

UC Merced

Proceedings of the Annual Meeting of the Cognitive Science Society

Title

Algorithmic Consequences of Particle Filters for Sentence Processing: Amplified Garden-Paths and Digging-In Effects

Permalink

<https://escholarship.org/uc/item/1bt7b981>

Journal

Proceedings of the Annual Meeting of the Cognitive Science Society, 48(0)

Authors

Maina-Kilaas, Amani

Levy, Roger P

Publication Date

2026

Copyright Information

This work is made available under the terms of a Creative Commons Attribution License, available at <https://creativecommons.org/licenses/by/4.0/>

Peer reviewed

Algorithmic Consequences of Particle Filters for Sentence Processing: Amplified Garden-Paths and Digging-In Effects

Amani Maina-Kilaas (amanirmk@mit.edu) & Roger Levy

Department of Brain and Cognitive Sciences, MIT

Abstract

Under surprisal theory, linguistic representations affect processing difficulty only through the bottleneck of surprisal. Our best estimates of surprisal come from large language models, which have no explicit representation of structural ambiguity. While LLM surprisal robustly predicts reading times across languages, it systematically underpredicts difficulty when structural expectations are violated—suggesting that representations of ambiguity are causally implicated in sentence processing. Particle filter models offer an alternative where structural hypotheses are explicitly represented as a finite set of particles. We prove several algorithmic consequences of particle filter models, including the amplification of garden-path effects. Most critically, we demonstrate that resampling, a common practice with these models, inherently produces real-time digging-in effects—where disambiguation difficulty increases with ambiguous region length. Digging-in magnitude scales inversely with particle count: fully parallel models predict no such effect.