

Uncertainty analysis of the durability of Guyanese wood fiber insulation panels using a Credal Network

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Context

Residual wood from French Guyana offers opportunities for bio-based insulation panels, yet applications remain limited by insufficient knowledge of biological durability in hot, humid, and biodiverse tropical environments. Few studies quantify how chemical composition and physical properties affect resistance to termites and fungi, and predictive approaches are scarce.

Tropical wood

Industrial by-products				Species adapted to plantations		Fast-growing species	
ANGELIQUE <i>Dicorynia guianensis</i>	GRIGNON <i>Sextonia rubra</i>	WAPA falcata <i>Eperua falcata</i>	MAHO rouge <i>Lecythis persistens</i>	BAGASSE <i>Bagassa guianensis</i>	SIMAROUBA <i>Simarouba amara</i>	BOIS CANON <i>Cecropia obtusa</i>	YAYAMADOU <i>Virola surinamensis</i>
							
Growth rate				Wood density			
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Insulation boards



Tropical fungal strain



Tropical & European termites



Cellulose + Hemicelluloses
Lignin
Ash, Moisture,
Extractive

Mass Loss

Cotation

Durability

Robust data-driven model using credal networks

Imprecise Dirichlet model

$$K(X_i | Pa(X_i) = x_j) = \left\{ p_{ij} : p_{ijk} \in \left[\frac{N_{ijk}}{s + N_{ij[k]}}, \frac{s + N_{ijk}}{s + N_{ij[k]}} \right], \sum_k p_{ijk} = 1 \right\}$$

Inference

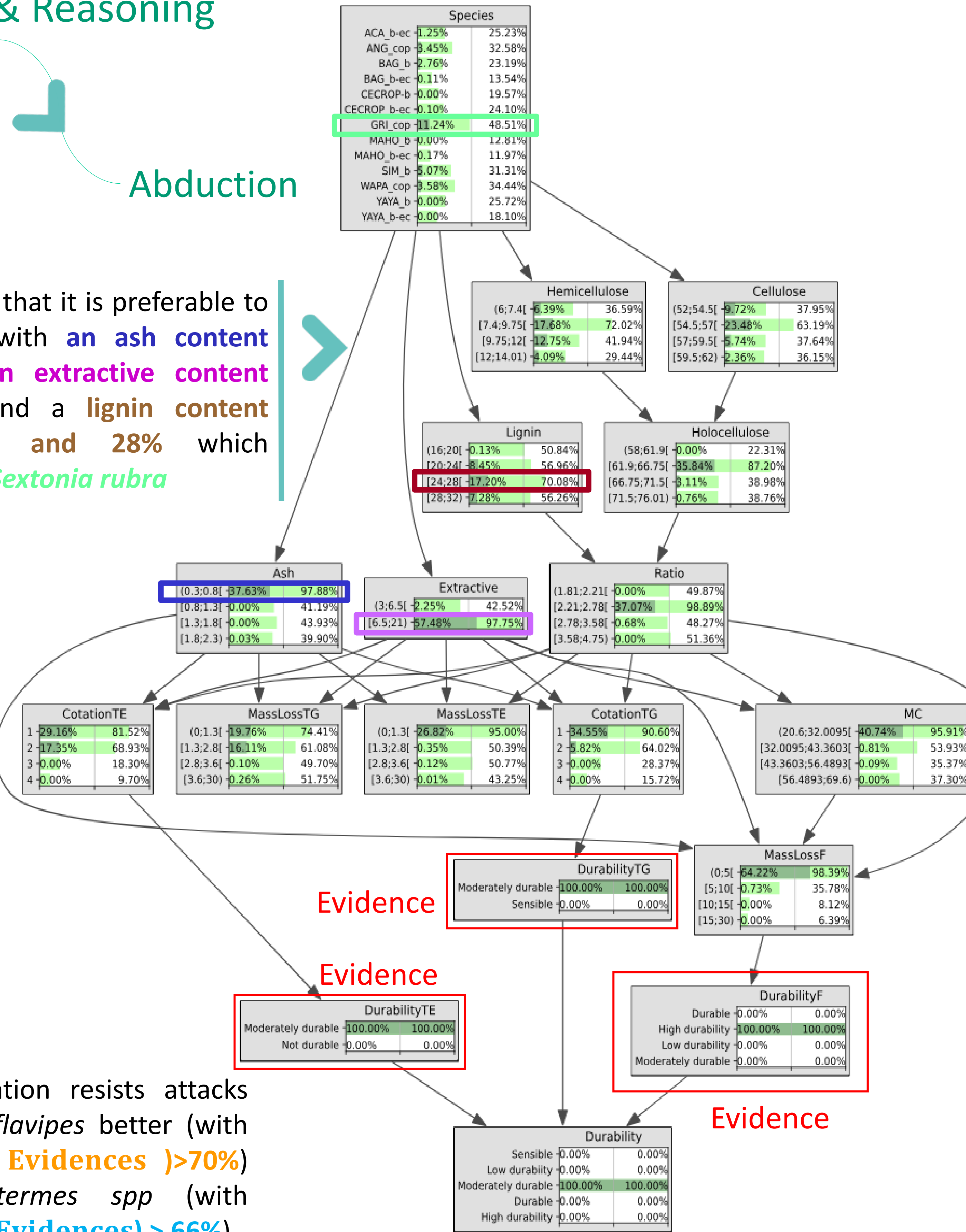
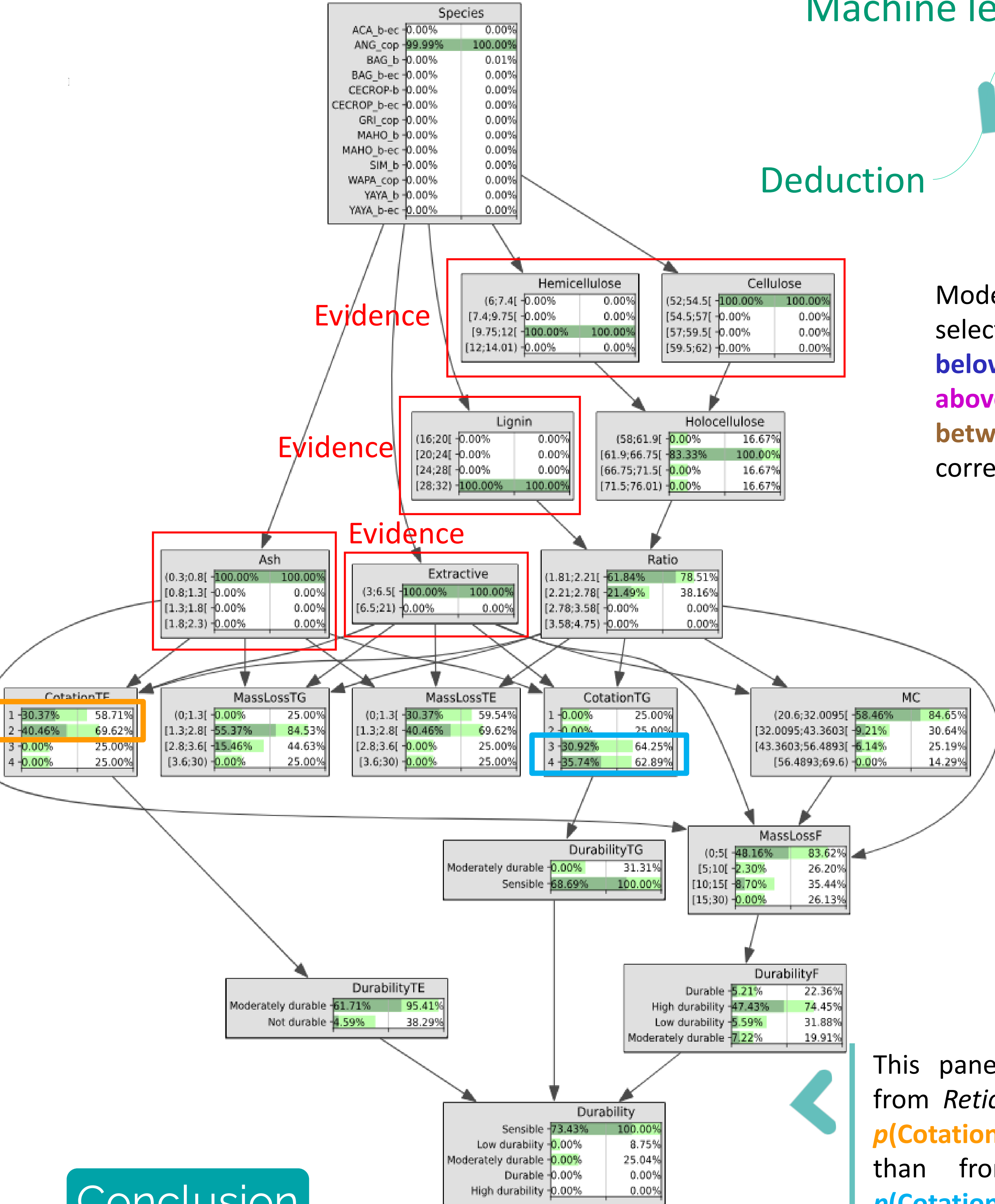
$$\underline{p}(X_Q | X_E) = \min_{p \in K(X)} \frac{\sum_{X_i \in X \setminus X_Q \cup X_E} \prod_{i=1}^n p(X_i | Pa(X_i))}{\sum_{X_i \in X \setminus X_E} \prod_{i=1}^n p(X_i | Pa(X_i))}$$

Machine learning & Reasoning

Deduction

Abduction

Model indicates that it is preferable to select species with an ash content below 0.8%, an extractive content above 6.5%, and a lignin content between 24% and 28% which corresponds to *Sextonia rubra*



This panel configuration resists attacks from *Reticulitermes flavipes* better (with $p(\text{CotationTE} \in \{1,2\} | \text{Evidences}) > 70\%$) than from *Cryptotermites spp* (with $p(\text{CotationTG} \in \{3,4\} | \text{Evidences}) > 66\%$).

Conclusion

Credal Networks offer a robust framework for modeling the durability of wood-fiber insulation panels under uncertainty. By accommodating imprecise probabilities and expert knowledge, this approach supports cautious, data-informed decisions for sustainable material selection in tropical environments like French Guiana.