# How to Exploit Structure while Solving Weighted Model Integration Problems

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## Weighted Model Integration:

- Calculate the weight of an SMT-formula given a weight function.
- Generalizes weighted model counting (Boolean formula) to the discrete-continuous domain

$$2xy$$

$$[(x{>}0) \wedge (x{<}1)] \wedge [(y{<}1) \vee ((x{>}y) \wedge (y{>}1/2))]$$

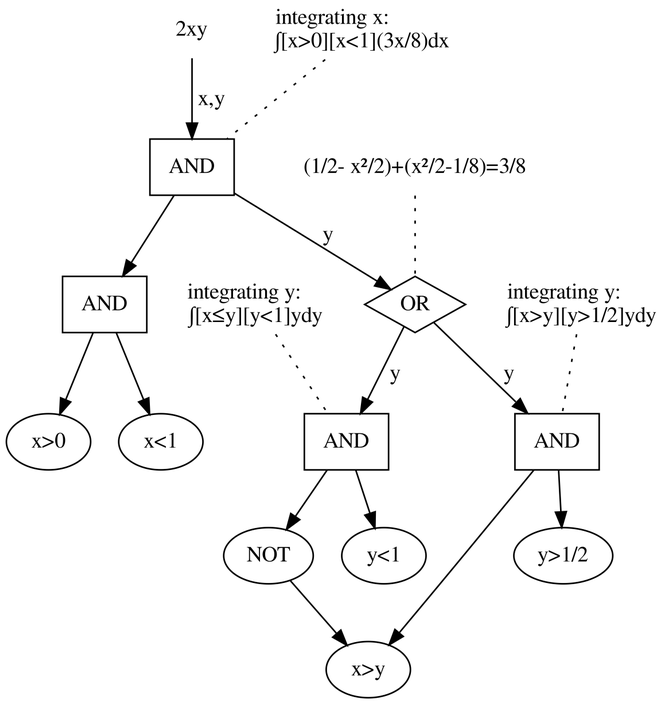
## λ-SMT: search vs. compilation

- Find the set of all satisfying assignments

| | PA | BR | Symbo | PRAiSE |
|---|---|---|---|---|
| **λ-SMT** | | | | |
| DPLL | ✓ | | | ✓ |
| Compilation | | XADD | XSDD | |
| **Integration** | | | | |
| Numeric | Latte | | | |
| Symbolic | | XADD | PSI (Tree) | Exp. Tree |

## Factorized Solving

1. Compile SMT formula to XSDD (λ-SMT).
2. Statically analyze circuit.
3. Push integration inside circuit.

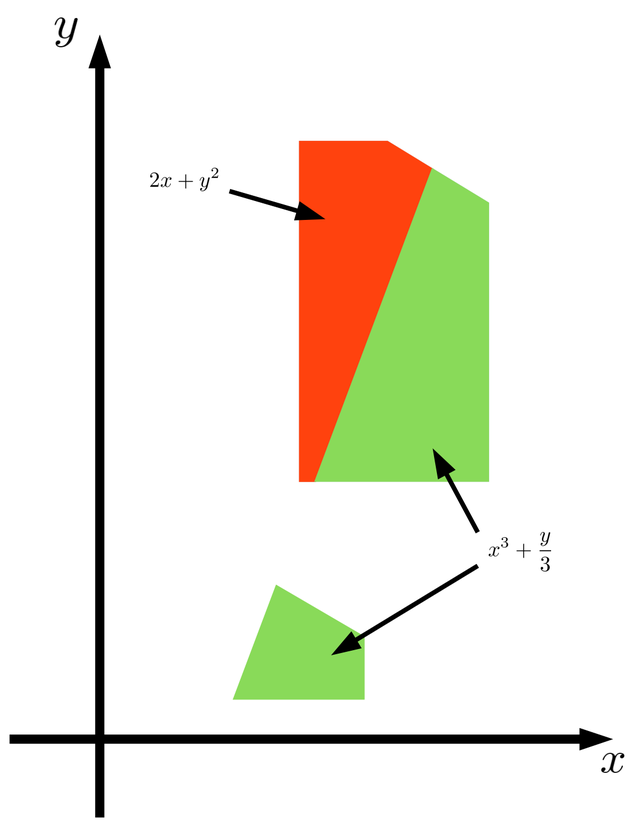



$$2\int_{(x>0)\wedge(x<1)}\left(\int_{(y<1)\wedge(x\geq y)} ydy + \int_{(y>1/2)\wedge(x>y)} ydy\right)xdx$$

# Exploiting structure in discrete-continuous probabilistic inference can lead to exponential-to-linear speed-ups in inference time.

**Check out our paper:**

**Check out our library:**




**Algorithm 1** Factorized Integration

world-weight $\omega$
**procedure** vol(XSDD $D$, vars $\mathbf{x}$)
  **if** $\mathbf{x} = \emptyset$ **then**
    **return** $[\![D]\!]$
  **else if** $D$ is terminal **then**
    **return** $\int [\![D]\!] \prod_{x\in\mathbf{x}} \omega_x(x) d\mathbf{x}$
  **else if** $D = \bigvee_c D_c$ **then**
    **return** $\sum_c \text{vol}(D_c, \mathbf{x})$
  **else if** $D = D_1 \wedge D_2$ **then**
    $\mathbf{x}_s = \mathbf{x} \cap \text{vars}(D_1) \cap \text{vars}(D_2)$
    $\mathbf{x}_1^*, \mathbf{x}_2^* = \text{vars}(D_1) \setminus \mathbf{x}_s, \text{vars}(D_2) \setminus \mathbf{x}_s$
    $r_1 = \text{vol}(D_1, \mathbf{x}_1^* \cap \mathbf{x})$
    $r_2 = \text{vol}(D_2, \mathbf{x}_2^* \cap \mathbf{x})$
    **return** $\int r_1 \cdot r_2 \cdot \prod_{x\in\mathbf{x}_s} \omega_x(x) d\mathbf{x}_s$

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