560
1	0	1	1	0.096
0	1	1	0	0.000
1	1	1	1	0.180

$$\phi(A, B, C) = (A \vee B) \wedge (\neg B \vee C)$$





Darwiche [2011]