The Music Never Stopped: A Grateful Data Compendium with a Category-Theoretic Interpretation

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1 Abstract

We present a modular, citation-bound data compendium for the Grateful Dead universe — shows, songs, performances, personnel timelines, venues, recordings, and reception — and a category-theoretic interpretation of the performance graph. The work is grounded in the archival reality that Grateful Dead history is both institutional and participatory: UCSC's Grateful Dead Archive and the Internet Archive collection preserve formal and community records [University of California, Santa Cruz University Library, 2025, int, Internet Archive Help Center, 2018], while taping and trading scholarship shows why setlists and recording metadata are cultural evidence, not merely fan trivia [Meriwether, 2015, Wallace, 2009]. The surrounding source dossier also binds the non-quantitative historical frame – formation and Acid Test context, Wall of Sound engineering, live recording/liveness scholarship, Deadhead sociology, studio-era reception, and public recognition – to checked sources rather than to folklore alone [Grateful Dead, Weir, 2011, Smithsonian Institution, 2024, McIntosh Laboratory, 2025, Brackett, 2023, Adams and Sardiello, 2000, Rock and Roll Hall of Fame, 1994, Recording Academy, 2007, John F. Kennedy Center for the Performing Arts, 2024]. The compendium integrates nine primary sources (`Setlist.fm` [set, a], `The SetList Program` [set, b], the Mark Leone CMU setlist archive [Leone, b, Gorstein], `GDsets` [gds, a,b], `gdshowsdb` [Smith, git], the Internet Archive Live Music Archive [int, fif], the Alex Allan / whitegum lyric finder [Allan, Leone, a], the official band site [dea], and Wikipedia [wik, b,a]) with four reference sources (Britannica [bri], the lineup-changes guide [ucr], Dodd and Trist's *The Complete Annotated Grateful Dead Lyrics* [Dodd and Trist, 2005], and the Grateful Stats front-end [gra]) and secondary corpora and community discussions [Thered, Blance, maximinus, red, a,b,c,d]. Each source is parsed by an independently testable *reference* module written against the documented record shape; the committed compendium under `data/archival/` is the dataset reported here (3341 ingested shows (gdshowsdb + truckin gap-fill; community literature estimates about 2318 canonical concerts), 645 songs, 912 venues, 40757 performance rows). A runtime completeness audit and figure-validation gate certify referential integrity and non-degenerate outputs on every pipeline run. Integration is a deterministic, sort-keyed merge over canonical slugs; registered figures also emit CSV/JSON data tables, and a first-principles claim ledger classifies each major result by irreducible input, hard constraint, assumption, validation artifact, and interpretation limit. Exploratory repertoire/uncertainty panels are labelled as pattern-discovery rather than causal inference. We then exhibit four small but real categorical constructions, situated against transformational and categorical music-theory precedents [Lewin, 2007, Padi et al., 2017, Popoff and Andreatta, 2023]: a poset category of dates, a discrete category of shows, a *monotone* cumulative setlist functor and lineup functor from dates into sets, and a span representation that takes each performance to be the apex of a span between its show and its song. Wide pullbacks over a fixed show recover the show's setlist; wide pullbacks over a fixed song recover the song's performance history. The active-band roster, by contrast, is a non-monotone presheaf on the date poset — a categorical formalization of the familiar fact that members come and go. The artefacts in this paper come from the committed archival snapshot; all source-ingestion modules are written against the *real* source shape so that `scripts/00_fetch_sources.py --online --write-archival` refreshes the full snapshot.

2 Introduction

2.1 What we mean by "the music never stopped"

The Grateful Dead performed roughly two and a half thousand concerts between 1965 and 1995. The public record of those concerts — setlists, recordings, ticket stubs, member rosters, composer credits, release histories, and decades of fan commentary — is one of the most extensively documented bodies of live performance in popular-music history. It is also unusually hybrid. UCSC's Grateful Dead Archive gives the band a formal institutional home [University of California, Santa Cruz University Library, 2025], while the Internet Archive collection and Deadhead taping culture preserve the community-built sound archive and its metadata [Internet Archive Help Center, 2018, Meriwether, 2015, Wallace, 2009]. The record is fragmented across primary databases, archival corpora, reference works, and a long tail of community spreadsheets and forum threads [red, a,c,d]. This paper introduces *The Music Never Stopped*: a reproducible, citation-bound compendium that integrates the primary sources into a single schema, exposes them to standard data-analysis machinery, and exhibits a small but genuine category-theoretic structure latent in the performance graph.

2.2 Sources surveyed

We organize the cited landscape into four layers.

Primary setlist sources. Setlist.fm publishes a crowd-curated, API-backed register of every Grateful Dead show [set, a]. The SetList Program at `setlists.net` covers 1965–1995 with an interactive interface [set, b]. The Mark Leone CMU archive [Leone, b], derived from the Jerry Stratton database, is the ancestor of many community scrapes; Noah Gorstein has converted the abandoned HTML into an open SQLite database [Gorstein]. `GDsets` combines setlists with ticket-stub and stage-pass images [gds, a,b]. The `gdshowsdb` repository ships a relational schema and a Ruby gem [Smith]; the GitHub topic `gratefuldead` is the meta-index that links these and other resources [git].

Primary lyric and song-attribution sources. Mark Leone's lyric index at CMU [Leone, a] points to the Stratton database via FTP. Alex Allan's `whitegum.com` is the canonical lyric and song finder for every song the Dead played, with composer/lyricist attribution and per-song performance data [Allan]. Dodd and Trist's *The Complete Annotated Grateful Dead Lyrics* supplies the authoritative interpretive and annotation context for lyric studies [Dodd and Trist, 2005]. We cite it as an external authority and store only pointer metadata; no lyric text is bundled. Hunter's own retrospective account and community discussion are used only as context for songwriter roles, never as an override of the structured composer/lyricist fields [Greene, 2015, red, b].

Personnel, discography, recording, and reception sources. The official band site lists members and roles [dea]. Wikipedia's Grateful Dead entry [wik, b] and discography [wik, a] anchor the biographical timeline; Britannica frames the wider cultural context [bri]. *Ultimate Classic Rock*'s lineup-changes guide [ucr] provides a chronological narrative of personnel transitions. The Internet Archive's Live Music Archive supplies recording metadata for the bulk of the live corpus [int], and its Grateful Dead collection policy explains the special access and metadata posture of those recordings [Internet Archive Help Center, 2018]. The `fifteen-songs-dataset` curates 2617 soundboard recordings of 15 songs for music-information-retrieval research [fif], while Wang et al.'s setlist-segmentation paper gives a broader MIR frame for why live setlist identification is non-trivial [Wang et al., 2014]. `jerryPycia` provides a Python query library over Dead show data [Blance]; the `grateful-dead-reviews` corpus collects long-form fan reviews [maximinus]. The `gratefulstats.com` front-end aggregates show/tune/venue statistics [gra]. The `gratefuldata` tutorial demonstrates an ETL pipeline using the Internet Archive together with ASCAP ACE composer data [Thered]. The compendium draws composer/lyricist attributions from these sources and encodes them in `data/archival/songs.json`.

Historical, technical, and interpretive context. The supplied enriched bibliography is useful as a discovery map, but the map is not itself evidence. Each durable topic is therefore rebound to checked source families: the official dead.net biography and FoundSF's Bob Weir oral-history page for formation and Acid Test context [Grateful Dead, Weir, 2011], Smithsonian and UCSC for institutional archive status [Smithsonian Institution, 2024, University of California, Santa Cruz University Library, 2025], McIntosh for the Wall of Sound hardware [McIntosh Laboratory, 2025], Marshall, JSTOR Daily, Meriwether, Wallace, and the Internet Archive policy page for the tape-trading and sound-archive ecosystem [Marshall, 2003, Daily, 2015, Meriwether, 2015, Wallace, 2009, Internet Archive Help Center, 2018], Brackett's *Live Dead* for liveness and recorded-performance scholarship [Brackett, 2023], Adams and Sardiello for Deadhead sociology [Adams and Sardiello, 2000], Dodd and Weiner for the bibliographic field map [Dodd and Weiner, 1997], Britannica and Americana Highways for narrow biographical and studio-reception context [Encyclopaedia Britannica, Highways, 2020], and official public-recognition sources for later institutional status [Rock and Roll Hall of Fame, 1994, Recording Academy, 2007, John F. Kennedy Center for the Performing Arts, 2024]. Community reconstructions such as touring revenue estimates are cited only as labelled business-history context, not as compendium measurements [Seconds, 2016].

2.3 What is in this repository

We ship a committed archival compendium under `data/archival/` that drives every analysis and category-theoretic claim in this paper end-to-end, plus a parser for each cited source so that refreshing the snapshot is a matter of running the same code with online flags.

2.4 Related work

Prior Grateful Dead data efforts are mostly *single-source* or *single-purpose*. Community setlist databases and the gdshowsdb / truckin-through-time projects [Smith, Gorstein] assemble the raw show record; aggregators such as Grateful Stats [gra] and community spreadsheets and forums [red, c,a] surface frequency rankings; and query libraries such as `jerryPycia` [Blance] and the `grateful-data` tutorial [Thered] expose one source programmatically. Archive and popular-music studies add a second frame: the Dead's sound record is co-produced by band, archive, tapers, uploaders, and curators rather than handed down by a single authority [Wallace, 2009, Meriwether, 2015, Internet Archive Help Center, 2018, Brackett, 2023]. Sociological work on Deadheads, bibliographic scholarship, and tape-trader studies explain why this record is also a community institution rather than simply a discography [Adams and Sardiello, 2000, Dodd and Weiner, 1997, Marshall, 2003, Daily, 2015].

This compendium differs on two axes. It is *integration-first*: primary sources are reconciled on canonical slugs into one immutable, citation-bound schema with a runtime honesty boundary and completeness/figure-validation probes. It is also *structure-first*: the performance record is read through small but mechanically checked categorical constructions (functors, spans, colimits, a date-poset Yoneda statement) rather than treated only as a frequency table. The music-theory lineage is Lewin's transformational shift from static objects to relations and transformations [Lewin, 2007], with newer categorical music work showing how such networks can be formalized diagrammatically [Padi et al., 2017, Popoff and Andreatta, 2023]. Our contribution is a concrete, reproducible instantiation on a real performance corpus, with every quantitative or categorical claim bound to code.

2.5 What is *not* in this repository

We do not bundle lyric text — full lyrics are copyrighted. The compendium stores songs as titled records with composer and lyricist attribution; the semantic layer (motifs, themes, annotations) is read against external indices such as Alex Allan's finder and Dodd's annotated lyrics [Allan, Dodd and Trist, 2005]. We do not bundle audio. The audio-enriched category in §3 is a structural abstraction over similarity weights; concrete weights are produced by an external pipeline against the `fifteen-songs-dataset` [fif].

3 Methodology

3.1 Schema

The compendium primitive is a small frozen-dataclass schema. Every entity validates its inputs in `__post_init__`; every primary key is computed by a canonical-slug function so that joins across sources reduce to dictionary lookups. The nine entity types are `Show`, `Venue`, `Person`, `Song`, `Performance`, `Recording`, `Release`, `Citation`, and `Lineup`; their fields and invariants are documented in `src/models.py`.

Two canonical-slug rules suffice for source-agnostic identity:

- a song slug is the ASCII-folded, punctuation-stripped slug of its title;
- a show slug is `YYYY-MM-DD@<venue-slug>`.

These deterministic functions absorb the cross-source-naming variance that would otherwise require a manual alias table.

3.1.1 Data dictionary (core entities)

The field-level contract for the entities that carry the quantitative claims; the authoritative definition with all invariants is `src/models.py`.

Entity	Key	Principal fields	Notes
`Show`	`slug` = `YYYY-MM-DD@venue`	`date`, `venue_slug`	one concert; `venue_slug` is a foreign key into `Venue`
`Venue`	`slug`	`name`, `city`, `state_or_region`, `country`	geo coordinates live in a `venue_geo` sidecar
`Song`	`slug` (slug of title)	`title`, `composers`, `lyricists`, `first_performed`, `last_performed`, `aliases`	catalogue entry; need not have been performed
`Performance`	`(show, song, set, position)`	`show_slug`, `song_slug`, `set_number`, `position`, `segue_into`, `notes`	the apex of the show↔song span
`Person`	`slug`	`intervals` = `(start, end, role)` tuples	open interval (`end=None`) means still active
`Recording`	`slug`	`show_slug` (or date), `source_type`	Internet Archive + curated rows
`Review`	—	`show_slug`, `kind`, `sentiment` $\in [-1, 1]$, `source_url`	positive sentiment requires a source URL (honesty check)
`Citation`	`key`	`kind`, `url`	bibliography + `references.bib`
`LyricPointer`	`song_slug`	`url`, `themes`, `lyricist`	URL metadata only — never lyric text

3.2 Source ingestion

Each cited source has its own *reference parser* at `src/sources/<name>.py`. Every parser exposes a single `parse` function whose input is a record in the documented upstream shape (JSON payload for API sources, line-oriented text block for HTML-derived archives, dict-of-tables for relational dumps) and whose output is in the canonical schema. The committed snapshot in `data/archival/` is built from gdshowsdb YAML, truckin-through-time SQLite gap-fill, and curated overlays. Live HTTP fetchers are implemented in `src/ingest/` and invoked by `scripts/00_fetch_sources.py --online --archival-max`. We support nine ingestion paths corresponding to the survey above:

Source	Module	Citation
Setlist.fm	`sources/setlistfm.py`	[set, a]
The SetList Program	`sources/setlist_program.py`	[set, b]
CMU / Mark Leone	`sources/cmu_setlists.py`	[Leone, b, Gorstein]
GDsets	`sources/gdsets.py`	[gds, a,b]
gdshowsdb	`sources/gdshowsdb.py`	[Smith]
Internet Archive LMA	`sources/internet_archive.py`	[int, fif]
Alex Allan / whitegum	`sources/alex_allan.py`	[Allan]
dead.net (official)	`sources/dead_net.py`	[dea]
Wikipedia	`sources/wikipedia.py`	[wik, b,a]

The Internet Archive path is treated as recording *metadata* rather than as an audio-ingestion license. The Grateful Dead collection has its own access and upload posture, and its item metadata can include source, taper, and transfer fields that are valuable without bundling audio files [Internet Archive Help Center, 2018]. Likewise, the lyric layer records URLs, lyricist attribution, and curated theme labels only; Dodd and Trist's annotated lyrics are cited as external interpretive context, not ingested text [Dodd and Trist, 2005].

3.2.1 Contextual-source layer

Historical context is deliberately stored as citations and prose, not as performance data. The enriched-bibliography pass added a fourth source class: checked contextual anchors for formation, public honors, sound engineering, tape-trading, Deadhead sociology, studio-era reception, bibliography, and live-recording scholarship [Grateful Dead, Weir, 2011, Smithsonian Institution, 2024, McIntosh Laboratory, 2025, Marshall, 2003, Brackett, 2023, Adams and Sardiello, 2000, Dodd and Weiner, 1997, Highways, 2020, John F. Kennedy Center for the Performing Arts, 2024]. These sources can explain why a date matters, but they do not create or override `Show`, `Performance`, `Recording`, or `Release` rows. The quality tiers are explicit:

- **Data-bearing primary sources** (gdshowsdb, Truckin, Setlist.fm, SetList Program, Internet Archive metadata) may create or corroborate schema rows through parser code.
- **Pointer-only sources** (whitegum, the CMU lyric index, dead.net song pages, Dodd/Trist) may supply URLs, attributions, and themes but never bundled lyric text.
- **Scholarly or institutional context** (UCSC, Wallace, Brackett, Adams/Sardiello, Lewin, NIST/Padi, Popoff/Andreatta) may support manuscript interpretation, methods scope, and related work.
- **Journalism or publisher context** (JSTOR Daily, Americana Highways, Billboard, Britannica, McIntosh) may support labelled reception, biography, or technical context only.
- **Community reconstruction** (Reddit threads, Grateful Seconds) may support explicitly labelled background, never quantitative findings.

No current-person, revenue, lyric, or audio claim from the source dossier is allowed into the quantitative layer unless it is independently sourced and represented in the schema. The same rule applies to citation placement: contextual sources may explain the provenance of a figure or timeline label, but the plotted statistics must still come from generated reports or exported figure data.

3.3 Integration

The integration layer at `src/integration/reconcile.py` performs a deterministic merge. The merge rule is pointwise per entity type — venues join on slug, songs join on slug with union of composer/lyricist tuples and min/max of first/last-performed dates, people join on slug with union of intervals, performances join on the four-tuple `(show, song, set, pos)`. The resulting `Compendium` is immutable and byte-stable across runs.

3.4 Committed compendium (`data/archival/`)

The published dataset lives under `data/archival/` (3341 ingested shows (gdshowsdb + truckin gap-fill; community literature estimates about 2318 canonical concerts), 645 songs, 912 venues, 40757 performance rows). It merges gdshowsdb YAML, truckin-through-time gap-fill, Internet Archive LMA metadata, bibliography citations, maximinus reviews, CMU lyric pointers, and curated personnel/releases overlays. `GRATEFUL_DATA_TIER=archival` selects this load path (see `src/tier.py`).

3.5 Analyses and validation

The analysis layer at `src/analysis/` computes descriptive statistics, co-occurrence and Markov transitions, era and personnel timelines, geo and tour aggregates, lyric-theme frequencies from pointers, review sentiment, segue extraction, eigenvector centrality, stationary distributions, and bustout (recurrence-gap) metrics — each as a pure function of the `Compendium`.

Distributional statistics are first-class objects rather than incidental plot annotations. `src/analysis/distributions.py` computes show-level performance-row summaries, robust percentiles, and simple concentration statistics (Gini, top-decile share, and the number of ranked items needed to cover 50% and 80% of rows). The method is descriptive only: it reports skew and concentration in the archival record without treating unequal song frequency, venue recurrence, or setlist length as causal effects. Show-level performance distributions include empty-setlist shows, because excluding them would make the setlist-completeness limitation invisible.

The same module now adds fixed-seed item-level bootstrap intervals for the song and venue concentration statistics. These intervals are reported as exploratory uncertainty bands around descriptive metrics: the resampling unit is the observed item count (a song's performance count or a venue's show count), not a claim about unobserved concerts, fan preference, or musical causation.

Exploratory repertoire modeling lives in `src/analysis/exploratory.py`. It constructs an era-by-song performance-count matrix with generic segment markers excluded, applies a centered SVD to log-count profiles, and clusters the two-dimensional coordinates with deterministic k-means-style updates and stable tie-breaks. The output is explicitly labelled as pattern discovery: it helps inspect era-weighted repertoire profiles, but it is not predictive, causal, or a definitive musicological taxonomy.

The transition analysis is intentionally modest: a first-order chain over adjacent within-show performance rows plus an explicit segue graph over source-marked `segue_into` edges. MIR work on full-concert setlist identification shows why audio-level segmentation is a separate, harder task that would require different evidence and different artifacts [Wang et al., 2014]. The current analysis report also includes a deterministic transition-sensitivity layer: predecessor-support thresholds are summarized with and without generic segment markers, and era-specific transition summaries are reported as descriptive diagnostics. These sensitivity rows do not rerun the permutation screen and do not create predictive claims; they show how fragile or stable the visible transition surface is under ordinary presentation choices.

Repertoire concentration is likewise reported with sensitivity context. Beyond the fixed-seed bootstrap intervals, the analysis report summarizes alternate top-N cuts for performance share, within-cut Gini, top-decile concentration, and era coverage. This keeps the manuscript from treating a single top-song cutoff or heatmap width as if it were an intrinsic property of the archive.

3.5.1 First-principles claim ledger

The methods layer now includes a claim-governance pass in `src/analysis/first_principles.py`. This is not a statistical model; it is a reproducibility device. The ledger deconstructs each major manuscript claim family into five irreducible parts: the data input, the hard constraint that must hold, the softer modeling or presentation choice, the assumption that remains after the hard constraint is enforced, and the interpretation limit. The current build classifies 12 claim families across 6 claim classes, naming 12 hard constraints, 12 assumptions, and 12 validation artifacts.

This layer prevents the common failure mode in computational humanities projects: a polished visualization silently upgrades a descriptive pattern into an explanatory claim. For example, repertoire rankings are permitted to say what was counted after segment-marker exclusion; they are not permitted to say what the band preferred. The transition matrix is permitted to summarize adjacent setlist rows; it is not permitted to infer musical causality. The historical-context timeline is permitted to orient computed show counts against cited milestones; it is not permitted to create or modify a `Show` row. `scripts/19_first_principles_review.py` serializes the ledger as `output/reports/first_principles_review.json` and `output/reports/first_principles_claims.csv`. Each row also names the manuscript section, figure filename, report key, governing test file, and claim status, so caveats can be routed through the ledger instead of repeated as free-floating prose.

3.5.2 Provenance, external pointers, and reviewer artifacts

Source provenance is exported as a sidecar rather than written into the frozen entity dataclasses. `src/provenance.py` records the source-layer families behind shows, songs, venues, performances, recordings, releases, citations, lyric pointers, reviews, personnel rows, and computed segue edges. The records are deliberately conservative: they identify ingest or computation layers, not hidden row-level certainty that the schema does not store.

The external-media layer is pointer-only. `src/external_manifests.py` writes audio and lyric URL manifests with compact metadata, hashes where available, and explicit policy labels. It rejects bundled audio, local paths, lyric text, transcripts, excerpts, waveforms, and derived text fields. It also writes a small pipeline contract that names allowed inputs and outputs for future external audio-feature and lyric-annotation workflows. This keeps future audio- or lyric-analysis work reproducible without changing the present copyright and data-boundary claims.

Visualization lives in `src/viz/`: reusable panel builders (`panels.py`), a figure registry (`figures.py`), mosaic composition (`compose.py`), alluvial flows (`alluvial.py`), and non-blank figure validation (`validate.py`). HTML dashboards and entity markdown pages live in `src/reporting/`.

The figure set is deliberately mixed: frequency and concentration views use ranked bars or cumulative-share curves; distributions use histograms with median and high-percentile reference lines; temporal activity uses bars/lines; co-occurrence and transition matrices use heatmaps; geography uses a size-encoded scatter map; and the composer/song/era view uses an alluvial diagram. Pie charts are avoided because the same categorical comparisons are more legible as sorted bars with counts and shares.

The contextual-source distinction also shapes the visual layer. The new historical-context timeline overlays a small set of cited milestones on computed show counts; it is a visual orientation aid, not an ingest product. The figure registry therefore carries its title, screen-reader alt text, caption hint, data source, statistic, exclusion rule, claim class, draw function, and figure-data exporter together. The same metadata feeds the dashboard, raw figure-data index, publication validator, and manuscript captions, so prose claims and plotted statistics are auditable from one registry. A plain static explorer under `output/explorer/` reuses exported show, song, venue, segue, figure, provenance, and claim-evidence data for local filtering without adding a frontend framework. The explorer supports URL-state filters, sortable table headers, related links, and filtered CSV download, so readers can inspect subsets without depending on a server.

Runtime probes certify manuscript claims beyond unit tests:

- `src/audit.py::audit_completeness` — referential integrity (tier-aware);
- `src/export.py` — full raw CSV/JSON export of every entity type;
- `src/analysis/first_principles.py` — first-principles claim/evidence ledger for hard constraints, assumptions, validation artifacts, and limits;
- `src/provenance.py` — sidecar provenance CSV/JSON for entity/source-layer review;
- `src/external_manifests.py` — pointer-only external audio/lyric manifests with protected-content rejection;
- `src/viz/datasets.py` — raw CSV/JSON export of 34 registered figure datasets;
- `src/viz/validate.py::validate_figures` — every expected PNG exists and is non-degenerate.

4 Category-theoretic interpretation

4.1 Why category theory

Category theory gives us a vocabulary for *structure that survives change of representation.* The four constructions below identify structure that does not depend on which source we drew the data from or on which subset of the corpus we are looking at: they are stable in exactly the sense category theory was built to express.

The point is not to claim that setlists require category theory. The point is to make the data model's relations explicit. Lewin's transformational theory famously shifts attention from musical objects to transformations among objects [Lewin, 2007]; NIST's music case study shows category theory used as an ontology and integration framework for musical knowledge [Padi et al., 2017]; and recent work on hidden categories in Lewinian GIS and Klumpenhouwer networks makes the categorical connection literal [Popoff and Andreatta, 2023]. Those works license the *kind* of move being made here – a shift from objects to relations and an ontology whose diagrams can be checked – but they do not make the Grateful Dead corpus categorically interesting by association. Our use is narrower: shows, songs, dates, and performances form a small relational system whose laws can be checked directly against the compendium.

Scope of these claims. **Date** is a *thin* poset category, so associativity holds automatically and the Yoneda statement is the elementary poset case rather than a deep theorem. We therefore present the mechanized checks below — law sampling, the colimit universal property, the Yoneda bijection, the span/functor commutation — as *encoding and sanity checks*: they verify that the schema faithfully instantiates these categorical structures and that the corresponding properties hold on the real corpus (each with a negative control that fails on broken input), not that a non-trivial mathematical theorem about the Grateful Dead has been proved. Their value is that the data model is demonstrably the categorical object we claim it is — which is what licenses the representation-independent reading — not mathematical novelty or a claim that categorical music theory explains the band's musical choices.

4.2 The date poset and the show category

Let **Date** be the small category whose objects are the distinct performance dates in the compendium and whose morphisms $d_1 \to d_2$ exist iff $d_1 \leq d_2$. **Date** is a thin poset category; identities and associativity hold by construction. Let **Show** be the discrete category whose objects are the show slugs. Both categories' laws are checked mechanically in `src/cattheory/categories.py::Category.check_laws`. Small categories are verified exhaustively; at archival scale the **Date** poset has 2312 objects, so an exhaustive associativity sweep is intractable. The checker instead verifies every identity and samples a fixed (seeded) set of random composable triples, checking both associativity and **closure** (that each sampled composite arrow is present in the table). Because the **Date** `compose` is order-preserving string composition, its associativity holds by construction; the data-reachable defect is a non-transitively-closed arrow table, which the sampled closure check catches with high probability. This is a *regression guard* — the laws hold by construction; the check is a sampled probe of systematic corruption, not a proof — paired with a negative control that fails on a deliberately non-closed table.

4.3 The setlist functor

Define $F_{\text{setlist}} : \mathbf{Date} \to \mathbf{Set}$ by sending each date d to the set of song slugs ever performed on or before d, and each arrow $d_1 \leq d_2$ to the inclusion of sets. F_{setlist} is a covariant functor because the cumulative-songs set is monotone in d. `cattheory/functors.py::setlist_functor` returns the explicit representation; `is_monotone` checks the functor law on the compendium.

4.4 The lineup functor and the active-roster presheaf

Define $F_{\text{lineup}} : \mathbf{Date} \to \mathbf{Set}$ by sending each date d to the set of personnel who have been in the band on or before d, and each arrow to the inclusion. F_{lineup} is again a monotone covariant functor.

The *active-roster* assignment $P_{\text{active}}(d) = \{p \mid p \text{ is in the band on } d\}$ is also natural, but it is *not* monotone: when Pigpen leaves the band in 1972 [ucr, dea], the active set shrinks, so P_{active} fails the covariant-functor law. It is, however, a perfectly good presheaf: contravariantly, the "forgetting" arrow $d_2 \to d_1$ can be sent to the restriction of the active set. We make both views available (`setlist_functor`, `lineup_functor`, `active_lineup_presheaf`) and check that one is monotone and the other is not. The categorical content matches the historical fact: cumulative views grow; instantaneous views oscillate.

4.5 Performances as spans, with fibers over shows and songs

For each performance $p = (\text{show}, \text{song}, \text{set}, \text{pos})$, define a (2-leg) span:

$$\text{Show} \xleftarrow{\pi_{\text{show}}} p \xrightarrow{\pi_{\text{song}}} \text{Song}.$$

In `cattheory/spans.py`, `PerformanceSpan` exposes the two projections explicitly. The *fiber* of π_{show} over a fixed show s — the preimage $\pi_{\text{show}}^{-1}(s)$, equivalently the wide pullback of all spans pinned on the left to s in the discrete fibration sense — recovers the show's setlist in canonical order. Symmetrically, the fiber of π_{song} over a fixed song recovers the song's performance history. We use "fiber / multi-leg span" rather than "wide pullback" in the strict universal-property sense; the discrete-base setting collapses the distinction. This construction shows that the performance primitive is not a derived field of the schema; it *is* the apex linking shows and songs, and the two projections commute by definition with the cumulative setlist functor.

The categorical content is small but real:

- No data is lost going either direction along a span; both projections are total.
- The two wide-pullback constructions give the two natural "transposes" of the performance table — show-major and song-major — without privileging either.
- Composition of spans (in the bicategory of spans) corresponds exactly to the relational operation "show A and show B both played a song C" — useful for cross-show similarity measures.

4.6 Audio enrichment

Following the precedent of the `fifteen-songs-dataset` [fif] and the broader MIR problem of identifying and segmenting live concert songs [Wang et al., 2014], pairs of performances of the *same song* could carry a similarity weight in $[0, 1]$. The category whose objects are performances and whose hom-objects are these weights is enriched over the unit-interval monoid $([0, 1], \max, 0)$. `cattheory/enriched.py::AudioEnrichedHom` captures the abstraction: the constructor enforces the weight constraint and the same-song precondition; identity homs at weight 1.0 behave as required in the enrichment.

We do not bundle audio. The enrichment is structural; concrete weights are expected to come from a downstream pipeline against the `fifteen-songs-dataset`.

4.7 Coproducts and colimits

`cattheory/colimits.py` exposes two constructions: the binary coproduct of two `Compendium` fragments, which by the reconciliation rules collapses into the disjoint-union compendium, and the colimit of the cumulative setlist functor on the compendium, which equals the set of all songs ever performed in the bundled data. Crucially, the colimit check verifies the *universal property*, not merely that each $F(d)$ is a subset of the union: `colimit_cone_factors` confirms that a strictly larger cocone vertex admits the unique mediating map and — as a built-in negative control — that a vertex *strictly smaller* than $\bigcup F$ fails to receive the colimit. A check that only asserted $F(d) \subseteq \bigcup F$ would be vacuous (true for any family); requiring the negative control to fail is what gives it teeth. The test `test_coproduct_disjoint_union` additionally asserts that splitting the shows and re-merging via the coproduct returns the original show set — a structural reproducibility witness for the reconciliation layer itself.

4.8 Natural transformations

The cardinality assignment η`_d = |F(d)|` is a natural transformation `F` $\Longrightarrow$ `\mathrm{Card} \circ F` for any monotone covariant functor `F : \mathbf{Date} \to \mathbf{Set}`. The naturality square reduces (on this thin poset) to `|F(d_1)| \le |F(d_2)|` whenever `d_1 \le d_2`. `src/cattheory/natural.py` exposes `naturality_square_holds` and the two concrete instances `setlist_cardinality_transformation`, `lineup_cardinality_transformation`; both pass on the compendium and both are tested against a hand-crafted broken-cardinality functor as a negative control. This is small but real categorical machinery — it lets us reason about *several* functors in parallel through a single shared transformation.

4.9 Representability (Yoneda) over the date poset

In the *discrete* show category the Yoneda embedding collapses to an equality indicator and is a near-tautology. The non-degenerate statement lives over the **Date poset**. For a fixed date d the covariant representable $\mathrm{Hom}(d, -)$ sends each date e to a singleton when $d \le e$ and to $\emptyset$ otherwise. A natural transformation $\mathrm{Hom}(d, -) \Rightarrow F_{\mathrm{setlist}}$ assigns the arrow $d \to e$ an element of $F_{\mathrm{setlist}}(e)$, and naturality with the inclusion legs forces a single element that must lie in $F_{\mathrm{setlist}}(e)$ for *every* $e \ge d$. Because the setlist functor is monotone, that condition holds exactly for the elements of $F_{\mathrm{setlist}}(d)$, giving the Yoneda bijection $\mathrm{Nat}(\mathrm{Hom}(d, -), F_{\mathrm{setlist}}) \cong F_{\mathrm{setlist}}(d)$: *the songs played by date d are the natural transformations into the setlist functor.* `cattheory/yoneda.py::yoneda_lemma_holds_for_setlist` checks this on the corpus, and `count_yoneda_naturals` has a negative control — on a non-monotone functor an element that later drops out is correctly rejected and the bijection fails.

4.10 What the construction buys

The payoff is that **the question "what songs were played when, by whom?"** decomposes as a fibered relation in the compendium category: the span projections commute with the cumulative setlist functor, and the fiber over a fixed show date gives back exactly that show's setlist for exactly that lineup. This is not asserted but *checked* — `cattheory/spans.py::projections_commute_with_setlist_functor` verifies, over the whole corpus, that the union of show-fibers up to each date equals the setlist functor's value there. The compendium primitive is the apex of the span, not a derived join — which is what the categorical reading makes explicit, and what allows seamless extension to any other performance corpus with the same shape.

5 Results on the compendium

All numbers in this section are computed at build time from the committed archival snapshot (`data/archival/`). Descriptive statistics and category-theoretic checks are serialized to `output/reports/analysis_report.json` and `output/reports/category_theory_report.json`; claim boundaries are serialized to `output/reports/first_principles_review.json`; referential completeness is certified by `output/reports/completeness_report.json` (zero dangling references on hard relations; 3341 shows with 40757 performance rows; venue geo coverage at archival scale); and every rendered figure is validated for existence and non-degeneracy in `output/reports/figure_validation.json`. Figures are generated by the registry in `src/viz/figures.py` and orchestrated through `scripts/04_figures.py`, `05_extended_figures.py`, `08_more_figures.py`, `06_mosaic.py`, and `10_alluvial.py`. Figure titles, alt-text hints, dashboard labels, caption metadata, and validation filenames are centralized in the same registry so the prose-facing visual documentation and the executable render target do not drift apart. The manuscript captions below use a common evidence pattern: data source, statistic, exclusion rule, and claim class.

5.1 Scope and completeness

The active build spans **3341 ingested shows** from 1965-05-05 through 1995-07-09 (3341 ingested shows (gdshowsdb + truckin gap-fill; community literature estimates about 2318 canonical concerts), 645 songs, 912 venues, 40757 performance rows; community literature cites about 2318 canonical concerts). The completeness audit confirms: every show resolves to a venue; every performance row resolves to a song; every venue in the compendium has geo coordinates; and no review, recording, or citation row dangles on hard relations. Importantly, `is_complete` is a *referential* claim — zero unresolved references on those hard relations — and explicitly NOT a claim that every show has a setlist: 282 of the 3341 catalogued shows have an empty setlist in gdshowsdb. These are surfaced as a pinned count (`n_shows_without_performances` in the report, bound by a ground-truth test) and reported as scope, not folded into the completeness gate. The completeness claims describe the ingested snapshot; they are not a claim that every optional layer (reviews, lyric text, exhaustive segue markup) is exhaustive.

5.2 Top-line counts

Layer	Count	Notes
Personnel	14	Intervals span 1965–1995 (curated)
Songs	645	Composer/lyricist attribution where known
Lyric pointers	548	URL metadata only (no lyric text)
Venues	912	Geo sidecar at 100% venue coverage
Shows	3341	gdshowsdb catalog; some setlists empty
Performances	40757	Ordered set/position rows
Recordings	7122	Internet Archive + curated rows
Releases	259	Wikipedia discography merge at archival tier
Reviews	1888	maximinus corpus + curated exemplar rows
Citations	139	Bibliography markdown + references.bib

The per-year distribution covers the band's entire active career; venue concentration in the Bay Area and major halls reflects the underlying gdshowsdb catalog rather than a hand-picked slice. Recording and archive rows should be read in the context of the Dead's mixed institutional/community record: UCSC preserves the formal archive, while the Internet Archive and taping/trading culture preserve circulating performance metadata [University of California, Santa Cruz University Library, 2025, Internet Archive Help Center, 2018, Meriwether, 2015, Wallace, 2009].

5.3 Statistical shape and concentration

The compendium is highly skewed, so the manuscript reports medians, percentiles, and concentration measures alongside top-line means. Figure 1 shows performance rows per show, including the 282 empty-setlist shows already surfaced by the completeness audit. The median show carries 17 performance rows, the mean is 12.2, the 90th percentile is 24, and the maximum observed row count is 37. These are setlist-row counts, not audio durations or claims about musical density.

Figure 2 makes the repertoire skew explicit. Generic segment markers are excluded, matching the top-song ranking. The song-performance Gini coefficient is 0.74; the top decile of songs accounts for 50.61% of non-segment performance

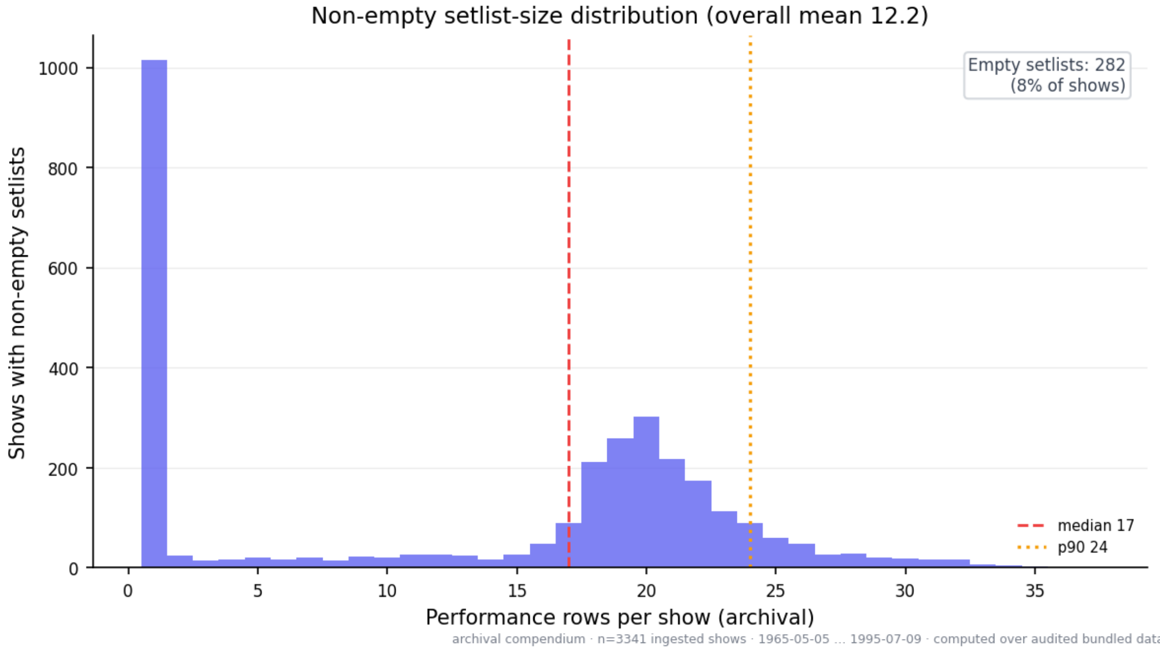


Figure 1: Distribution of performance rows per show in the archival compendium, including empty setlists. Data source: bundled show/performance tables. Statistic: non-empty show-level histogram with overall median and 90th percentile reference lines. Exclusion rule: empty setlists are not binned but are counted in the callout and raw CSV/JSON export. Claim class: descriptive.

rows. The first 44 ranked songs (9.89% of ranked songs) account for half of those rows, and the first 93 songs (20.9%) account for 80%. This is a descriptive Pareto view of rotation intensity, not a claim that the remaining catalogue was unimportant.

Figure 3 checks whether the top-song cutoff changes the repertoire story. The exported rows compare top-N cuts 25, 50, 100, 200 over the same non-segment performance table; the largest displayed cut, N=200, accounts for 97.32% of non-segment performance rows. The era band shows that top-song coverage is not uniform across periods, so the top-song panels are summaries of the visible rotation rather than a complete description of each era.

Figure 4 applies the same concentration lens to venues. The venue-show Gini coefficient is 0.59, with the top decile of venue slugs accounting for 51.81% of show rows. The first 84 ranked venues (9.21% of venue slugs) account for half of the show rows, while 345 venues (37.83%) account for 80%. Because venue slugs remain source-derived and conservative aliasing is reported separately, this figure should be read as concentration over the bundled venue table, not as a fully disambiguated venue-history census.

Figure 5 adds the bootstrap layer behind these concentration claims. For song-performance concentration, the Gini point estimate 0.738 has a fixed-seed 95% interval [0.713, 0.759], and the song top-decile share estimate 50.61% has interval [45.947, 55.041]%. For venue-show concentration, the Gini interval is [0.555, 0.617], and the venue top-decile share interval is [47.693, 55.282]%. These intervals are item-level resampling diagnostics for the observed archive, not uncertainty about an unobserved causal data-generating process.

The exploratory repertoire layer asks a different question: if each top song is represented by its era-by-era performance-count profile, what structure is visible without adding audio features, lyric text, or causal claims? Figure 6 embeds the top 80 non-segment songs into two centered SVD components, retaining 48.11% and 28.91% of the log-profile variance in the first two displayed components, then assigns 5 deterministic clusters. The cluster summary is intentionally compact: C0: 10 songs, Brent dominant; C1: 16 songs, Brent dominant; C2: 13 songs, Brent dominant; C3: 15 songs, Brent dominant; C4: 26 songs, Brent dominant. This should be read as a diagnostic map of era-weighted profiles, not as a discovered set of song genres.

Figure 7 gives the matrix view behind the embedding. Each cell is the share of that era's non-segment performance rows assigned to the song, so vertical comparisons within an era are meaningful; raw row counts remain available in `output/data/figures/`. This heatmap is the more conservative companion to the SVD scatter because it exposes

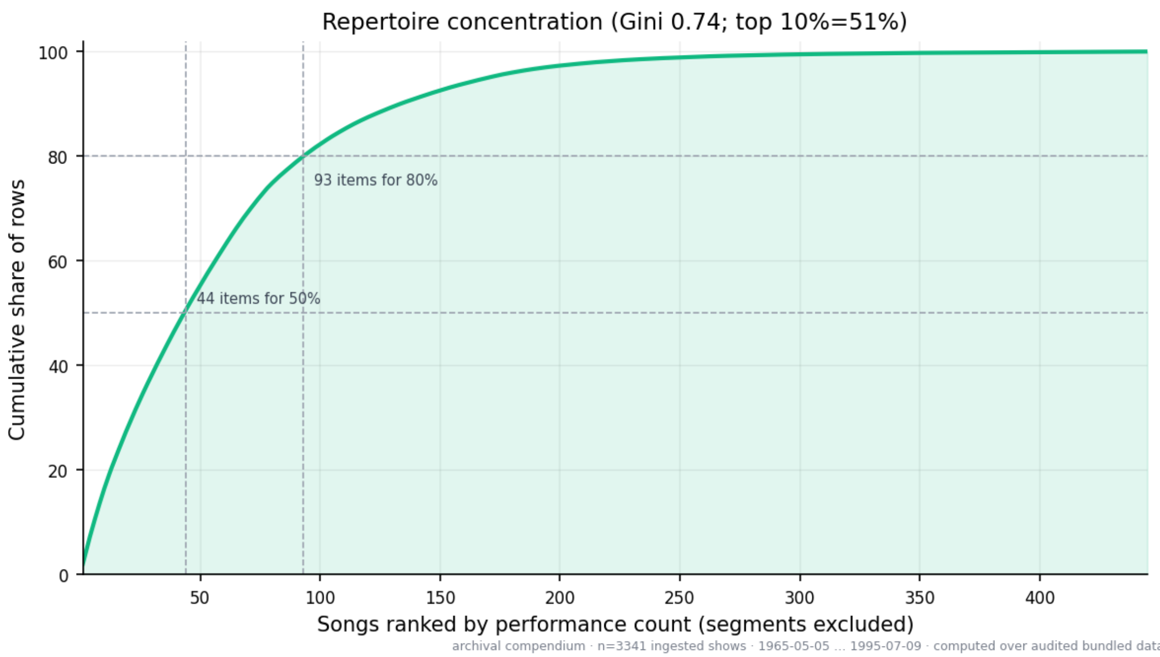


Figure 2: Repertoire concentration: cumulative share of non-segment performance rows by ranked song. Data source: bundled performance rows. Statistic: cumulative share with 50%/80% coverage guides, Gini, and top-decile share. Exclusion rule: generic segment markers are excluded. Claim class: descriptive.

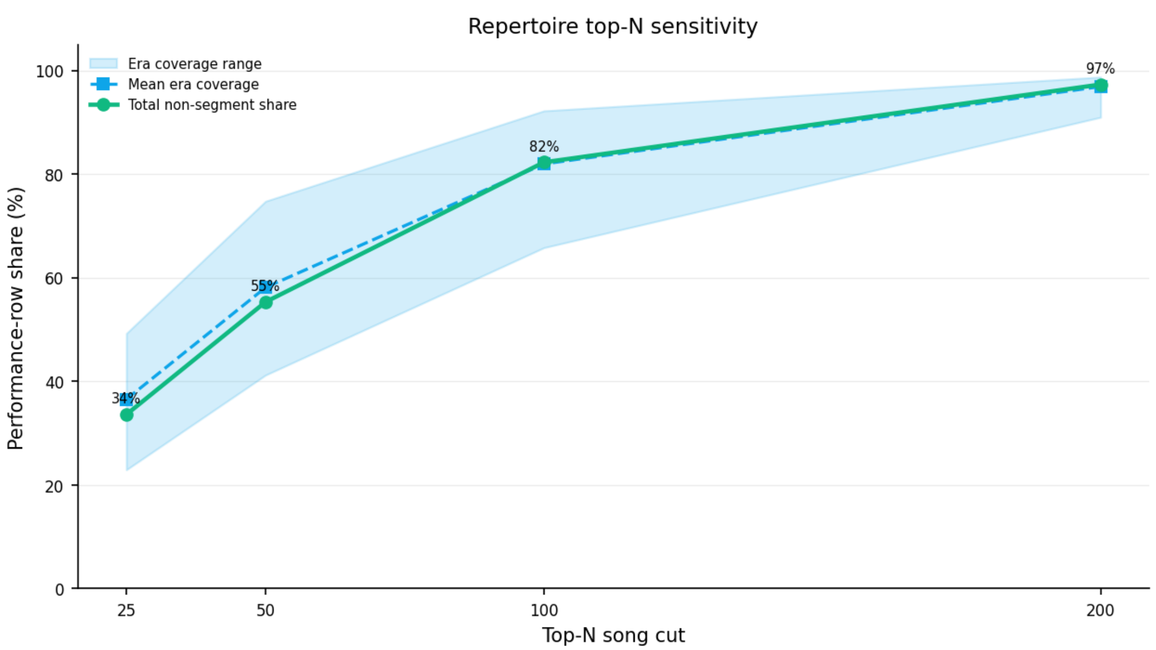


Figure 3: Repertoire top-N sensitivity. Data source: bundled performance rows and era labels. Statistic: selected top-N performance share plus minimum, mean, and maximum era-level coverage. Exclusion rule: generic segment markers are excluded. Claim class: exploratory sensitivity diagnostic.

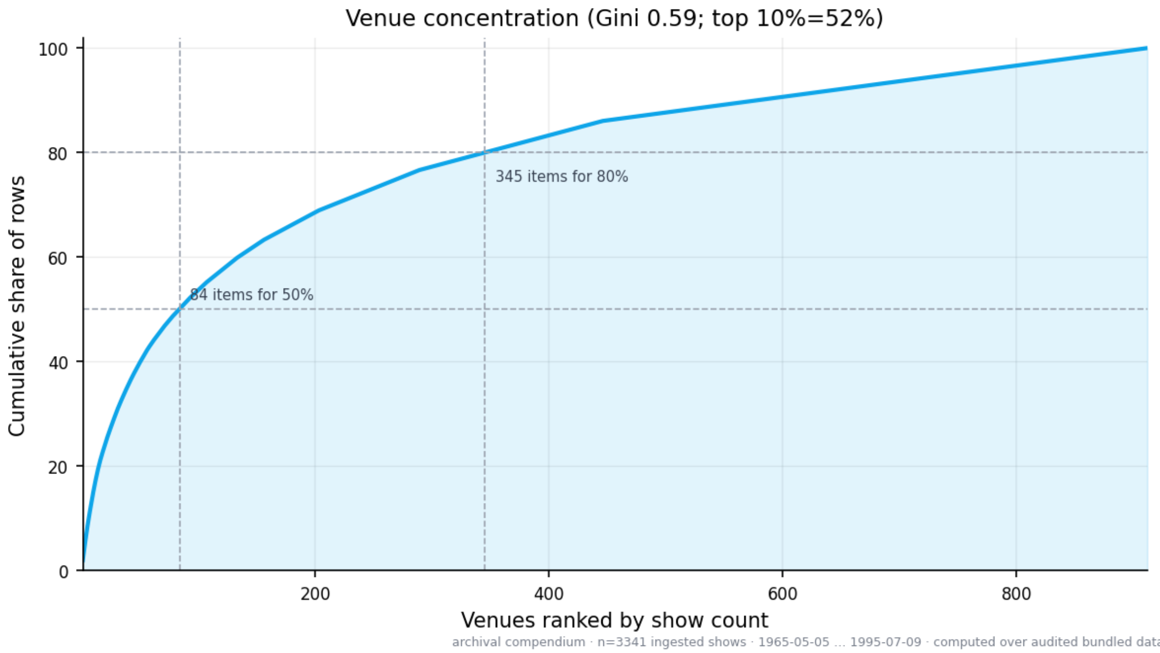


Figure 4: Venue concentration: cumulative share of show rows by ranked venue slug. Data source: bundled show and venue tables. Statistic: cumulative show share with concentration thresholds, Gini, and top-decile share. Exclusion rule: source-derived venue slugs are retained; the venue identity review is report-only. Claim class: descriptive concentration diagnostic.

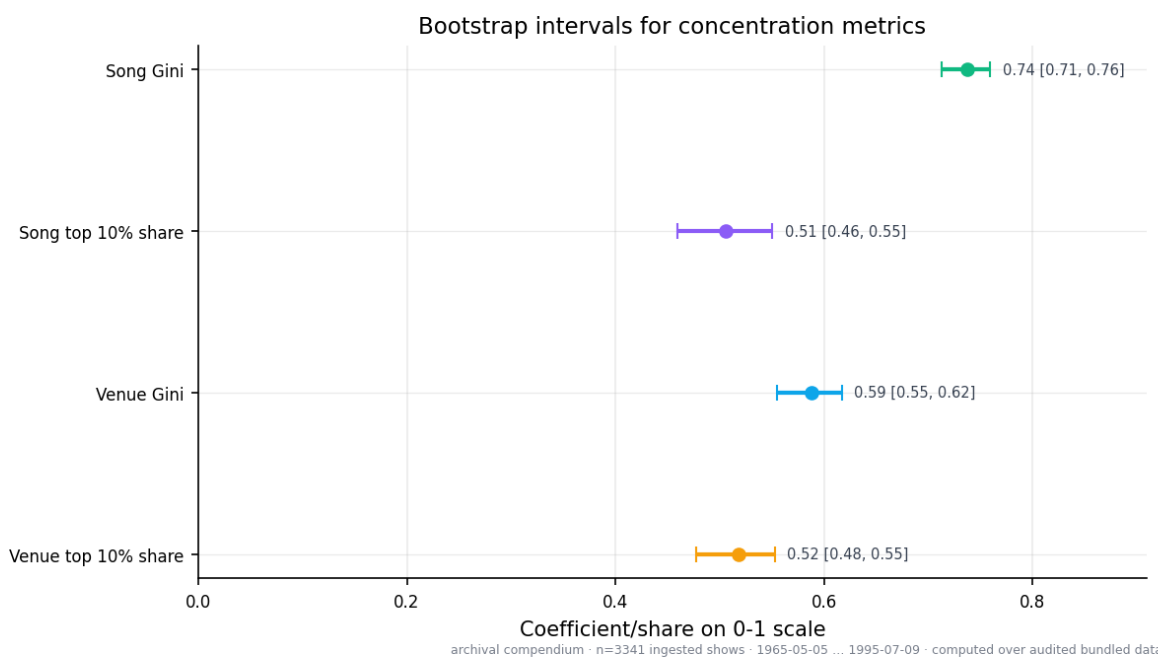


Figure 5: Concentration uncertainty: fixed-seed item-level bootstrap intervals for repertoire and venue concentration statistics. Data source: bundled song-performance and venue-show count vectors. Statistic: 95% item-level bootstrap intervals for Gini and top-decile share. Exclusion rule: song rows exclude generic segment markers; venue rows use source-derived venue slugs. Claim class: exploratory uncertainty diagnostic, not a causal model.

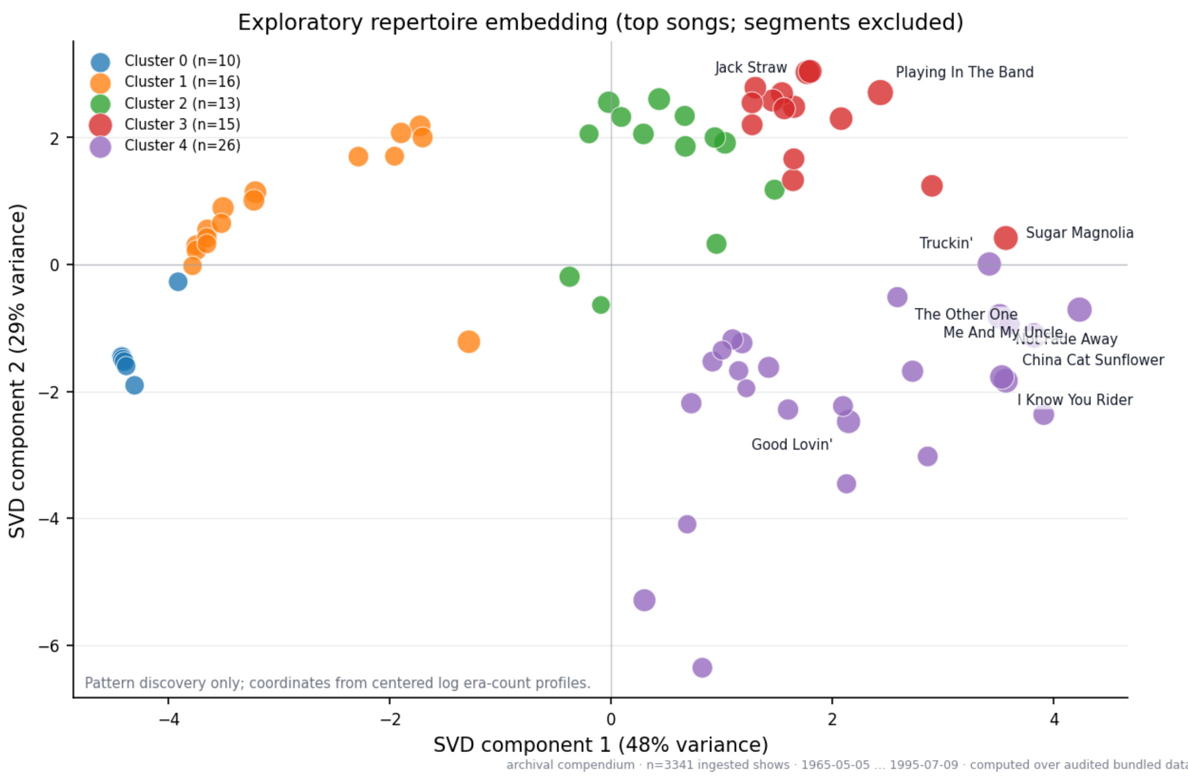


Figure 6: Exploratory repertoire embedding: top non-segment songs are embedded from log era-by-song performance counts using centered SVD, then colored by a deterministic k-means-style cluster assignment. Data source: bundled performance rows and era labels. Statistic: SVD coordinates and deterministic clusters. Exclusion rule: generic segment markers are excluded. Claim class: exploratory pattern-discovery.

the normalization directly.

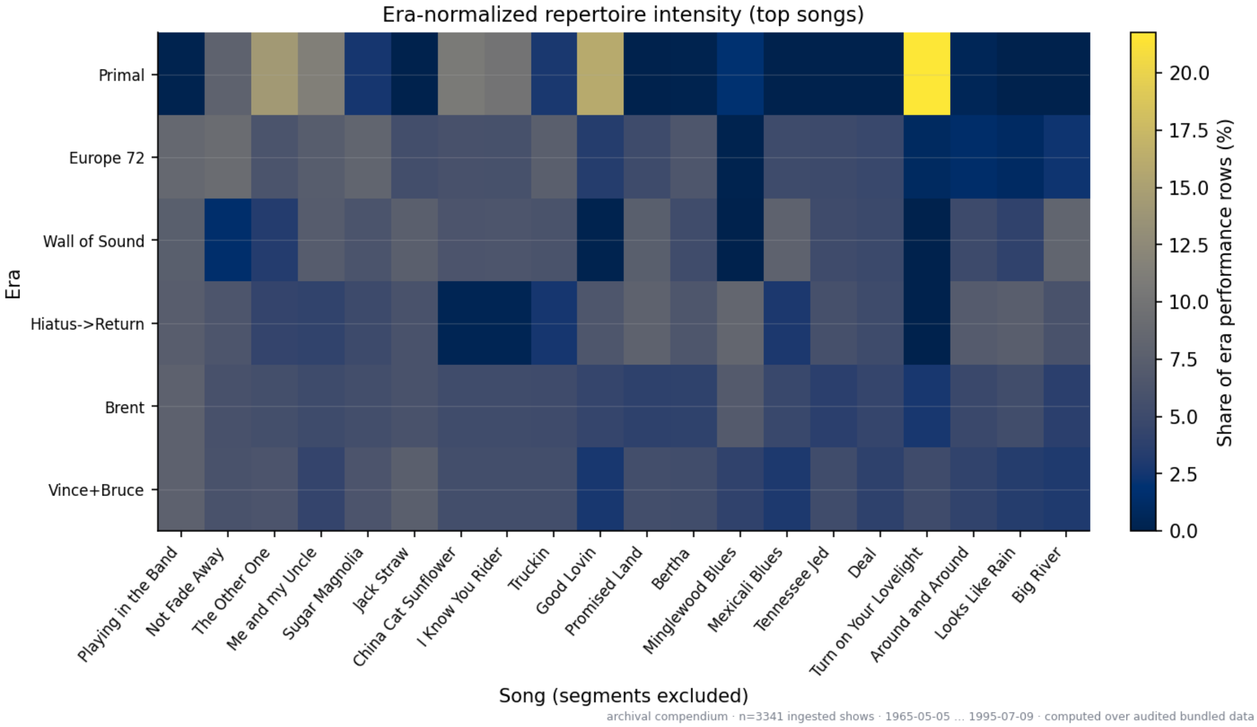


Figure 7: Era repertoire heatmap: era-normalized performance-row share for the top non-segment songs. Data source: bundled performance rows and era labels. Statistic: within-era performance-row share. Exclusion rule: generic segment markers are excluded. Claim class: exploratory matrix diagnostic.

5.4 Temporal activity

Figure 8 plots the dual-axis career arc: distinct shows per calendar year (bars) and total performance rows (line). The shape matches the familiar three-act narrative in the standard references [wik, b, bri, University of California, Santa Cruz University Library, 2025]: rapid build-out in 1969–1972, mid-70s consolidation, and sustained late-period touring with peaks in 1977 and 1989–1990.

Figure 9 adds a deliberately separate contextual overlay. The bars are the same computed show counts; the labels are cited historical waypoints from the source dossier: formation and Acid Test context, the live-recording turn around *Live/Dead*, the 1970 studio-songwriting pivot, the 1974 Wall of Sound, the formal taper-section era, the late-1980s mainstream breakthrough, and the 1995 endpoint [Grateful Dead, Weir, 2011, Smithsonian Institution, 2024, McIntosh Laboratory, 2025, Meriwether, 2015, Brackett, 2023, Highways, 2020, Encyclopaedia Britannica]. The labels are not ingested rows and do not affect the counts.

5.5 Repertoire frequency and co-occurrence

`playing_in_the_band'' leads the archival compendium with 752 performance rows, followed by`not_fade_away'' (666) and "the_other_one'' (664). Figure 10 ranks the top 15; the ordering aligns qualitatively with community aggregates [gra, red, c].

This ranking is a *repertoire* ranking: it deliberately excludes the generic structural segments `drums'',`space'', `jam'',`tuning'', and `feedback'', which are not compositions but recurring set segments. Counted as raw slugs they would dominate the corpus -`drums'' and `space'' are in fact the two highest-count performance slugs overall - so including them would make the headline ranking true-of-the-data but misleading-as-music. Their counts are reported separately rather than discarded (see`src/analysis/markers.p the`segment_marker_counts`field of`analysis_report.json`); named improvisational pieces such as`Spanish Jam'' are catalogued songs and are *not* treated as generic markers. Of the 645 catalogued songs, 445 enter the

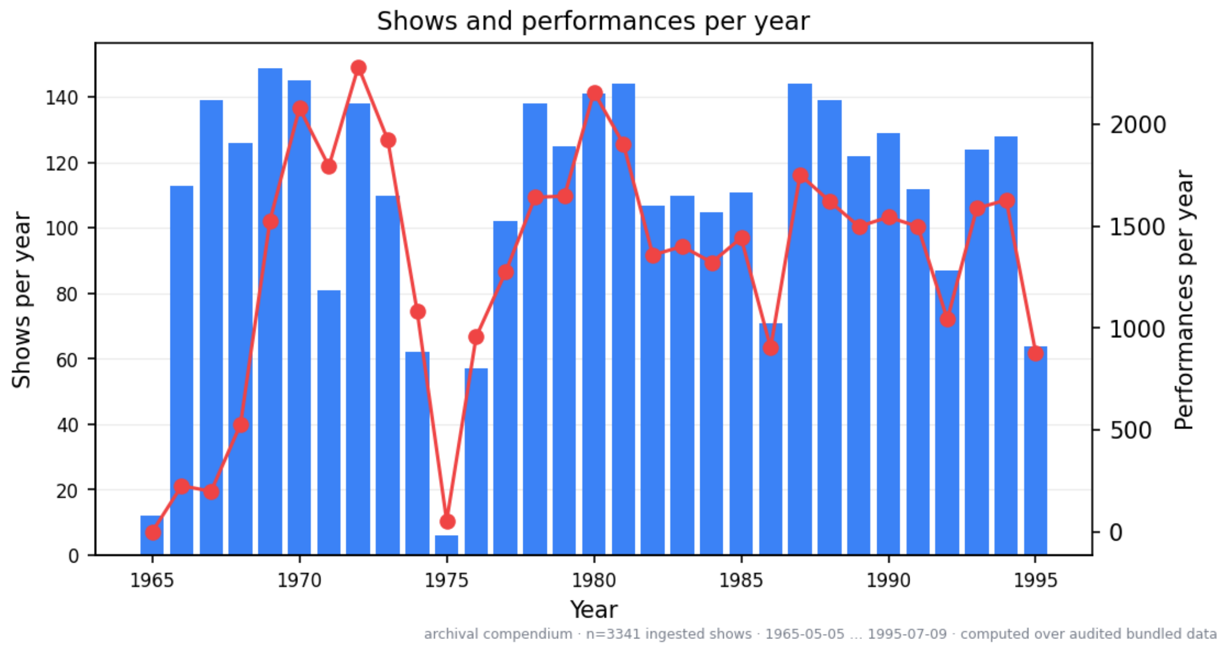


Figure 8: Temporal activity in the archival compendium (n=3341 shows). Data source: bundled show and performance tables. Statistic: bars count distinct concerts per calendar year; the line counts total performance rows (setlist entries). Exclusion rule: no shows are dropped; empty-setlist shows contribute to show counts but not performance-row totals. Claim class: descriptive temporal summary.

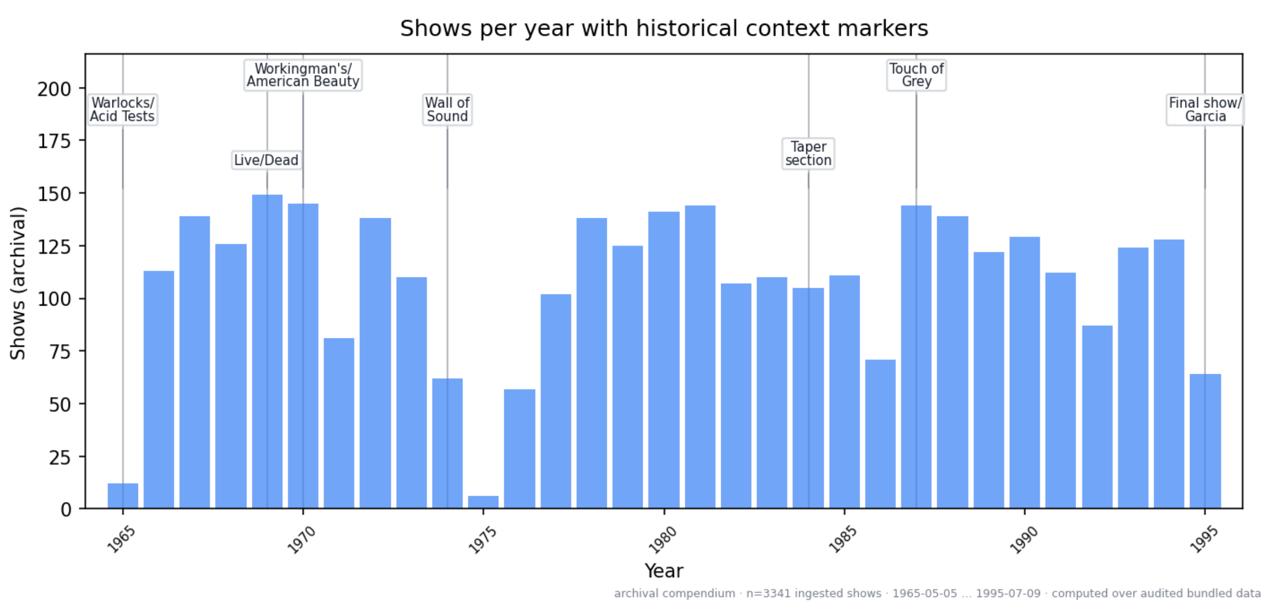


Figure 9: Shows per year with cited historical context markers. Data source: bundled show table plus checked contextual sources. Statistic: annual show counts with selected labelled historical waypoints. Exclusion rule: context labels are interpretive overlays and are not ingested rows. Claim class: descriptive chronology with contextual annotation.

performance record (69.42% catalogue coverage) and 196 are catalogued but never performed in the ingested snapshot.

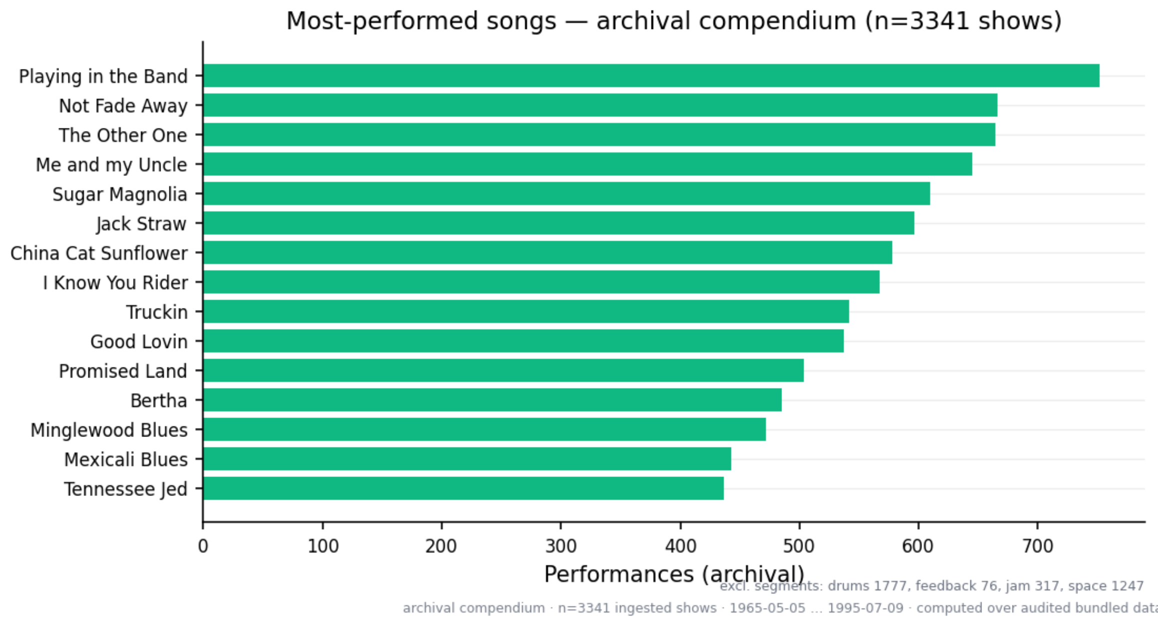


Figure 10: Most-performed songs in the archival compendium. Data source: bundled performance rows. Statistic: top-15 performance counts. Exclusion rule: generic segment markers are excluded and surfaced separately in “analysis$_r$*eport.json* :: *segment*$_m$*arker*$_c$*ounts*‟.*Claimclass* : *descriptive*.

Figure 11 restricts the song–song co-occurrence matrix to the 25 most-played titles. High off-diagonal mass marks pairs that share shows frequently — including segue-adjacent pairs such as `Scarlet Begonias'' /Fire on the` Mountain’’ when both appear in the same setlist block. This is a setlist-level relation; audio-level similarity and boundary estimation remain outside scope and would require the kind of signal pipeline described in MIR setlist-segmentation work [Wang et al., 2014].

5.6 Markov structure of setlist order

A first-order Markov model fit on within-show song order (see `src/analysis/transitions.py`) yields the sub-block in Figure 12. The manuscript-ready matrix excludes generic segment markers so the main panel is a song-to-song repertoire view; the sensitivity panel below reports what changes when markers are included. Chains such as `Help on the Way'' $\to$`Slipknot!’’ → “Franklin’s Tower’’ appear as high-probability transitions when those titles co-occur in the compendium setlists.

Figure 13 gives the support-threshold audit for the transition surface. It uses the deterministic report rows in `analysis_report.json::transition_sensitivity` and evaluates predecessor support thresholds 1, 5, 10, 20, 50 with markers included and excluded. This is the guardrail against treating one-observation probabilities as stable structure.

The stationary distribution (Figure 14) and association centrality (Figure 15) provide complementary views: the former summarizes long-run Markov mass; the latter weights songs that bridge many co-occurring pairs in the show graph. Centrality is computed on the *Jaccard-association* adjacency rather than the raw co-occurrence counts. This is a deliberate modeling choice, not a uniquely correct one: on raw counts, eigenvector centrality largely re-derives raw play frequency (a song played in hundreds of shows co-occurs with almost everything), so the association normalization reduces that volume bias and surfaces songs that bridge many pairs rather than songs that were simply played often.

5.7 Category-theoretic cardinalities

Figure 16 plots cumulative setlist and lineup functor cardinalities $|F_{\text{setlist}}(d)|$ and $|F_{\text{lineup}}(d)|$ along the chronological show index. Both are monotone non-decreasing on the compendium tier, as required. The active-roster presheaf

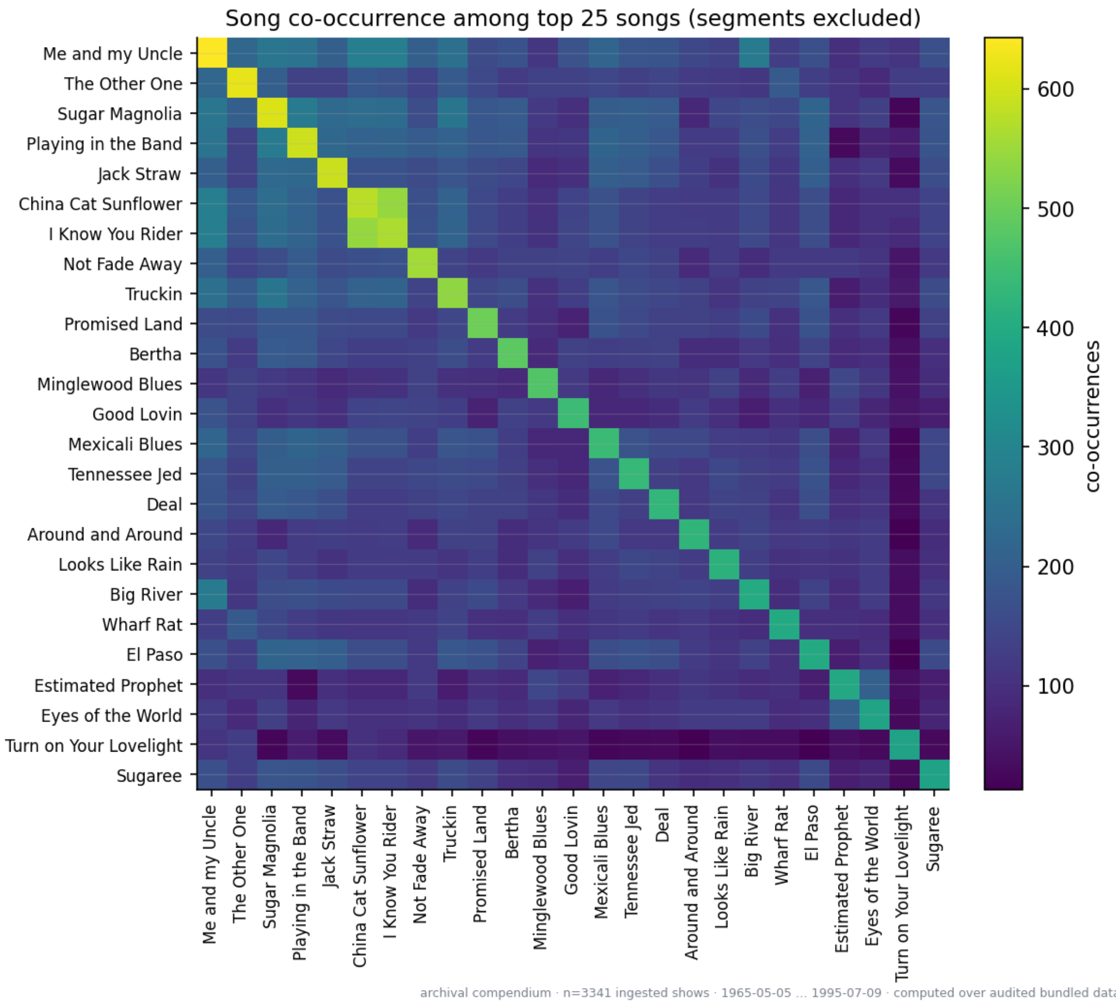


Figure 11: Co-occurrence heatmap among the 25 most-performed non-segment songs. Data source: bundled show/performance rows. Statistic: cell (i, j) counts shows in which both songs appear; diagonal entries are per-song show counts. Exclusion rule: generic segment markers are excluded. Claim class: descriptive association summary.

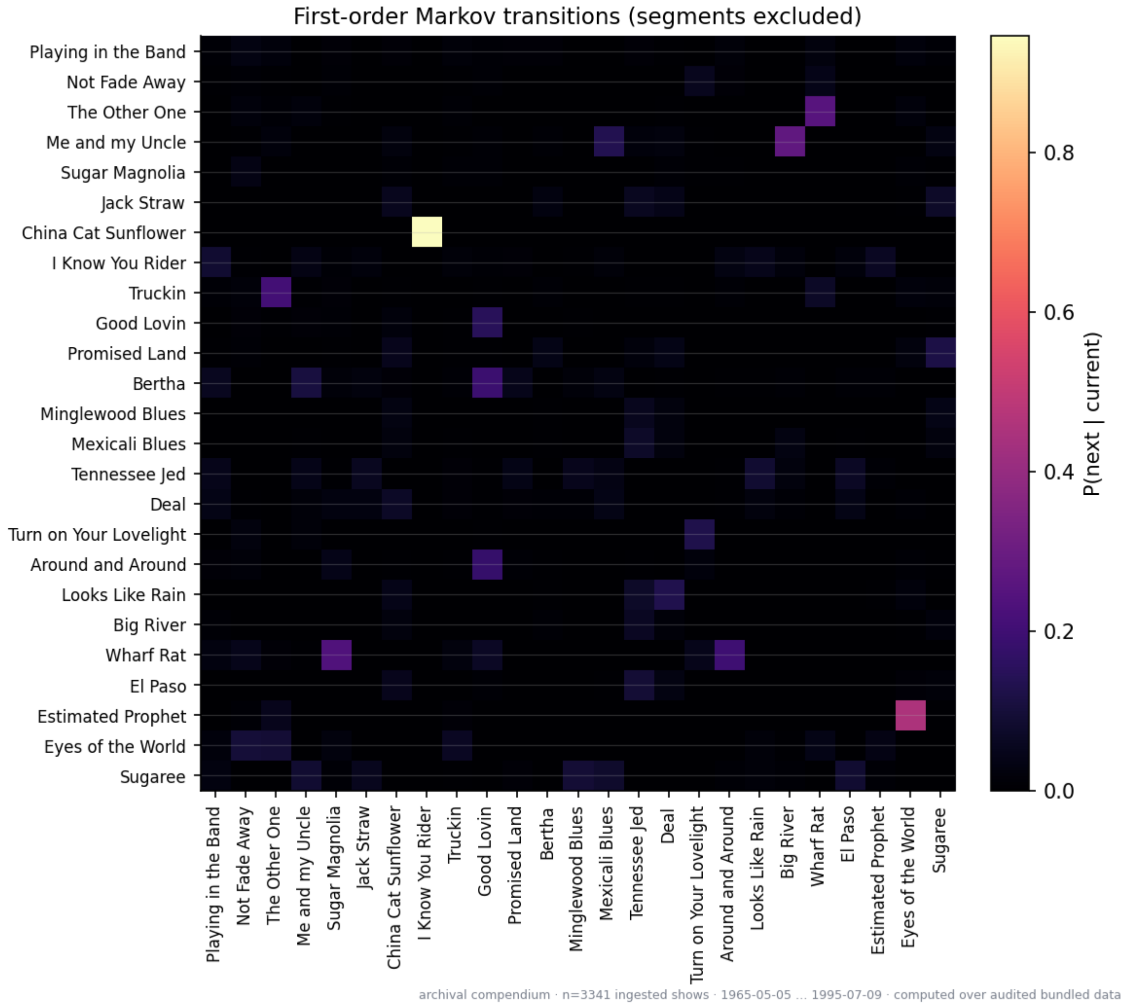


Figure 12: Estimated first-order transition probabilities among the top 25 non-segment songs by performance count. Data source: ordered bundled performance rows. Statistic: row-stochastic successor probability over observed within-show order. Exclusion rule: generic segment markers are excluded here and compared in Figure 13. Claim class: exploratory descriptive model.

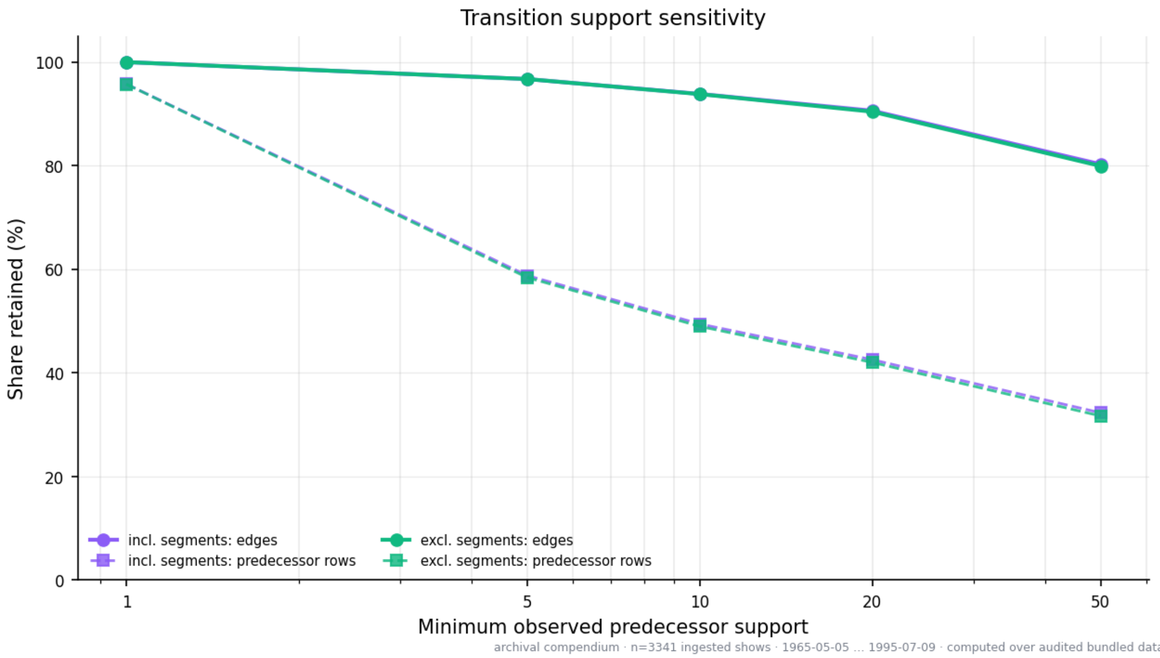


Figure 13: Transition sensitivity. Data source: ordered bundled performance rows and the segment-marker policy. Statistic: share of nonzero transition edges and predecessor rows retained as the minimum predecessor-support threshold increases. Exclusion rule: the panel explicitly compares markers included versus excluded. Claim class: exploratory sensitivity diagnostic.

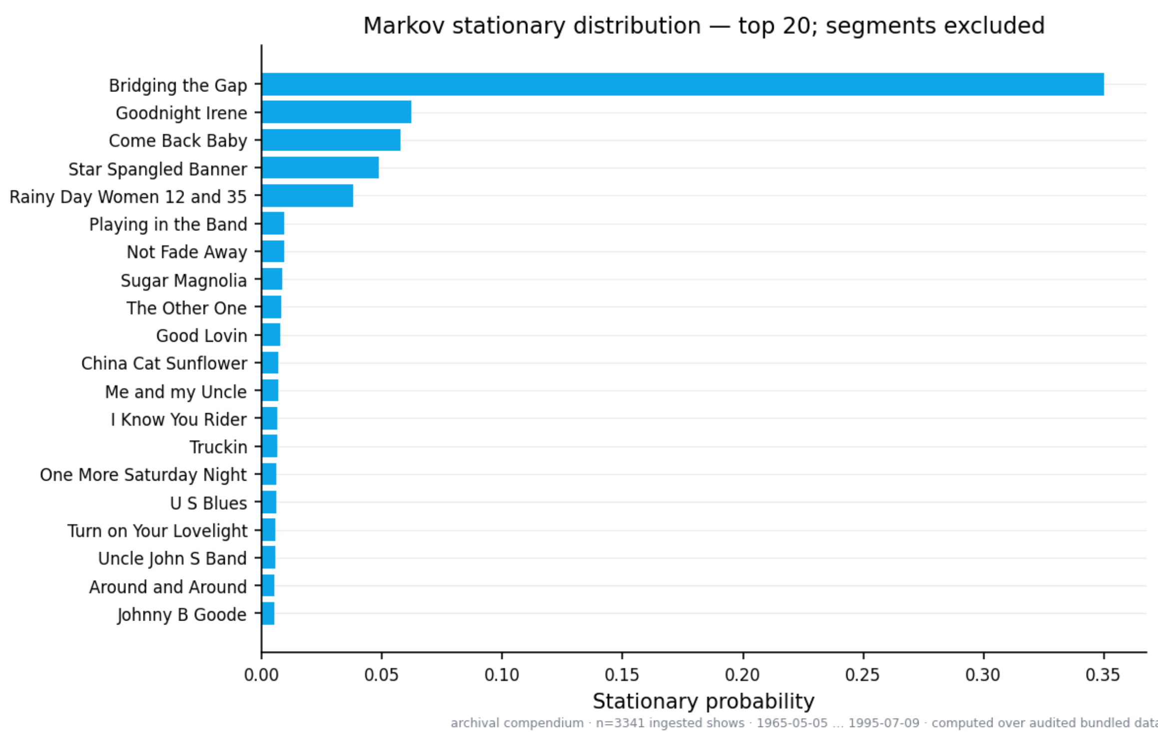


Figure 14: Top 20 non-segment songs by stationary probability under the compendium Markov model. Data source: ordered bundled performance rows. Statistic: stationary mass of the row-stochastic first-order transition matrix. Exclusion rule: generic segment markers are excluded. Claim class: exploratory model summary.

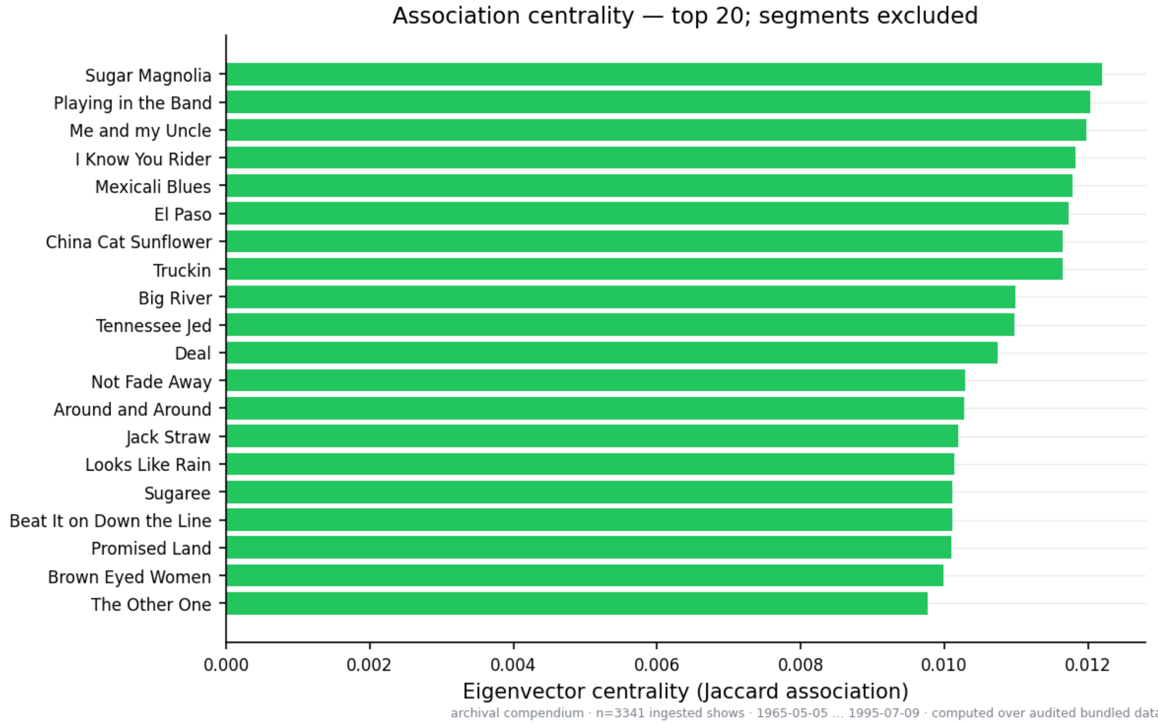


Figure 15: Top 20 non-segment songs by association centrality. Data source: show-level song co-occurrence. Statistic: eigenvector centrality on the Jaccard-association adjacency, reducing raw play-frequency bias. Exclusion rule: generic segment markers are excluded. Claim class: exploratory association summary.

P_{active} (not shown in this single panel) is intentionally non-monotone: Pigpen's 1972 departure [ucr, dea] and Brent Mydland's 1990 death produce expected dips in instantaneous roster size while cumulative lineup size continues to grow.

The category-theory report records 40757 performance spans, cumulative setlist cardinality 449 at the terminal date, cumulative lineup cardinality 14, and passing `Category.check_laws` for both **Date** and **Show**.

5.8 Composers, eras, and personnel

Figure 17 contrasts songs-written counts with performance-weighted attribution, exposing the familiar asymmetry between prolific Garcia/Hunter writing and high-performance-weight Weir/Barlow closers. Figure 18 shows show density by year and month; Figure 19 is a Gantt chart of the 15 personnel intervals in the current build.

Figure 20 aggregates shows into the six era windows used throughout `src/analysis/eras.py`; Figure 21 tracks active lineup size over time.

5.9 Reception, citations, and recordings

The archival compendium bundles 1888 show-level reviews (including the maximinus corpus at archival tier plus 12 curated exemplar rows); Figure 22 reports mean sentiment by kind. Figure 23 and Figure 24 summarize the 139 bibliographic citations and 7122 Internet Archive recording rows. The added citation mass is intentionally weighted toward archival, scholarly, official, and publisher-controlled sources – not fan lore – so the paper's cultural claims have a different evidence path from its show/performance rows [Brackett, 2023, Dodd and Weiner, 1997, Adams and Sardiello, 2000, John F. Kennedy Center for the Performing Arts, 2024, Rock and Roll Hall of Fame, 1994, Recording Academy, 2007].

5.10 Lyric pointers and segues

Lyric *text* is deliberately absent; Figure 25 counts theme tags attached to the 548 lyric pointers (CMU lyrics index, curated overlay, and dead.net gap-fill URLs). 80 pointers carry an attributed lyricist; 0 performed songs lack any pointer

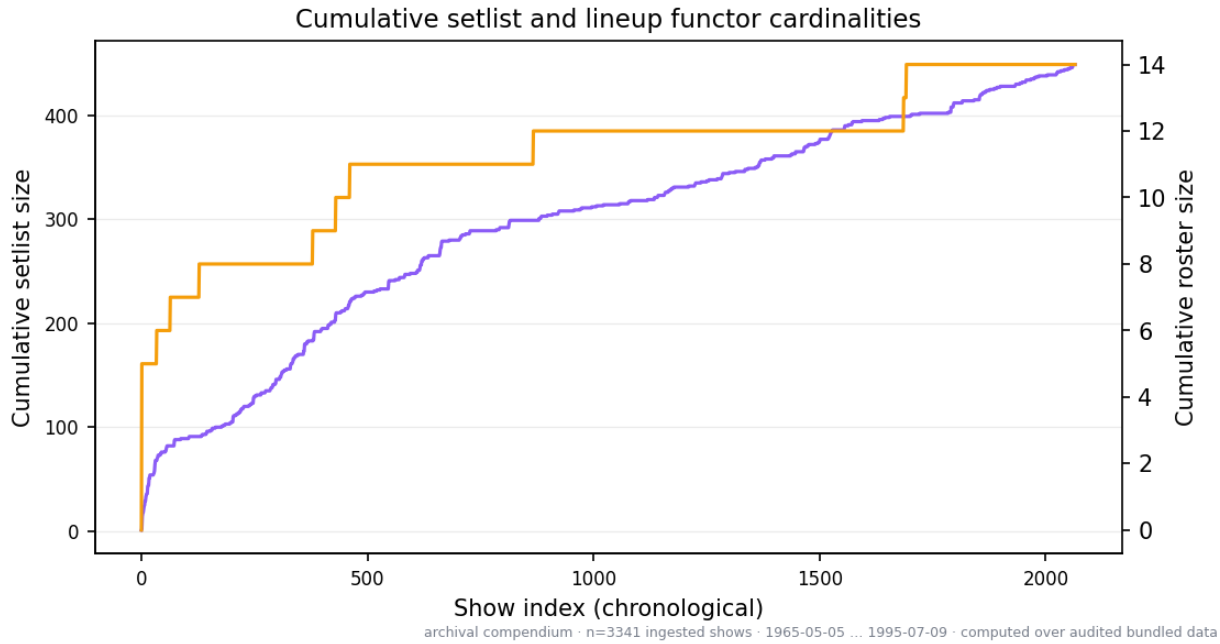


Figure 16: Cumulative setlist size (purple, left axis) and cumulative lineup roster size (amber, right axis) along the chronological show timeline. Data source: bundled ordered performances and curated personnel intervals. Statistic: cumulative set cardinalities for the setlist and lineup functors. Exclusion rule: cumulative functor construction includes all loaded performances and personnel intervals; no segment-marker filtering is applied. Claim class: validation, with machine-checked verdicts in `output/reports/category_theory_report.json`.

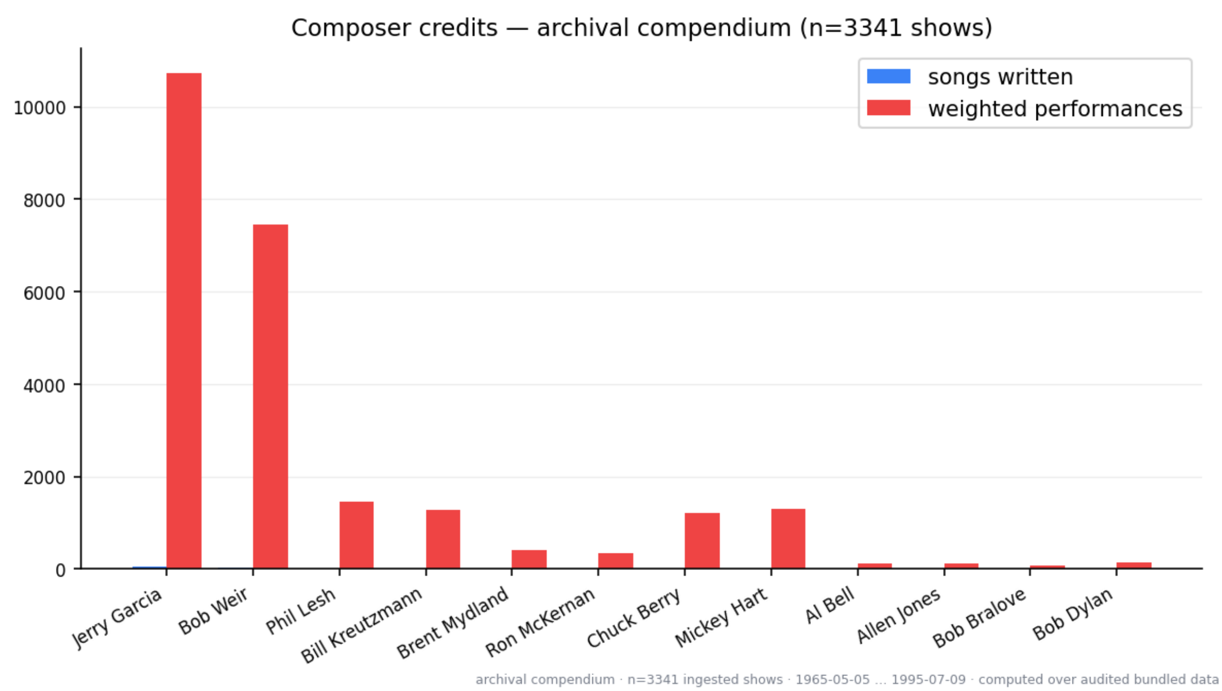


Figure 17: Composer attribution for the top 12 credited writers in the archival compendium. Data source: bundled song composer fields joined to performance rows. Statistic: songs written versus performance-weighted composer attribution. Exclusion rule: songs without composer metadata do not contribute composer-credit rows; no lyric or audio content is bundled. Claim class: descriptive attribution summary.

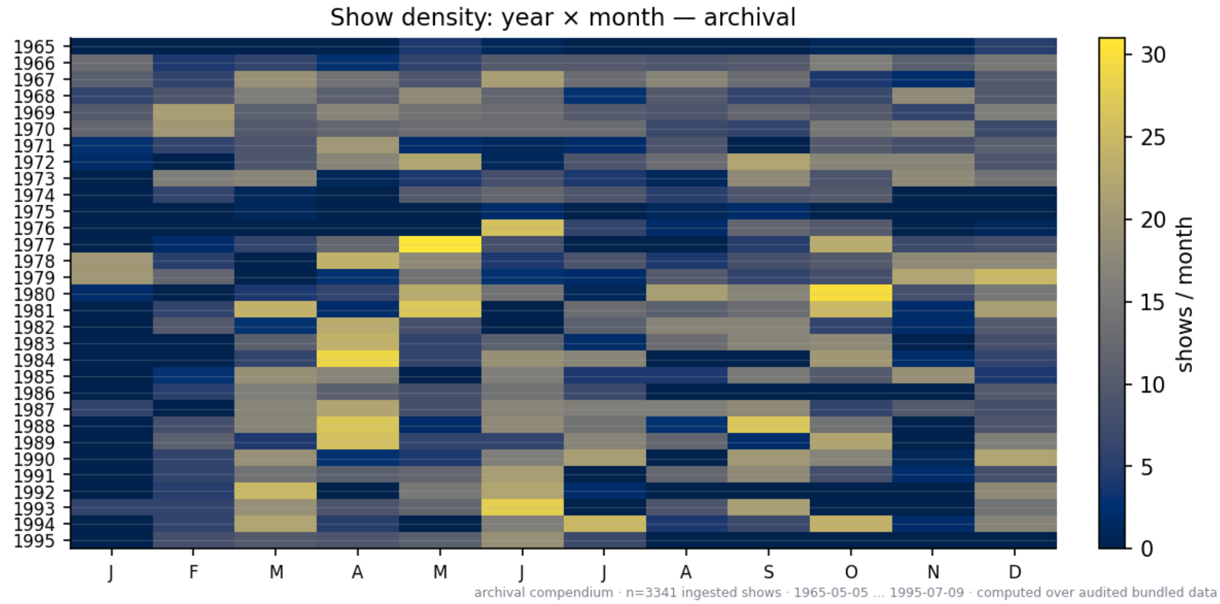


Figure 18: Show density by calendar year and month. Data source: bundled show dates. Statistic: 294 year-month show-count cells. Exclusion rule: no shows are dropped; empty-setlist shows still count as shows. Claim class: descriptive calendar-density summary.

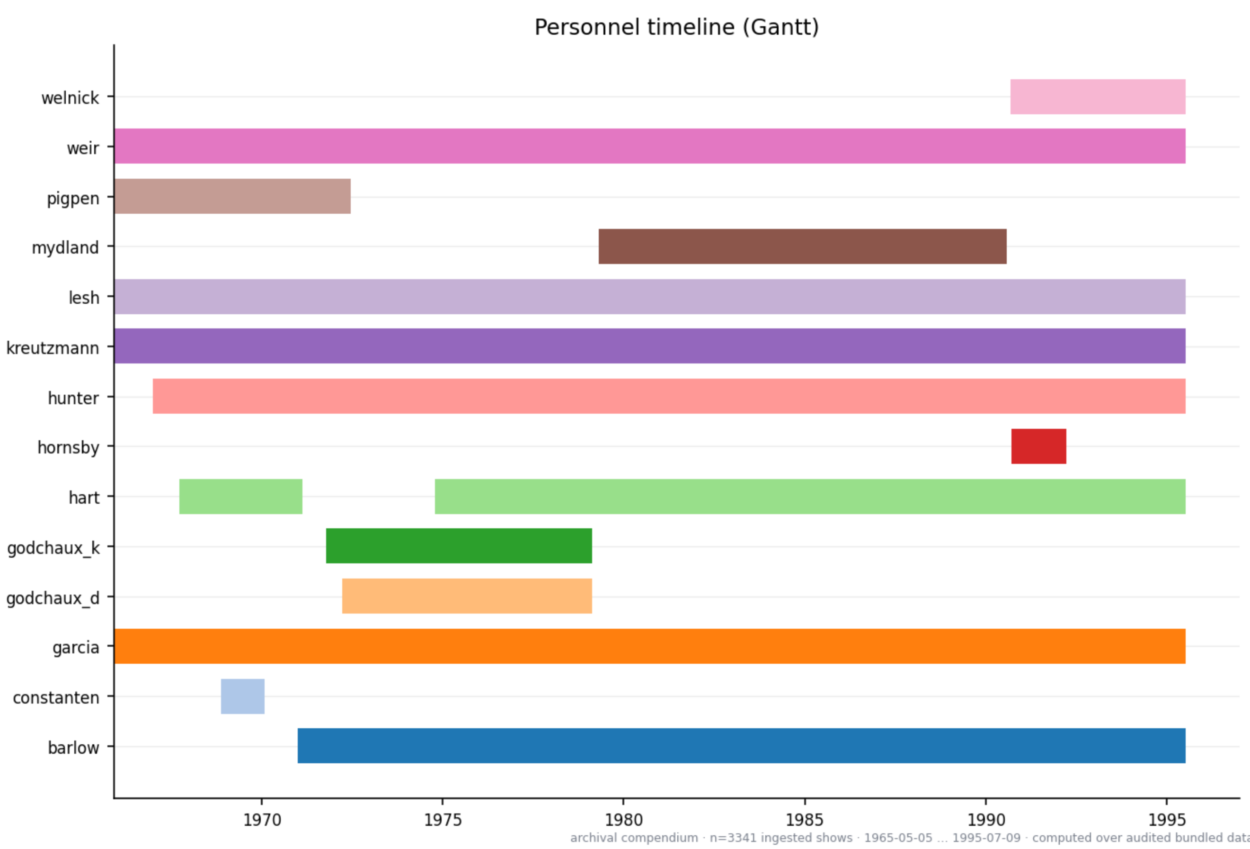


Figure 19: Personnel timeline. Data source: curated personnel interval table. Statistic: 15 membership/role intervals displayed as horizontal date ranges. Exclusion rule: only explicit interval metadata is plotted; inferred guest appearances are outside scope. Claim class: descriptive provenance-backed roster summary.

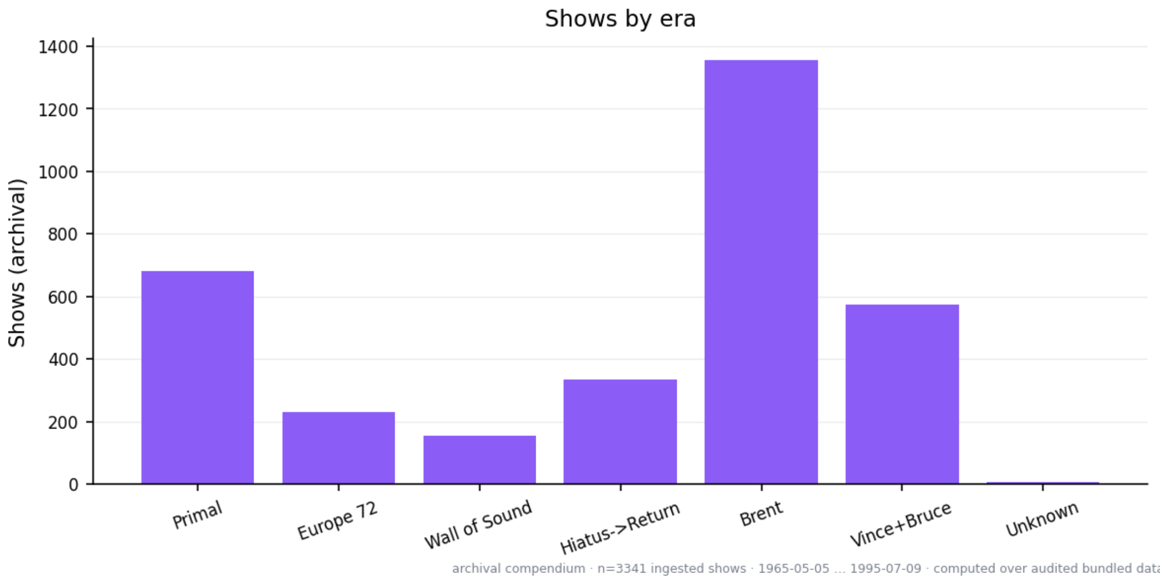


Figure 20: Shows per era label in the archival compendium. Data source: bundled show dates and deterministic era windows. Statistic: show counts across 7 era buckets. Exclusion rule: no shows are dropped; era labels are analytical bins rather than source claims. Claim class: descriptive era aggregation.

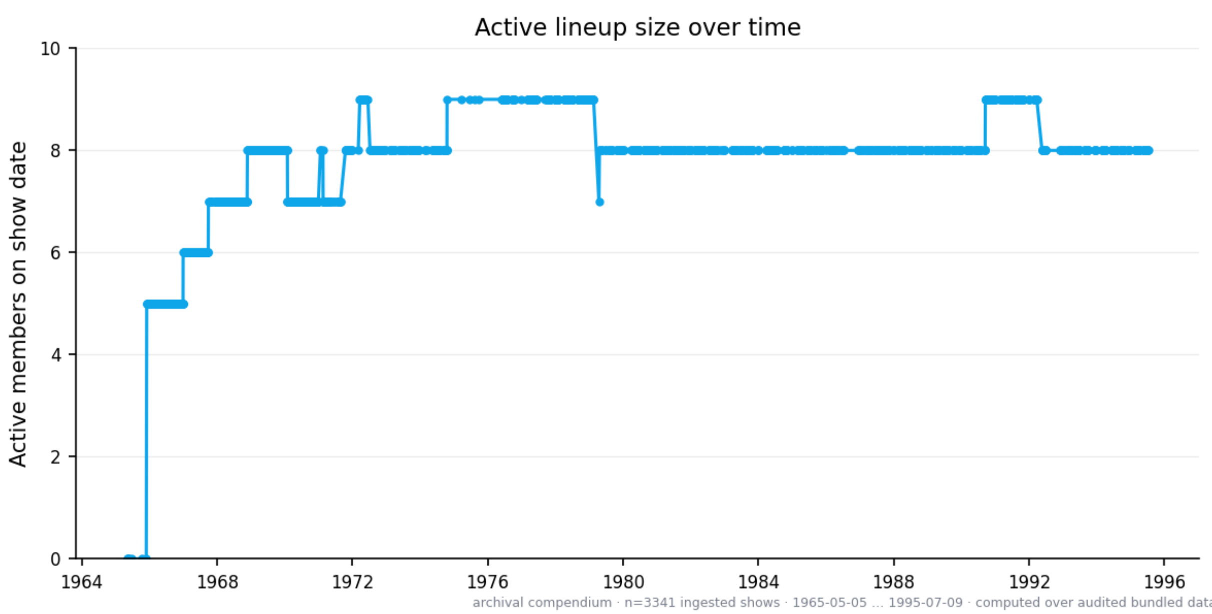


Figure 21: Active lineup size by show date. Data source: bundled show dates and curated personnel intervals. Statistic: active-member count over 2312 distinct show dates. Exclusion rule: counts use interval coverage on each date and are not cumulative roster totals. Claim class: descriptive personnel-time summary.

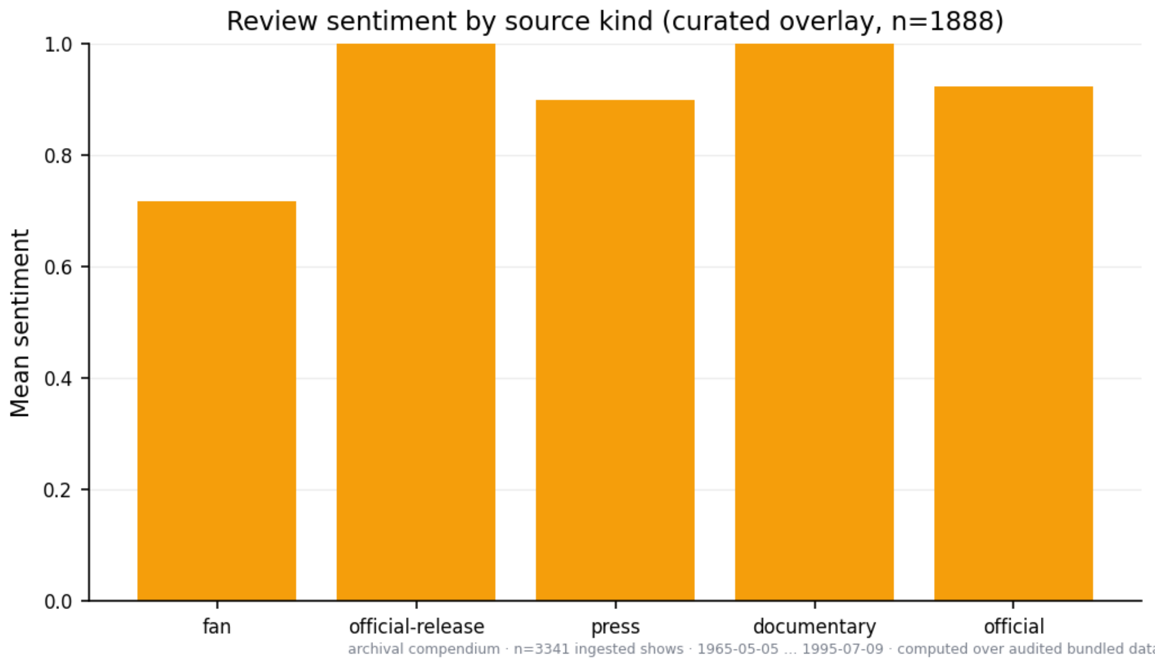


Figure 22: Review sentiment by source kind in the archival compendium. Data source: bundled review-pointer table (n=1888 reviews across 5 source kinds). Statistic: mean sentiment by kind with support and dispersion in the raw CSV/JSON export. Exclusion rule: reviews without pointer/source metadata are not fabricated; sentiment is limited to curated and maximinus review rows. Claim class: descriptive reception summary.

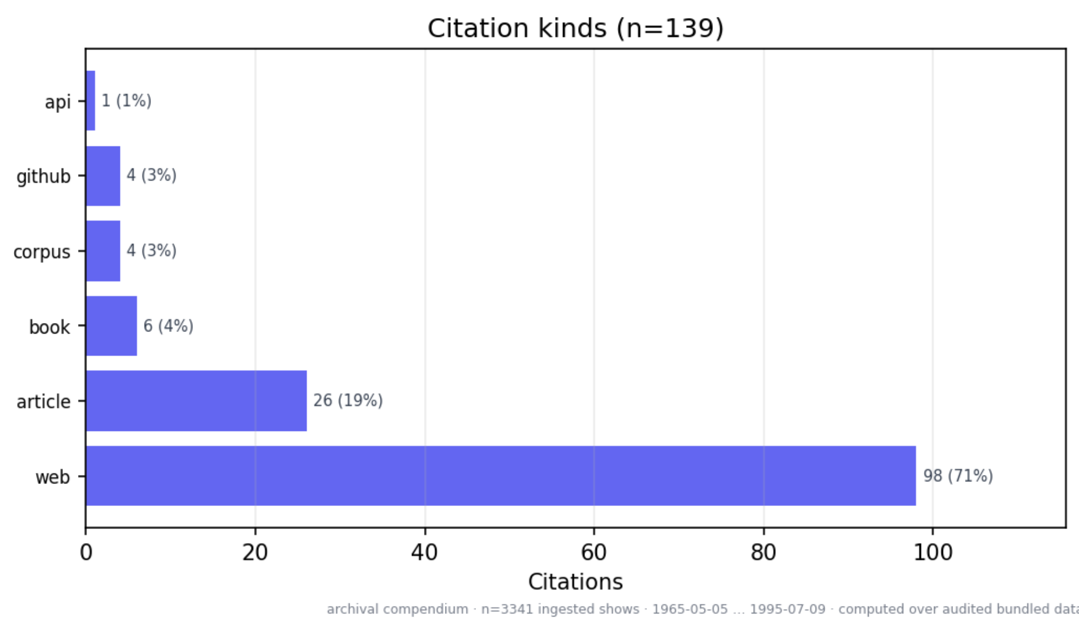


Figure 23: Citation kinds across the 139 references in `manuscript/references.bib` and `data/archival/citations.json`. Data source: bibliography markdown, BibTeX, and archival citation rows. Statistic: counts and share-of-total across 6 citation kinds. Exclusion rule: citation rows are metadata pointers; no source text is bundled. Claim class: descriptive bibliography-provenance summary.

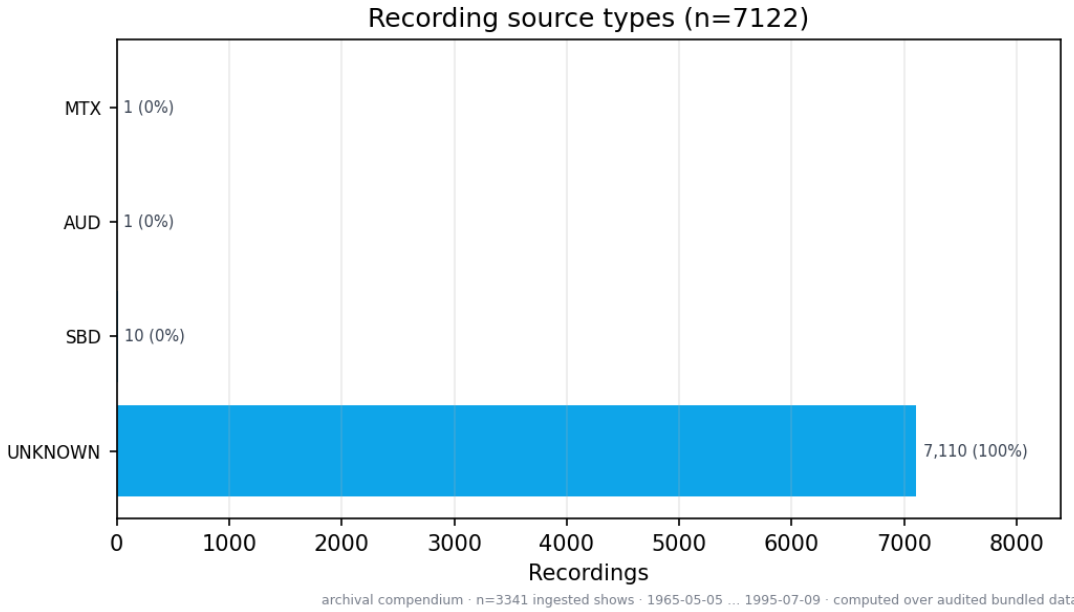


Figure 24: Recording source types in the bundled Internet Archive ingest (n=7122 recordings). Data source: bundled recording metadata. Statistic: counts and shares across 4 source-type labels. Exclusion rule: missing source-type labels remain `UNKNOWN`; the ingest does not infer SBD/AUD/MTX from audio. Claim class: descriptive data-quality summary.

URL in this build. The compendium carries 16585 explicit `segue_into'' edges from gdshowsdb`:segued`flags via`performances.json“. Figure 26 ranks the most frequent segues directly (a node-link layout collapses into an unreadable tangle once the top edge occurs over a thousand times); the segue *structure* is interpreted in Section 6.

5.11 Geography, set position, tours, and bustouts

Figure 27 maps geocoded venues (point size ∝ shows at that venue). Figure 29 shows within-set position histograms; Figure 30 ranks tour tags by show count (most shows lack tour metadata in the ingest and appear under an untagged bucket); Figure 31 highlights songs with the widest gap between successive performances in the archival compendium.

Figure 28 is the companion to venue concentration: it shows the report-only identity audit rather than silently rewriting venue rows. The alias map is conservative, keeps negative controls distinct, and surfaces 311 ambiguous same-date collisions for review instead of merging them.

Figure 32 gives the complementary *lifespan* view: each of the top songs as a horizontal segment from its debut year to its last-played year, ordered by debut and colored by debut era. Where Figure 31 measures recurrence gaps, this shows when each piece entered and left rotation — the temporal spine of the repertoire.

Figure 33 places the 259 bundled releases on a timeline by kind.

5.12 Composite views

Figure 34 is the single-page extent artefact: title block, analytical panels, context timeline, and a per-layer provenance table. Figure 35 traces the top 40 composer → song → era flows by performance weight.

5.13 Claim evidence map

The first-principles review in Figure 36 is a meta-analytic control surface for the manuscript. It does not count shows, songs, or performances; it counts claim families by claim class and by their primary validation artifact. The value is negative as much as positive: the map records where a claim is merely contextual, exploratory, structural, or boundary-enforcing before prose or figure polish can make it sound stronger than the evidence supports.

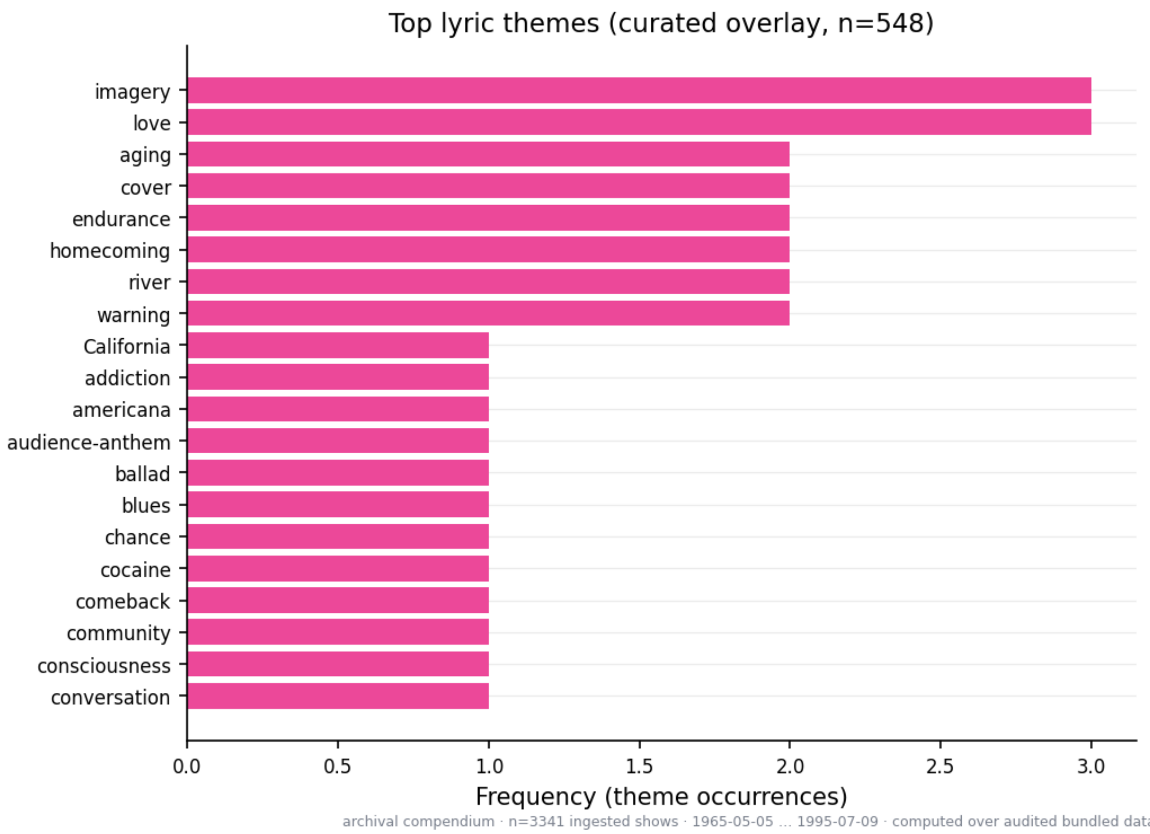


Figure 25: Lyric pointer theme tags. Data source: CMU/dead.net/curated lyric pointer metadata only (n=548 pointers). Statistic: frequency of the top 20 theme tags. Exclusion rule: lyric text is not bundled, parsed, quoted, or derived. Claim class: descriptive metadata summary.

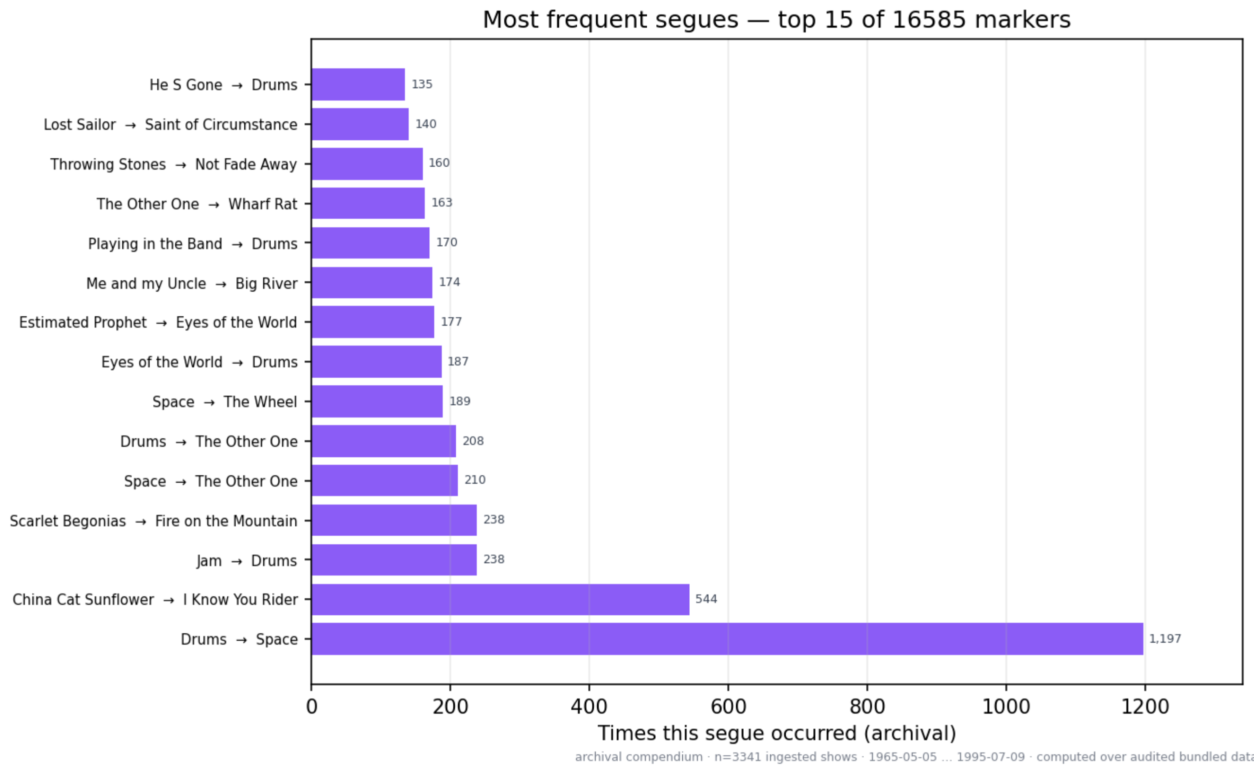


Figure 26: Most frequent explicit segues. Data source: bundled ordered performance rows with source-marked `segue_into` flags (n=16585 markers). Statistic: top 15 directed song-to-song edge counts. Exclusion rule: adjacent songs are not inferred as segues; only explicit flags contribute. Claim class: descriptive transition-edge summary.

5.14 Limitations and threats to validity

The quantitative views above describe the *ingested snapshot*, not ground truth, and several caveats bound their interpretation:

- **Segment markers.** `drums`/`space`/`jam`/`tuning`/`feedback` are set segments, not songs. Manuscript-ready repertoire, co-occurrence, transition, stationary, and association panels exclude them; their counts and marker-inclusive transition sensitivity are reported separately. This policy is recorded in the first-principles ledger rather than repeated as a hidden assumption.
- **Descriptive, not inferential by default.** Co-occurrence and the first-order Markov chain summarize observed setlists. Raw transition probabilities conflate one-observation certainties with well-supported estimates; we therefore report support per row and a permutation-null screen with **Benjamini–Hochberg false-discovery-rate control** across all 7639 eligible cells. At FDR $q = 0.05$, 1533 transitions are significant — versus 2284 that would pass an *uncorrected* per-cell threshold (multiple-comparison correction is essential: on random within-show order the FDR-controlled count is 0, while the uncorrected screen still flags about 5% of cells by chance). The surviving edges are the canonical segues (`drums` → `space`, `Scarlet Begonias` → `Fire on the Mountain`, `China Cat Sunflower` → `I Know You Rider`).
- **Centrality measures association, not volume.** Computed on the Jaccard-association adjacency to avoid simply re-deriving play frequency.
- **Venue granularity.** Venues are keyed by normalized name, so a single physical venue can appear under several slugs. The conservative alias layer identifies 20 duplicate slugs and 311 ambiguous same-date collisions, but this pass does not mutate venue rows. The full policy, negative controls, and mean collision Jaccard (0.047) are emitted to `analysis_report.json::venue_identity_review` and summarized in Figure 28.
- **Tour and review coverage are partial.** Most shows lack tour metadata (the dominant `tours_top` bucket is untagged), and sentiment is computed over a curated/maximinus review subset, not a representative sample.
- **Catalogue coverage.** 196 catalogued songs never enter the performance record in this snapshot (69.42% coverage); the catalogue is broader than the performed repertoire.
- **Audit reach.** The recording date cross-check fires only for Internet Archive identifiers that encode a date

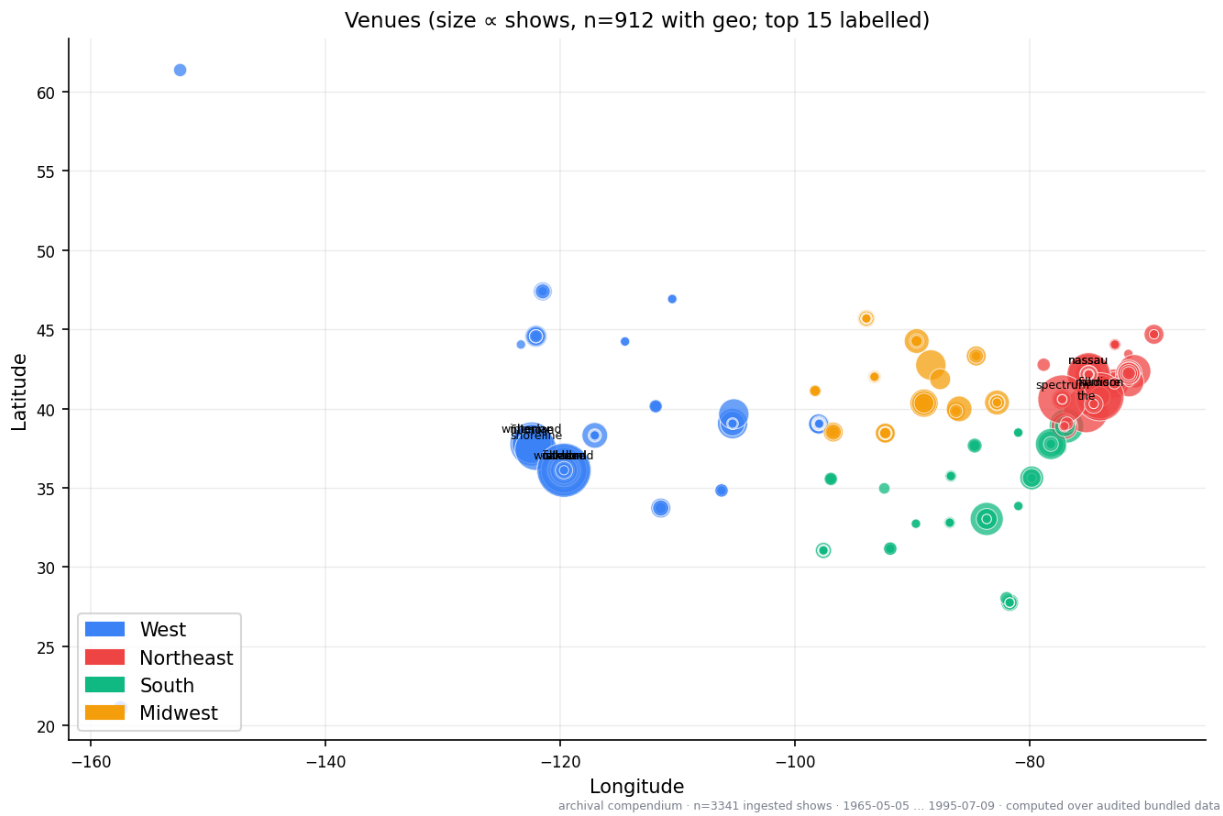


Figure 27: Venue geography for geocoded venues (n=912 in compendium). Data source: bundled venue table plus geo sidecar. Statistic: point area scales with show count at that venue. Exclusion rule: only venues with geocoded sidecar rows are plotted; current archival coverage is complete. Claim class: descriptive.

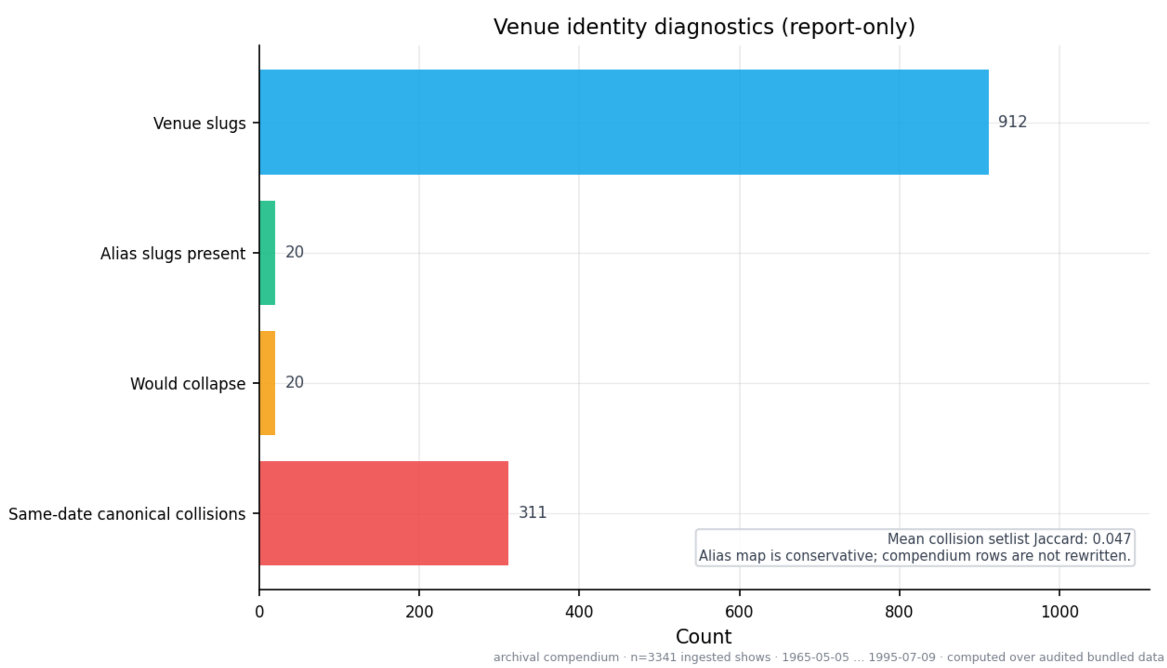


Figure 28: Venue identity review. Data source: bundled show/venue/performance tables and curated venue alias map. Statistic: venue-slug counts, conservative alias-collapse counts, ambiguous same-date collision count, and mean collision setlist Jaccard. Exclusion rule: report-only review; compendium venue rows are not rewritten. Claim class: validation and data-quality diagnostic.

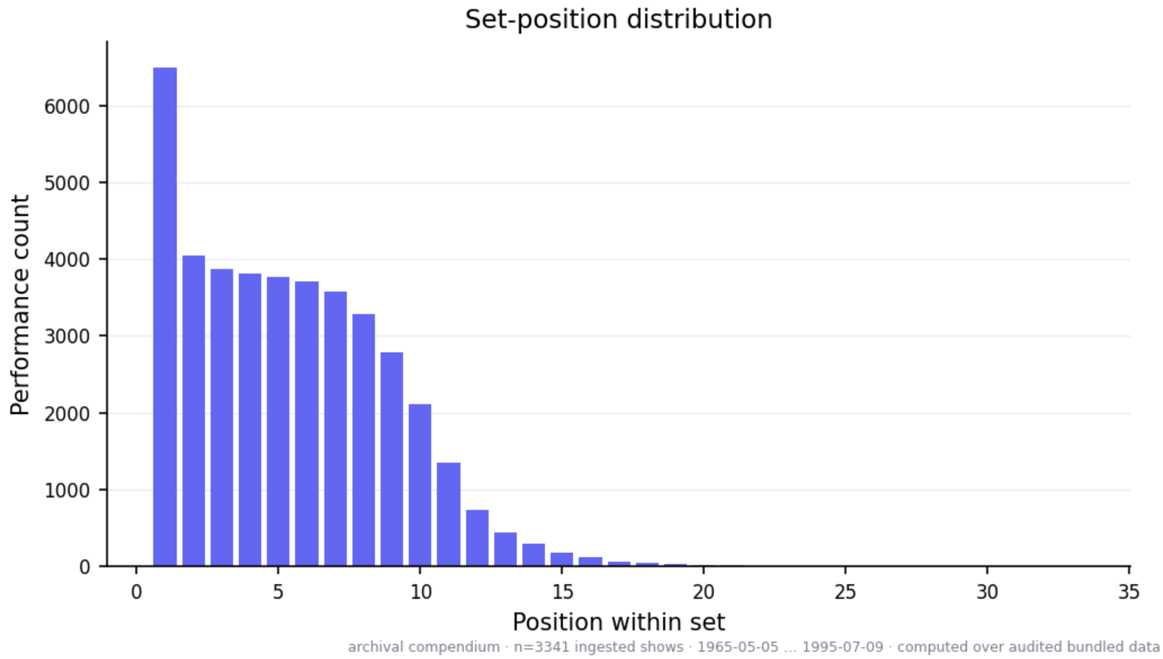


Figure 29: Set-position distribution. Data source: bundled ordered performance rows. Statistic: performance-row counts across 33 within-set position indexes. Exclusion rule: all loaded performance rows with positions are counted, including segment markers. Claim class: descriptive setlist-structure summary.

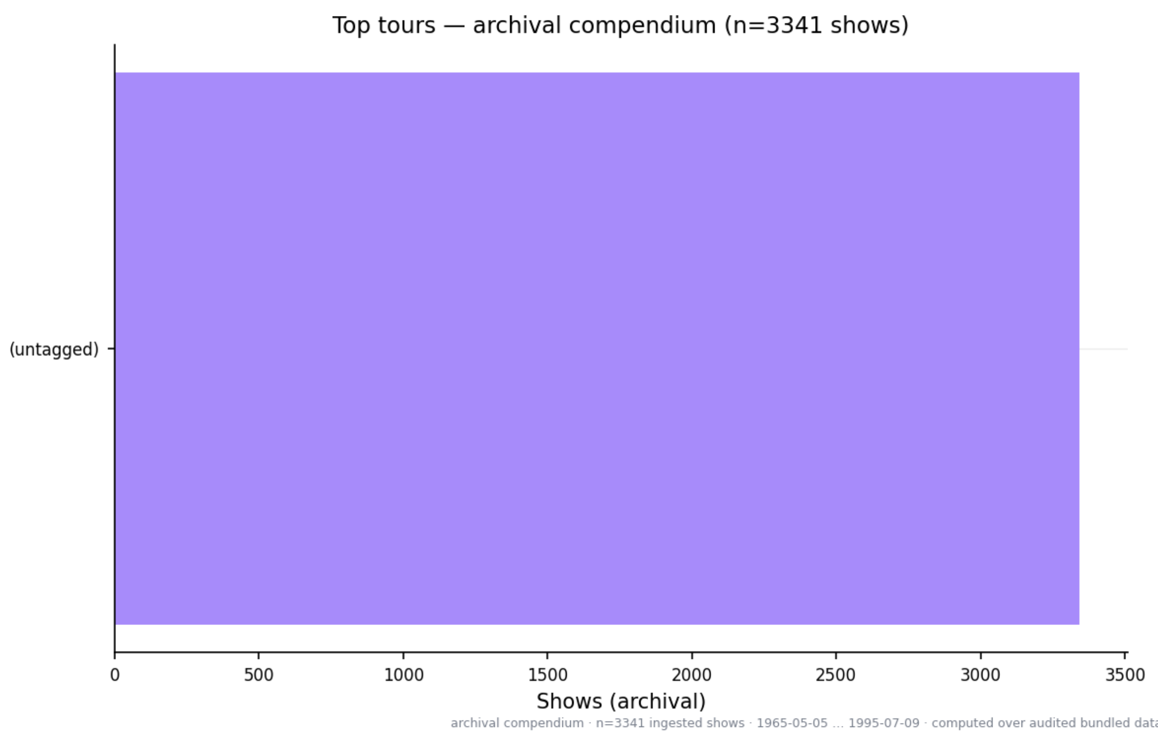


Figure 30: Top tour labels by number of shows. Data source: bundled show metadata. Statistic: show counts across 1 displayed tour label bucket(s). Exclusion rule: shows without tour metadata remain in the untagged bucket rather than being imputed. Claim class: descriptive coverage-quality summary.

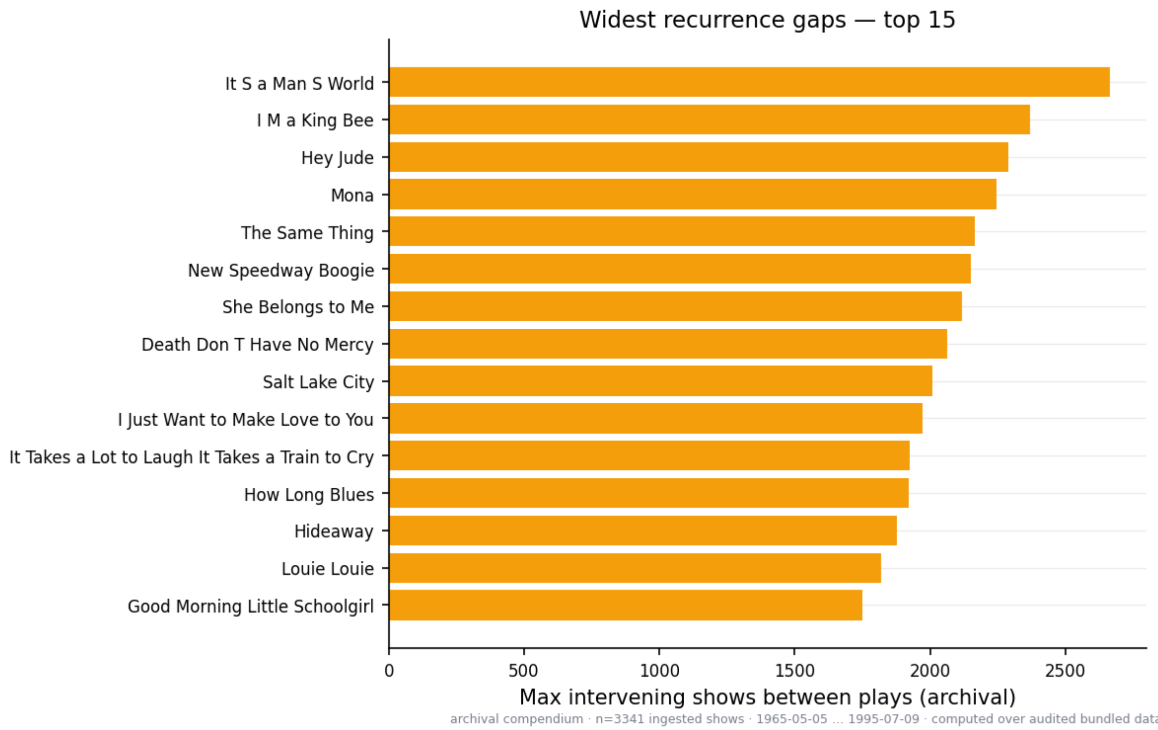


Figure 31: Songs with the widest recurrence gaps. Data source: chronological show order and bundled performance rows. Statistic: top 15 maximum intervening-show gaps between successive performances. Exclusion rule: generic segment markers are excluded; songs with a single performance receive a zero recurrence gap in the raw analysis. Claim class: descriptive repertoire-recurrence summary.

(`gdYYYY-MM-DD`); recordings under other identifier schemes are checked for show-resolution but not date agreement. Venue records are merged "first non-empty value wins," so a venue appearing in two sources with conflicting non-empty metadata keeps the first-seen value; the committed snapshot is built from sorted sources, so this is deterministic, but it is a merge convention, not a conflict resolver.

- **Figure validation is a blank-canvas tripwire, not a correctness oracle** — a figure plotting wrong-but-non-degenerate data would pass; figure correctness is bound by the archival ground-truth tests on the underlying numbers, not by pixel variance.
- **The claim ledger is governance, not proof.** It makes assumptions and evidence links explicit, but it cannot by itself prove that an adopted source is complete or that a historical interpretation is exhaustive. It is a guard against over-claiming, not a substitute for source criticism.

These are referential and descriptive claims about the ingested corpus, not claims of completeness over every Grateful Dead performance.

5.15 Honest framing

Every figure carries an identical provenance footer stamped from the active tier at render time. Refresh the committed snapshot with `scripts/00_fetch_sources.py --online --archival-max` (unlimited Internet Archive pagination; Setlist.fm when `SETLISTFM_API_KEY` is set; CMU mirror fallbacks), then re-run `scripts/99_pipeline.py --tier archival`. The schema, integration, category-theoretic constructions, and validation gates are unchanged at any scale.

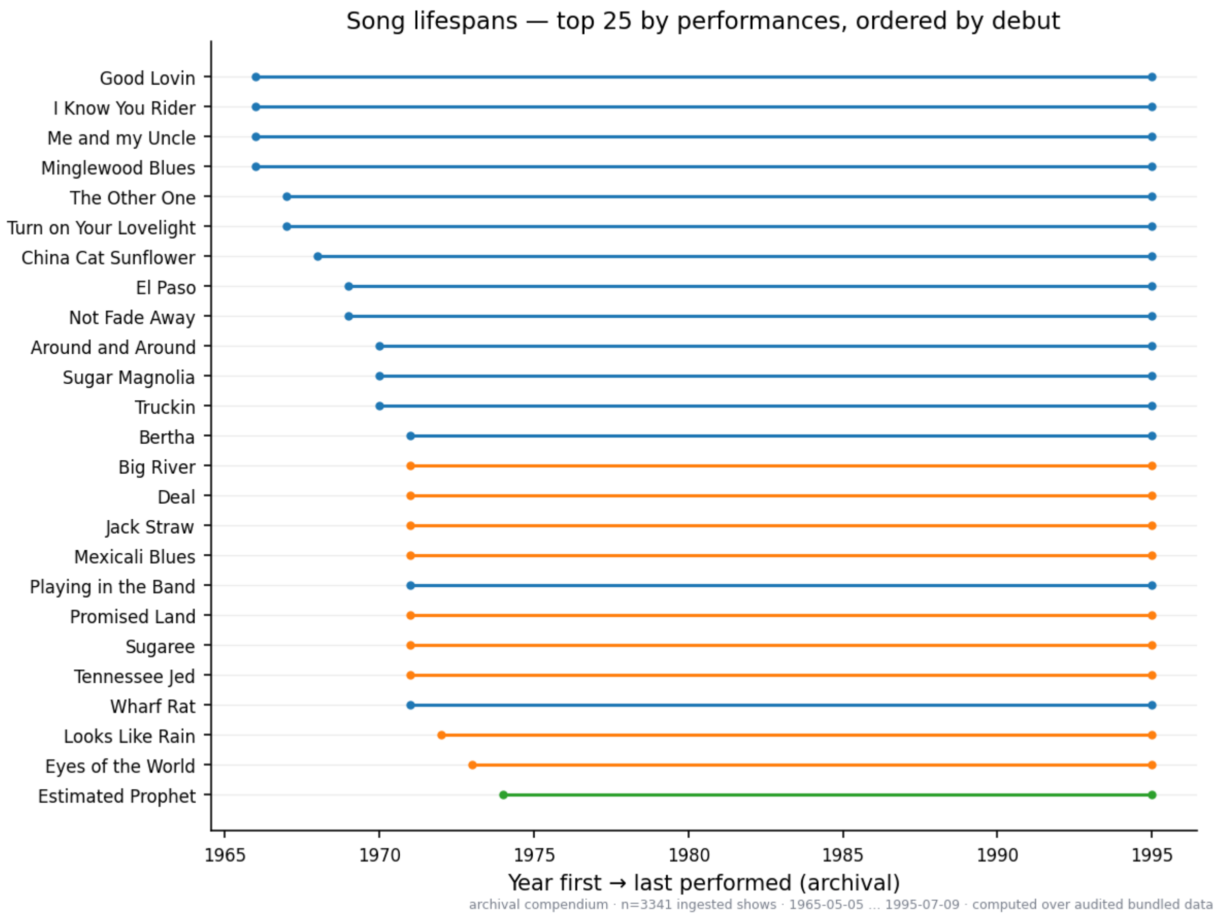


Figure 32: Song lifespans in the archival compendium. Data source: bundled performance rows and era labels. Statistic: first-to-last performance year for 25 top songs by performance count, ordered by debut and colored by debut era. Exclusion rule: generic segment markers are excluded. Claim class: descriptive repertoire-span summary.

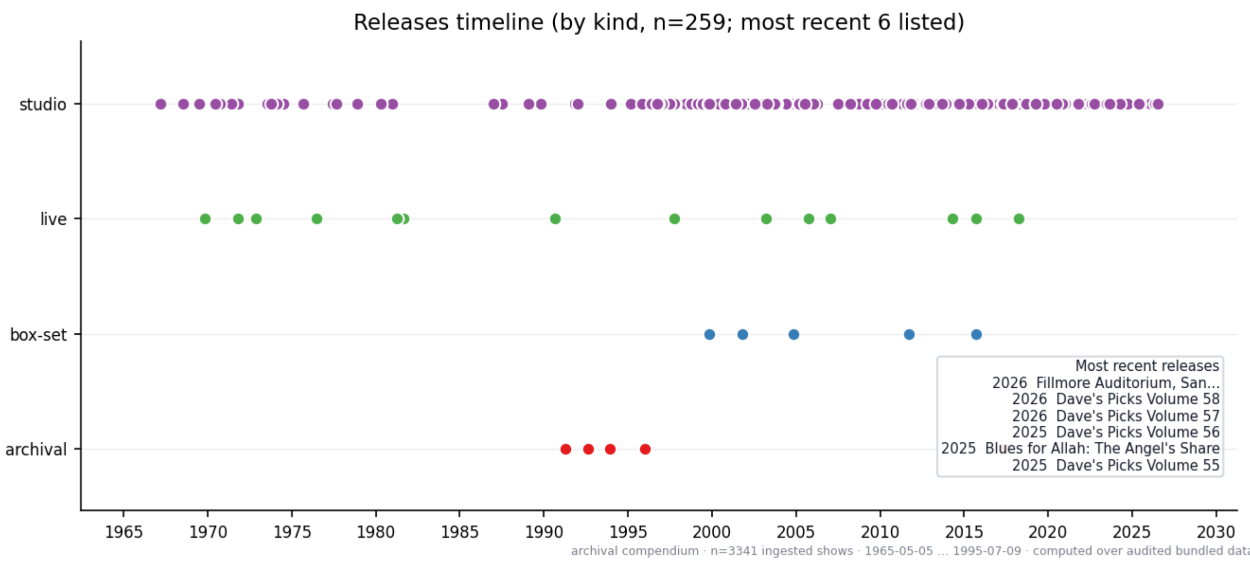
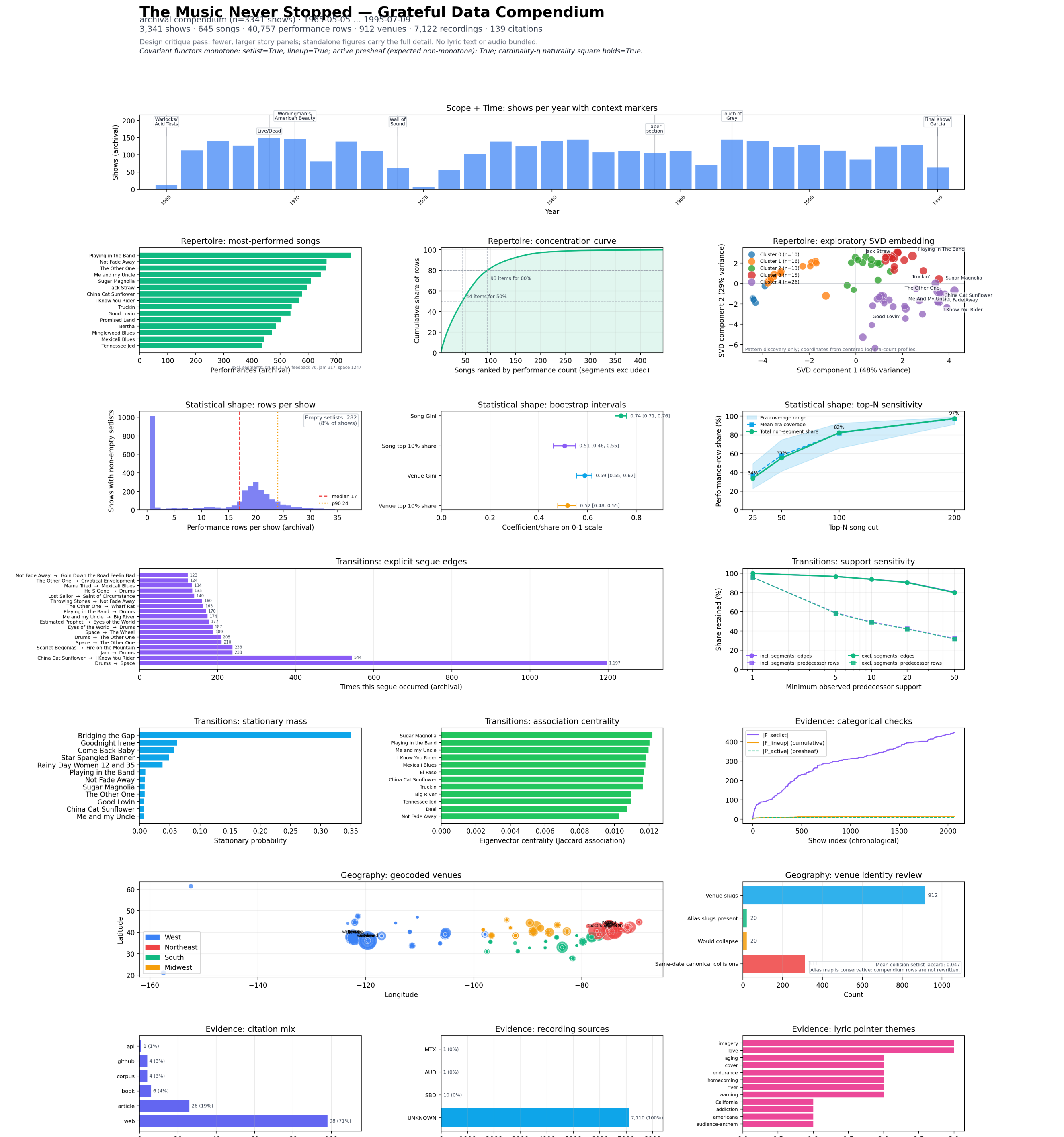


Figure 33: Release timeline by kind. Data source: bundled release metadata. Statistic: release dates and kinds for 259 release records in the archival compendium. Exclusion rule: release rows without a source show link remain release metadata and do not alter performance counts. Claim class: descriptive discography-context summary.



Layer	Count	Source / note
Shows	3,341	gdshowsdb + gap-fill sources
Performance rows	40,757	performances.json / derived
Songs	645	gdshowsdb + alex_allan
Venues	912	derived from show ingestion
Venue geo entries	912	data/archival/venue_geo.json
Recordings	7,122	internet_archive_lma + curated
Releases	259	wikipedia + curated
Lyric pointers	548	pointer metadata; no lyrics
Reviews	1,888	data/archival/reviews.json
Citations	139	bibliography + references.bib
Segue edges	2,751	explicit segue_into markers
Lyric themes	62	derived from pointer set
Figure raw data	CSV + JSON	output/data/figures/
Honesty boundary	ON	src/honesty.py
Schema validation	ON	src/validation.py

archival compendium · n=3341 ingested shows · 1965-05-05 ... 1995-07-09 · computed over audited bundled data

Figure 34: Total mosaic for the archival compendium. Data source: selected registry-backed figures and top-line report values. Statistic: composite overview selected from the 36 validated figure outputs, grouped by scope/time, statistical shape, repertoire/transitions, geography, and evidence. Exclusion rule: the mosaic is a summary view; standalone figures and raw CSV/JSON exports carry the full panel detail. Claim class: descriptive synthesis.

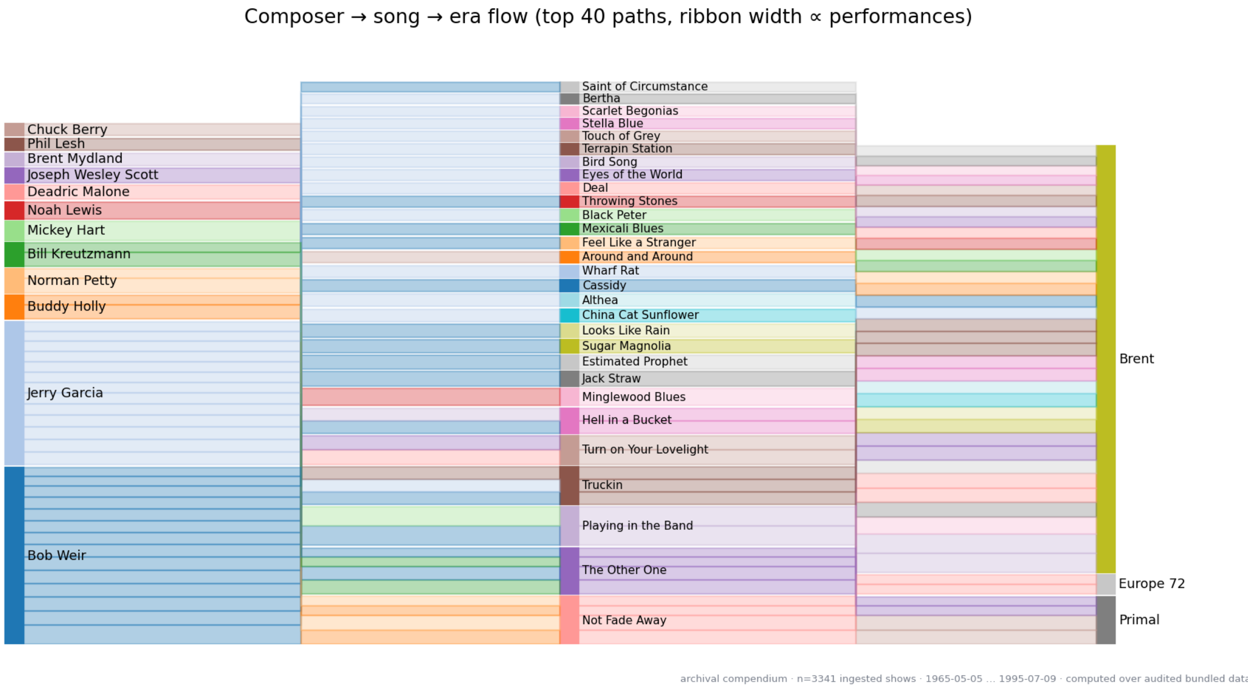


Figure 35: Composer — > song — > era alluvial diagram. Data source: bundled performance rows joined to song composer metadata and show-era labels. Statistic: top 40 composer-song-era paths by performance count, with ribbon width proportional to flow mass. Exclusion rule: paths require composer metadata; lyric text and audio features are not bundled. Claim class: descriptive attribution-flow summary.

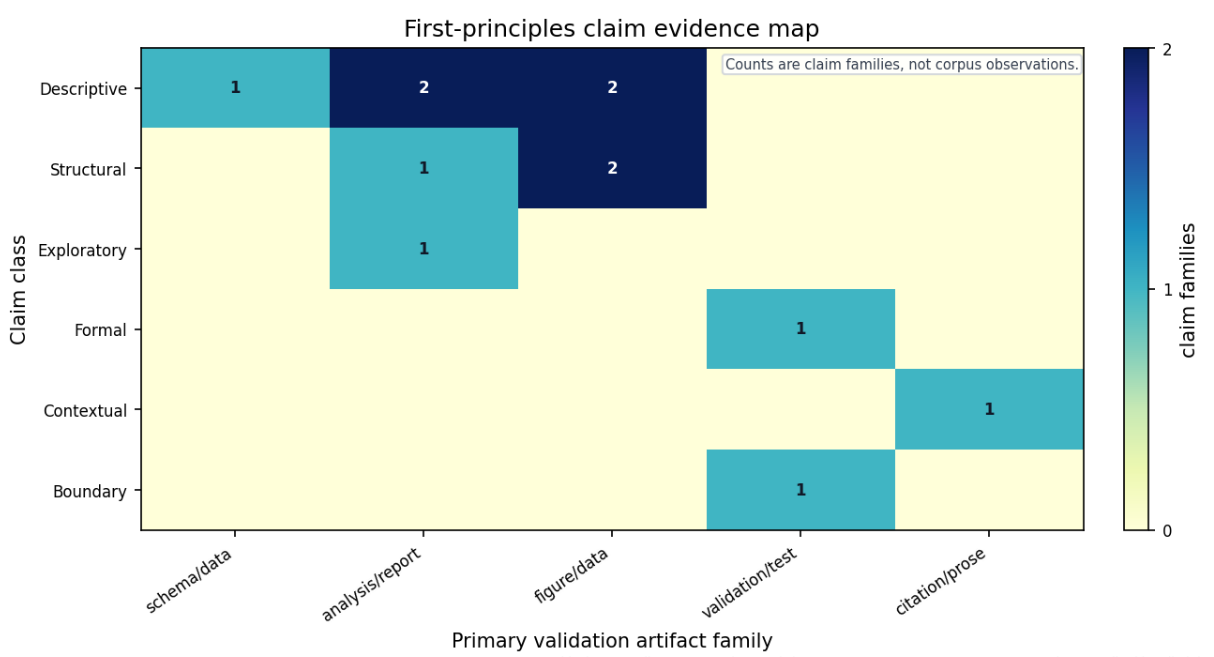


Figure 36: First-principles claim evidence matrix. Data source: the first-principles analysis module. Statistic: count of 12 claim families by claim class and primary validation-artifact family. Exclusion rule: no corpus rows are added or removed by this governance layer. Claim class: validation/evidence governance rather than descriptive corpus measurement. The full ledger is serialized as JSON and CSV files under "output/reports/".

6 Segue and transition structure

The Grateful Dead's setlists are not a bag of songs but a *sequenced* object: certain songs flow into certain others, often without pause, and those flows are as much a part of the band's identity as the songs themselves. The compendium captures this at two distinct levels of evidence, and keeping them separate is the point of this section. That separation also aligns with MIR work on full-concert setlist segmentation: audio-level identification must contend with banter, applause, covers, transitions, and live-version variation [Wang et al., 2014], while this compendium starts from curated setlist rows and explicit editorial segue markers.

6.1 Two notions of "what follows what"

A **transition** is positional: song B immediately follows song A within a set, whether or not the band marked a musical link. These are what the first-order Markov model in Section 5 counts, and the permutation-null screen retains 1533 of them as significant under false-discovery-rate control (out of 7639 eligible ordered pairs).

A **segue** is explicit: the source data marks a "->" / ">" link between two performances, encoded in the compendium as a `segue_into` edge. There are 16585 such markers spanning 2751 distinct directed song pairs. A segue is therefore a *curated subset* of the transitions — the ones a setlist editor judged to be a genuine musical continuation — and carries stronger evidentiary weight than mere adjacency.

The two notions agree where it matters and diverge informatively. The FDR-significant transitions and the top segues share their podium in this archival build — "China Cat Sunflower" -> "I Know You Rider" and "Scarlet Begonias" -> "Fire on the Mountain" top both lists — which is reassuring: the explicit editorial judgement and the blind statistical screen converge on the same canonical pairings. Where they diverge, the transition view sees adjacencies that were never marked as segues (e.g. an encore break that the Markov model cannot distinguish from a continuation), which is exactly why the segue markers are the higher-confidence signal.

6.2 The most frequent segues

Figure 26 ranks the segues directly. The single most frequent is "drums" -> "space" with 1197 occurrences — the canonical "Drums" -> "Space" passage that anchors the second-set improvisational core for most of the band's career. That this structural segment, rather than any song, is the corpus's most frequent segue is not an artefact: it reflects a real feature of the music, and it is reported honestly here precisely because the segment markers are *kept* in the transition/segue analyses (they are excluded only from the repertoire ranking of Section 5, where they are not compositions). Below the segment core, the ranking is a tour of the band's signature pairings — the "China Cat" -> "Rider" fusion, the "Scarlet" -> "Fire" suite, the "Estimated Prophet" -> "Eyes of the World" flow — recovered from the markers alone, with no title-based inference.

6.3 Segue hubs

Out-degree in the segue graph identifies *launch points* — songs that most often flow into something else. The highest is "drums' ' (1763 outgoing segues), consistent with the structural role of the "Drums"/"Space" core as a hinge between composed material: the band exits the improvisational segment into a wide variety of songs, so it accumulates a large, fan-shaped out-degree rather than a single dominant successor. Composed songs, by contrast, tend to have concentrated out-degree — a song like "Scarlet Begonias" overwhelmingly segues into one partner — which is the graph-theoretic signature of a fixed suite versus an improvisational junction.

6.4 What this does and does not establish

These are descriptive structures over the ingested setlists, not causal or exhaustive claims. The segue markers are only as complete as the source editors' annotations; an unmarked continuation is invisible to the segue view and appears only as a (weaker) transition. The Markov model is first-order by construction, so longer signature chains — "Help on the Way" -> "Slipknot!" -> "Franklin's Tower" — are visible only as their pairwise links, not as a single third-order object. The taping and trading literature is a useful guardrail here: recordings and setlists are co-curated cultural records [Meriwether, 2015, Wallace, 2009], so this section reports what the encoded record says rather than what the band "really" intended in every performance. Both limitations are inherent to the representation and are revisited in the limitations of Section 5.

7 Conclusion

We have introduced *The Music Never Stopped*, a reproducible, citation-bound Grateful Dead data compendium, and we have shown that the performance graph carries a small but genuine category-theoretic structure. The compendium primitive is a frozen-dataclass schema with deterministic canonical-slug joins; the integration layer reconciles nine cited sources into one immutable `Compendium`; the analysis layer computes descriptive, co-occurrence, Markov-transition, time-series, and network views; and the category-theoretic layer exhibits the date poset, the show category, the monotone cumulative setlist and lineup functors, the non-monotone active-roster presheaf, and the performance-as-span construction whose wide pullbacks recover setlists and per-song histories.

Several extensions are natural. First, integrating optional API overlays (Setlist.fm, Grateful Stats) when credentials are available. Second, integrating Dodd's annotated lyrics [Dodd and Trist, 2005, bil] as a pointer-only semantic enrichment layer over the song objects. Third, computing concrete audio-feature weights against the `fifteen-songs-dataset` [fif] and exercising the enriched category at scale. Fourth, integrating the `gratefuldata` ETL patterns [Thered] and the `jerryPycia` query surface [Blance] to broaden the analytical reach. Fifth, integrating the `grateful-dead-reviews` corpus [maximinus] for a reception layer that hangs off the performance spans on the show side.

The deeper transferable lesson is that **the compendium primitive should be chosen so that the question you are asking is literally a categorical construction over it**. For the Grateful Dead, the performance is the apex of a span between show and song; for any analogous live-performance corpus (jam-band, classical concert series, theatrical run), the same primitive works without modification. The categorical reading is not an aesthetic overlay; it is the explicit statement of which joins commute, which codomains are monotone, and which views are unavoidably non-functorial.

8 Reproducibility

This manuscript's numeric, categorical, and figure claims are bound to live code paths. The pipeline runs deterministically from the committed archival compendium (`data/archival/`); nothing in this paper is generated by hand.

8.1 Single-command reproduction

```
cd projects/working/grateful_data

# Refresh committed snapshot (optional; requires network)
uv run python scripts/00_fetch_sources.py --online --archival-max

# Full analysis pipeline + figures + manuscript variables
GRATEFUL_DATA_TIER=archival uv run python scripts/99_pipeline.py --tier archival
```

The pipeline writes `output/data/compendium.json`, `output/reports/{analysis,category_theory,completeness,first_pri` `../figures/*.png` (36 validated figures), `output/dashboard.html`, `output/data/manuscript_variables.json`, `output/manuscript/` (token-resolved markdown for PDF), and raw entity exports under `output/data/raw/`. It also writes `output/reports/first_principles_claims.csv` and 34 registered figure-data exports under `output/data/figures/`: each supported panel has a CSV table, a JSON table with metadata, and an `index.json` record consumed by the dashboard. Index rows include data source, statistic, exclusion rule, and claim class, so captions and raw data can be audited together. The same pipeline now writes provenance sidecars under `output/data/provenance/`, pointer-only audio/lyric manifests under `output/data/external/`, a static explorer under `output/explorer/`, a peer-review dossier under `output/reports/`, and a promotion-readiness report that does not move lifecycle folders. Optional entity markdown: `scripts/09_song_pages.py` and `scripts/11_entity_pages.py`.

For a strict publication gate after the template render:

```
uv run python scripts/20_validate_publication_outputs.py --strict
```

For a non-mutating command-order and release-prep check:

```
uv run python scripts/21_release_prep.py --dry-run
```

8.2 Manuscript PDF (template renderer)

From the template repository root:

```
cd projects/working/grateful_data
uv run python scripts/z_generate_manuscript_variables.py

cd /path/to/template
uv run python scripts/03_render_pdf.py --project grateful_data
uv run python scripts/05_copy_outputs.py --project grateful_data
```

This performs the multi-pass LaTeX + bibliography build and writes `output/grateful_data/pdf/grateful_data_combined.pdf` (citations from `references.bib` resolve in the rendered output).

8.3 CLI

```
cd projects/working/grateful_data
GRATEFUL_DATA_TIER=archival uv run python -m src.cli stats
uv run python -m src.cli song scarlet_begonias
uv run python -m src.cli show 1977-05-08@barton_hall_ithaca
uv run python -m src.cli person garcia
uv run python -m src.cli venue barton_hall_ithaca
uv run python -m src.cli list shows
uv run python -m src.cli list releases
```

```
uv run python -m src.cli composers
uv run python -m src.cli provenance songs scarlet_begonias
```

8.4 What's bound to what

Claim in manuscript	Bound by
Numeric counts in §4	`output/data/manuscript_variables.json` + `output/reports/analysis_report.json`
Referential completeness	`scripts/13_audit_completeness.py` → `completeness_report.json` (`dangling_total: 0`)
Figure integrity (blank-canvas tripwire)	`scripts/14_validate_figures.py` → `figure_validation.json` (36 non-blank). Figure *correctness* is bound by the archival ground-truth tests, not by pixel variance.
Figure filenames, titles, alt text, captions, data source, statistic, exclusion rule, claim class	`src/viz/figures.py` registry + `manuscript/04_results.md` + `output/data/figures/index.json`
Figure raw data	`scripts/18_export_figure_data.py` → `output/data/figures/{*.csv,*.json,index.json}`
Claim boundaries	`scripts/19_first_principles_review.py` → `first_principles_review.json` + `first_principles_claims.csv` with section, figure, report, test, and status columns
Transition sensitivity	`output/reports/analysis_report.json` → `transition_sensitivity` plus `transition_sensitivity.png` and figure CSV/JSON
Repertoire sensitivity	`output/reports/analysis_report.json` → `statistical_shape.repertoire_topn_sensitivity` plus `repertoire_topn_sensitivity.png` and figure CSV/JSON
Venue identity review	`output/reports/analysis_report.json` → `venue_identity_review` plus `venue_identity_review.png` and figure CSV/JSON
Source provenance	`scripts/23_export_provenance.py` → `output/data/provenance/{provenance.csv,provenance.json,*.c`
External protected-content boundary	`scripts/24_external_manifests.py` → pointer-only audio/lyric manifests plus `pipeline_contract.json`; protected content fields are rejected
Static explorer	`scripts/25_generate_explorer.py` → `output/explorer/index.html` + `explorer_data.json` with URL-state filters, sortable headers, related links, figure metadata, and filtered CSV download
Peer-review dossier	`scripts/26_peer_review_dossier.py` → claim-to-artifact map in JSON and Markdown
Publication output gate	`scripts/20_validate_publication_outputs.py --strict` → `publication_validation.json`
Non-destructive archival refresh diff	`scripts/22_archival_refresh_diff.py` → `output/refresh/archival_refresh_diff.{json,md}`; never overwrites `data/archival/`
Contextual historical claims	`manuscript/references.bib` + checked official/scholarly URLs; not ingested as `Show` or `Performance` rows
Functor monotonicity	`category_theory_report.json`; `tests/test_cattheory.py`
Naturality of η	`src/cattheory/natural.py` + negative-control tests
Wide-pullback setlist recovery	`tests/test_cattheory.py` on concrete compendium shows
Citations	`manuscript/references.bib` + bibliography markdown (139 merged citations in the active build)

Claim in manuscript	Bound by
Honesty boundary	`src/honesty.py` enforced at every `load_seed_compendium()`

The bibliography parser accepts legacy `\url{...}` wrappers, explicit `url = {...}` fields, DOI-only entries, and explicit BibTeX years. That matters because the source dossier mixes web archives, books, conference papers, and DOI-bearing scholarly sources rather than a single citation style. The enriched-bibliography context pass is reproducible in the narrower sense that each adopted topic is represented by a stable citation key, verified metadata where available, and a rendered bibliographic entry. The dossier narrative itself is not used as an uncited authority: source topics enter the manuscript only through direct citation keys, and generated statistics still come from reports, figure-data exports, and tests.

8.5 No mocks

No test uses `MagicMock`, `mocker.patch`, or `unittest.mock`. Fixtures and the archival compendium are the test ground truth.

8.6 Determinism

All analyses are pure functions of the immutable `Compendium`; matplotlib uses the headless `Agg` backend; exploratory bootstrap and clustering code uses fixed deterministic seeds and tie-breaks. Re-running `scripts/99_pipeline.py --tier archival` produces byte-stable CSV/JSON and visually-stable figures on the same machine.

9 The executable honesty boundary

The prose elsewhere in this manuscript draws a bright line between *ingested snapshot* and *live upstream*, between *pointer metadata* and *lyric text*, between *cited source* and *HTTP fetch*. This section promotes that boundary from prose to a runtime contract enforced inside the compendium loader by :class:`grateful_data.honesty.HonestyBoundary`.

9.1 What the boundary refuses

The boundary recursively walks the raw JSON payloads and the built `Compendium` and raises :class:`HonestyViolation` on any of the following shapes:

Forbidden shape	Detection rule
`lyric_text` / `lyrics` / `verse` / `chorus` / `stanza` / `refrain` keys anywhere	recursive walk on lowercased key name; project bundles pointers, not text
`audio_feature_*` / `synth_*` keys anywhere	recursive walk on lowercased key prefix; project bundles no audio
`Review` with `sentiment > 0` and empty `source_url`	over-claim shape ("positive but unverifiable")
`Citation` with empty or non-`http(s)://` URL	broken provenance
`Recording` with `gd`-prefixed `archive_id` whose URL does not point at `archive.org`	identifier suggests Internet Archive but URL is elsewhere
`LyricPointer` with empty `source_url`	we promise a pointer; missing pointer is over-claim

A violation aborts `load_seed_compendium` before any analysis runs. `enforce_honesty=False` is available but exists only for tests of the boundary itself.

The same rule applies to prose-only context introduced from the supplied source dossier. Formation stories, Wall of Sound details, public honors, songwriter recollections, studio-era reception, and tape-trading claims must cite checked sources and remain prose or citation metadata unless the project has a schema field for them [Grateful Dead, Weir, 2011, McIntosh Laboratory, 2025, John F. Kennedy Center for the Performing Arts, 2024, Marshall, 2003, Greene, 2015, Highways, 2020]. The dossier does not authorize new quantitative rows, current-person claims, lyric text, audio features, or revenue figures inside `data/archival/`. Community reconstructions are explicitly labelled as context when cited [Seconds, 2016].

9.2 Why this exists

Two lessons from the prior-work memory drove it directly:

- **disclosure is not remediation** — buried hedges in research-manuscript prose are laundering, not honesty. A runtime check forced into every load is the durable form.
- **shape tests don't bind truth** — a unit test that checks the *shape* of a review record passes happily on a fabricated positive review. The honesty boundary checks the *content* shape that fabrication takes.

9.3 Binding to tests

Each forbidden shape has a dedicated negative-control test that constructs a synthetic violation and asserts the boundary rejects it. The positive control is the committed archival compendium: `test_seed_loader_passes_honesty` asserts that the real snapshot loads with `enforce_honesty=True`. The whole loop is tested in `tests/test_honesty.py` and (with one tamper test per failure mode flipping a real row to a known-bad shape) in `tests/test_honesty_tamper.py`.

9.4 Verdict

CERTIFY-WITH-RESIDUALS for v0.1. The honesty boundary enforces every named failure mode at load time, the negative-control tamper tests demonstrate it fails loud on the right shapes, and the entity-page generators are anti-fabrication-tested in `tests/test_entity_pages_no_fabrication.py`. Acknowledged residuals at this version:

- schema validation catches shape violations but cross-field semantic validity (e.g. date $\in$ band-active-window, set position $\leq$ setlist length) is not yet a gate — that is the next layer of refinement;
- the `cattheory/` package's load-bearing modules (categories, functors, spans, natural, colimits, yoneda) each carry a *negative control* — a broken composition, a non-monotone functor, or a too-small colimit vertex that the check must reject — so the constructions are tested for teeth, not merely exercised. The colimit now verifies the universal property (not just subset-of-union) and Yoneda is checked over the non-degenerate `Date` poset rather than the trivial discrete case. The one remaining piece of honest *scaffolding* is `enriched.py`: the audio-similarity enrichment is structural only — concrete weights would come from a downstream pipeline against the `fifteen-songs-dataset` [fif], and the honesty boundary forbids bundling audio features, so it is labelled a stub rather than presented as an empirical result.

9.5 Licensing and provenance

The compendium integrates many community and institutional sources, and is explicit about reuse posture. The *code and the derived compendium schema* (the slugged entity tables and the category-theoretic constructions) are the contribution of this project; the *underlying facts* — setlists, dates, venues, personnel — are drawn from the cited sources, each of which carries its own terms. Setlist and show data derive primarily from community archives (gdshowsdb, the truckin-through-time dataset, Setlist.fm) and reference works (Wikipedia, Britannica); recording metadata comes from the Internet Archive Live Music Archive, whose Grateful Dead collection has its own access policy and metadata conventions [Internet Archive Help Center, 2018]; reviews are a curated/maximinus subset. No lyric text and no audio-feature data are bundled — lyric pointers are URL metadata only — both to respect copyright and as the project's stated ethical boundary. Dodd and Trist's annotated lyrics are cited as scholarship, not copied as data [Dodd and Trist, 2005].

One nuance worth stating explicitly: while individual facts (a date, a venue, a song title) are not protectable, a *curated compilation* — a particular hand-edited setlist or segue sequence — can carry its own rights independent of lyrics or audio, and our setlist and segue data derive from such community-curated sources. Archive scholarship on the Dead's sound record underscores that this is a co-created curation ecosystem, not a source-free fact dump [Wallace, 2009, Meriwether, 2015]. Downstream users should therefore consult each cited source for its own licensing before redistribution; this work claims rights only over the integration code and the structural representation, not over the source facts or any upstream curator's compilation.

9.6 Out of scope

The boundary is not a content-moderation system or a lyric classifier. It is a small set of refusals encoding what the *project itself* has promised to do and not do, written in code so a future contributor cannot quietly drift past it.

10 References

The full bibliographic database is at `manuscript/references.bib`.

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