An Event-Sourced Graph Algebra for Group Tracking

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Abstract

Reliable livestock records underpin farm efficiency, biosecurity traceability, and sustainability reporting. Such records are hard to maintain: grazing livestock are managed in mobs (herds and flocks), groups whose size and composition change continually. Stock entries and exits drive part of this change; management practices drive the rest, as limited paddock sizes force splitting and merging even when numbers are unchanged. We study a farm system of record whose source of truth is an event-sourced log of relative changes (deltas) punctuated by occasional absolute recounts; mob state is derived, not stored. Reconstructing a mob's history from this log is required to answer basic questions such as how many animals it held on a given day or how many were treated before joining it. Reconstruction is difficult because records often arrive out of order and editing a past record may alter all following values. We present a small algebra of atomic operations that supports both relative and absolute changes and builds a queryable graph of a livestock population's history one event at a time. Each operation maps a valid graph to a valid graph and has an exact inverse, so the graph stays correct and queryable after every event and every edit is reversible. Each operation also enforces two levels of correctness: structural integrity and head-count conservation. Inconsistent data therefore produces a specific, locatable rule violation instead of a silently wrong answer. Applied to commercial farm data, the algebra reconstructs mob histories and surfaces data-entry errors.

Keywords: atomic operations; data provenance; head-count conservation; incremental construction; livestock population