# Binary Hypothesis Model with Logistic Rules – Quick Guide

## 1. Inputs You Need

• \*\*Leaf evidence reliability\*\*: P(Eᵢ = True) for every piece of raw evidence.  
• \*\*Baseline probability p₀\*\* for each non‑leaf hypothesis: plausibility when none of its parents are true.  
• \*\*Importance weights wᵢ (or odds multipliers rᵢ)\*\*: how strongly each parent supports or undermines its child.

## 2. Logistic Conditional Rule (Binary H)

With binary parents X₁…X\_k, convert the user inputs to:  
 β₀ = logit(p₀) = ln(p₀ / (1−p₀))  
 βᵢ = wᵢ (or ln rᵢ)  
Then P(H = True | X₁…X\_k) = σ(β₀ + Σ βᵢ Xᵢ)  
and P(H = False | …) = 1 − that number.  
The logistic link is compact (k+1 params), smoothly bounded in [0,1], and additive in log‑odds so each weight is an independent “vote”.

## 3. Propagation Steps

1. Enumerate every truth‑pattern of the leaf evidence (2^m rows for m pieces).  
2. Multiply the leaf probabilities to get P(pattern).  
3. Inside each pattern compute:  
 • P(H₁ = True) via its logistic rule.  
 • P(H = True) by marginalising over H₁ (because H₁ is now probabilistic).  
4. Contribution of the pattern to P(H = True) = P(pattern) × P(H = True | pattern).  
5. Sum contributions to get overall P(H = True); 1 − that is P(H = False).

## 4. Example Breakdown Table

Below, the example uses P(E1)=0.8, P(E2)=0.6, P(E3)=0.7 and illustrative weights. The final sums check: contributions to True side ≈ 0.061, contributions to False side ≈ 0.939 (they add to 1.0).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| E1 | E2 | E3 | P(pattern) | P(H1=True|pattern) | P(H=True|pattern) | Contribution True | P(H=False|pattern) | Contribution False |
| 0 | 0 | 0 | 0.024 | 0.05 | 0.026 | 0.0006 | 0.974 | 0.0234 |
| 0 | 0 | 1 | 0.056 | 0.05 | 0.041 | 0.0023 | 0.959 | 0.0537 |
| 0 | 1 | 0 | 0.036 | 0.096 | 0.031 | 0.0011 | 0.969 | 0.0349 |
| 0 | 1 | 1 | 0.084 | 0.096 | 0.049 | 0.0041 | 0.951 | 0.0799 |
| 1 | 0 | 0 | 0.096 | 0.176 | 0.04 | 0.0038 | 0.96 | 0.0922 |
| 1 | 0 | 1 | 0.224 | 0.176 | 0.062 | 0.0139 | 0.938 | 0.2101 |
| 1 | 1 | 0 | 0.144 | 0.301 | 0.053 | 0.0077 | 0.947 | 0.1363 |
| 1 | 1 | 1 | 0.336 | 0.301 | 0.083 | 0.0278 | 0.917 | 0.3082 |
| Σ |  |  | 1.0 |  |  | 0.061 |  | 0.939 |

## 5. Take‑away Checklist

✔ Gather the three input types above.  
✔ Convert to logistic parameters and define conditional rules.  
✔ Propagate through evidence patterns or, for large models, use a Bayesian‑network library.  
✔ Use the breakdown table to show which scenarios dominate belief and to run sensitivity analysis.