Chokepoint Capitalism in Knowledge Infrastructures: An RSVP-Theoretic Analysis

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Abstract

This essay examines chokepoint capitalism as a mechanism for restricting knowledge diversity across digital, physical, and cultural infrastructures, using an RSVP-theoretic framework enriched with category and sheaf theory. Through cases spanning mobile operating systems, festival economics, visa policies, AI research platforms, and the historical evolution of alphabetic systems, I argue that chokepoints misprice epistemic diversity by enforcing premature evaluation, reducing negentropic potential. A functional paradigm of deferred automation, modeled as a monadic lazy-evaluation regime, is proposed as a counter-strategy, with the Arabic script's morphological generators serving as a computational exemplar. Mathematical formalisms are offered not only to populate abstract registers but also to critique the cultural fetish for mathematical authority, with natural-language translations provided for accessibility.

1 Introduction

Chokepoint capitalism, as articulated by Giblin and Doctorow [2022], describes economic structures where gatekeepers control access to markets, extracting rents while suppressing alternatives. This essay extends the concept to knowledge infrastructures, arguing that chokepoints—whether in digital platforms, physical events, immigration policies, or historical script evolution—systematically undervalue viewpoint diversity, a critical driver of epistemic resilience. Using the RSVP framework, where scalar capacity (Φ), vector flows (v), and entropy (S) model system dynamics, I demonstrate how such restrictions function as right-adjoint filters that collapse diversity colimits. A functional paradigm of deferred evaluation, inspired by lazy computation, is proposed to preserve negentropic potential, with the Arabic script's morphology as a computational case study.

2 Chokepoint Capitalism as Knowledge Restriction

2.1 Digital Platforms

Mobile operating systems (Android, iOS) impose chokepoints by restricting system-level customization (e.g., fonts, terminals). For instance, Samsung's theme economy licenses font design as a scarce privilege, akin to a lottery, while Android's "Always use this app" prompt enforces premature defaults, creating hysteresis that discourages exploration of alternatives [Doctorow, 2020].

These design choices function as economic and epistemic tollbooths: they diminish the range of feasible pathways by privileging a narrow set of defaults and excluding unapproved alternatives.

In RSVP terms, the scalar capacity (Φ) of possible user configurations is artificially constrained; vector flows (v) of exploration are collapsed into channels sanctioned by platform gatekeepers; and entropy (S), which would normally measure the richness of heterogeneity across the user base, is suppressed into homogenized usage patterns.

This dynamic mirrors the rent-seeking structure of chokepoint capitalism more broadly: the ecosystem is portrayed as open and diverse, yet the underlying infrastructure routes all innovation through bottleneck interfaces. Once defaults are entrenched, users face high switching costs—a form of enforced eager evaluation, where possibilities are collapsed before exploration can occur. The system extracts value not by producing novelty but by restricting its circulation, reducing epistemic diversity while monetizing access.

2.2 Physical Analogues

At festivals, organizers charge vendors exorbitant fees for exclusivity, policing independent sellers to maintain artificial scarcity. This mirrors digital chokepoints: access is monetized, and diversity (of vendors or ideas) is suppressed [Giblin and Doctorow, 2022]. Such practices transform what could be open commons of exchange into curated monocultures, where the cost of entry filters out all but the most capitalized participants.

The festival economy illustrates a broader structural logic: rather than maximizing serendipity and heterogeneity of encounters, organizers constrain flows through tollbooths. In RSVP-theoretic terms, scalar capacity (Φ) is artificially reduced—the potential number of feasible vendors is far greater than those admitted—while vector flows (v) are redirected through exclusive contracts and patrols. The entropy term (S), which would normally reflect distributed novelty and diversity, is collapsed into a handful of predictable offerings.

This is not unique to cultural festivals. Analogous patterns can be found in farmers' markets that restrict "non-certified" growers, in concert venues where only corporate sponsors are allowed to vend, and in academic conferences where publication or registration fees function as economic filters. In each case, chokepoints are rationalized as quality-control mechanisms but function primarily as revenue streams.

The lesson for knowledge infrastructures is that physical chokepoints habituate participants to constrained choice and normalize the extraction of rents for access. Just as mobile platforms shape user expectations of defaults and exclusivity, so too do festivals and markets encode scarcity as the condition of participation, narrowing the epistemic and cultural diversity that might otherwise emerge.

2.3 State-Level Chokepoints

The U.S. H-1B visa fee of $100,000, implemented on September 20, 2025, restricts labor mobility, mispricing the epistemic value of diverse perspectives from high-population countries like India and China [CBC News, 2025]. The policy, signed by President Donald Trump, applies only to new applicants and has sparked confusion, with the White House clarifying it does not affect current holders or renewals. Over 70 percent of H-1B holders are from India, and the policy has been denounced by India's Ministry of External Affairs for potential humanitarian disruptions to families. Critics argue it undercuts American workers by favoring lower-wage foreign hires, ignoring their role as negentropic amplifiers [CBC News, 2025].

2.4 AI Research Platforms

In traditional scientific practice, research institutions incur the costs of experimentation and then disseminate their results for public benefit. By contrast, AI companies invert this model: they charge end users for the privilege of *stress-testing* frontier models, effectively outsourcing validation and adversarial probing to the very communities that would once have been compensated as research contractors. This inversion transforms a public good into a chokepoint, where access to the means of knowledge production is tolled.

The economic magnitude of this inversion is striking. One leading firm has been estimated to capture on the order of \$15 trillion in negentropic value through systematic harvesting of user interactions—value that would otherwise require decades of distributed research labor and formal verification. Yet the actual costs borne by the company are comparatively marginal: the infrastructure to run inference, modest researcher oversight, and cloud-level compute provisioning. The epistemic surplus—error modes uncovered, domain knowledge stress-tested, and cross-disciplinary insights generated—is effectively appropriated under platform lock-in.

Within RSVP terms, this arrangement can be modeled as a diversion of entropy flux (S): instead of dissipating across a heterogeneous network of institutions, S is concentrated through a narrow vector flow (v) controlled by a single gatekeeper. Scalar capacity (Φ), understood as the informational reservoir of humanity, is thus undervalued by design, since diversity of probes and contexts is only recognized insofar as it accrues to the platform's private valuation.

From a functional programming perspective, this is premature forcing at scale: the epistemic pipeline is evaluated inside the company's monad rather than being deferred across the global research community. The result is a systematic mispricing of viewpoint diversity: alternative interpretations, adversarial probes, and localized knowledge are reduced to training tokens rather than preserved as distinct amalgams. Entropic futarchy (Appendix B) would predict precisely this inequality: the colimit of all possible probes is richer than the restricted subpresheaf permitted by corporate chokepoints.

3 Alphabetic Evolution as Historical Chokepoints

The evolution of Phoenician into Hebrew, Arabic, Greek, and Latin scripts illustrates chokepoint dynamics in cultural infrastructures. Phoenician's consonantal script was a high-entropy substrate, allowing lazy evaluation across cultures. Greek and Latin enforced eager vowelization, reducing ambiguity but creating tears in gluable diversity, while Hebrew and Arabic deferred vocalization, preserving combinatorial richness.

4 Arabic Script as Computational Assembler

The Arabic script exemplifies a computational generator system, analogous to an assembler in low-level programming. Consonants function as base instructions (generators), with vowels (َ, ُ, ِ) and sukūn as arguments that instantiate syllables, and morphological measures (Forms I–X) as higher-order transformations that derive semantic fields from roots. This structure mirrors lazy evaluation: roots remain symbolic until context or diacritics force realization, maximizing interpretive potential. Unlike Greek's early vowel commitment, Arabic's deferred system supports a high-entropy lexical colimit, which I formalize as a monadic regime in Appendix D.

5 Counter-Strategy: Deferred Evaluation as Futarchy

Deferring automation—whether in knowledge pipelines, app defaults, or script evolution—preserves epistemic diversity. Modeled as a monad in the RSVP category, this strategy delays forcing until colimits of local sections (drafts, app choices, cultural adaptations) are explored, maximizing negentropic value. My own pipeline, which generates directory trees (not just essays), embodies this principle, as does the Arabic script's morphology.

6 Chokepoint Field Theory for Vocabulary Choice

In languages with modern standards like Arabic (MSA vs. dialects) or Spanish (RAE standards), chokepoints manifest as hierarchical filtering through businesses, media, and idiolects. Let X be the context manifold and $\mathcal{L}_g \to X$ the concept bundle. The vocabulary field $\sigma_g : X \to \mathcal{L}_g$ minimizes the action

$$\mathcal{S}[\sigma_g] = \int_X \big[\alpha C_{\text{comp}}(x, \sigma_g(x)) + \beta C_{\text{prest}}(x, \sigma_g(x)) + \gamma \|\nabla_A \sigma_g(x)\|^2 + \lambda V_{\text{choke}}(x, \sigma_g(x))\big] \, d\mu(x).$$

Local choice follows softmax on energy $E(x, w)$, with coupling yielding phase boundaries. See Appendix J for details.

7 Conclusion

Throughout this essay, we have argued that chokepoint capitalism and its linguistic analogues can be understood as field-theoretic phenomena. By treating vocabulary choice, gesture systems, and even ecological stigmergy as sections of a manifold constrained by gatekeeping potentials V_{choke}, we recover a unified picture: deferred diversity, entropy management, institutional curvature, and exogenous neural networks. The comparative functorial mappings—from deer tail-flagging to human waves to forest branchings—demonstrate that all communicative systems can be situated on a higher meta-language manifold. Functors translate between local codes wherever chokepoint curvature is compatible; where it fails, entropy tears and phase boundaries emerge.

Chokepoint field theory reframes capitalism, linguistics, gesture, and ecology under one principle: communication is infrastructure subject to entropy and curvature. The apparent diversity of media—words, bodies, paths—is a set of charts on a single manifold. The task is not to abolish chokepoints (impossible), but to understand, defer, and redistribute them in ways that preserve generativity and minimize destructive entropy.

Future work may formalize this framework within RSVP theory's entropic action principles, embedding language choice and infrastructural design into the same thermodynamic ethics. In this way, questions of economy, speech, gesture, and ecology can be treated as instances of futarchy run by physical substrates: each making bets on which communicative pathways will carry meaning into the future.

Epilogue: Living With Chokepoints

At first glance, chokepoints look like obstacles. They raise prices, limit access, and enforce defaults. But in language, gesture, and ecology, we have seen that chokepoints also shape the very forms of communication we rely on. They are not accidental; they are part of how systems generate meaning and stability.

A neighbor spotting you behind a gate, a deer flagging its tail, a path pressed into the forest floor—all of these are moments where visibility, scarcity, or constraint crystallize into a message. Each is a reminder that communication is not free-floating: it depends on substrates that carry it forward, and those substrates have their own bottlenecks and rules.

The task, then, is not to dream of a world without chokepoints, but to cultivate ways of living with them. We can defer commitments, keep options open, and design infrastructures that distribute chokepoints rather than concentrating them. We can notice when a platform, an academy, or a trail becomes too narrow, and ask whether it is still serving generativity or merely enforcing compliance.

Seen this way, the parallels between capitalism, language, gesture, and ecology are not metaphors but literal alignments. All are systems of meaning that pass through gates. And all invite us to ask the same question: how can we arrange our chokepoints so that they amplify possibility rather than diminish it?

Closing Thought. Chokepoints do not only restrict; they also mark. Under certain conditions, what we call a chokepoint is better understood as a *landmark*—a feature in the landscape of meaning that guides passage, anchors memory, and allows orientation across time and space.

Disclaimer on Formalism

The mathematical translations in the appendices parody the cultural fetish for formal rigor while populating an abstract semantic register. Readers may skip these for the natural-language arguments, which stand independently.

A Chokepoint Mispricing Theorem

Let RSVP be a symmetric monoidal category of states $x = (\Phi, v, S)$ and morphisms respecting conservation/relaxation. Fix a space X with topology J. The presheaf $A : \mathrm{Op}(X)^{\mathrm{op}} \to \mathrm{Set}$ assigns to $U \subseteq X$ the set $A(U)$ of locally feasible RSVP behaviors. A chokepoint policy is a subpresheaf $A_F \subseteq A$ with inclusion $\iota : A_F \hookrightarrow A$. The diversity object is $\mathrm{Div}(A) = \mathrm{colimSec}(A)$. Let $V : \mathrm{Set} \to \mathbb{R}_{\geq 0}$ be a valuation monotone in injections and colimit-superadditive, RSVP-sensitive.

Lemma 1. *If there is a tear (local sections in A_F glue in A but not A_F), then $\kappa : \mathrm{Div}(A_F) \hookrightarrow \mathrm{Div}(A)$ is a proper mono.*

Proof. A tear gives a cone in $\mathrm{Sec}(A_F)$ that maps to a gluable cone in $\mathrm{Sec}(A)$. The induced comparison is injective but not surjective. □

Proposition 1. *If κ is proper, then $V(\mathrm{Div}(A_F)) < V(\mathrm{Div}(A))$.*

Proof. Proper mono into a set with non-null complement strictly increases valuation on codomain. □

Theorem 1 (Chokepoint Mispricing)**.** *Under tears and (V1)–(V3), $V(\mathrm{Div}(A_F)) < V(\mathrm{Div}(A))$.*

Proof. Lemma 1 makes κ proper; Proposition 2 yields strict loss. □

B Entropic Futarchy in Knowledge Pipelines

Let RSVP be the base category. An institution is modeled as a graph $R = (R, E)$ enriched by RSVP states x_r on vertices. A presheaf $H : \mathrm{Op}(X)^{\mathrm{op}} \to \mathrm{Set}$ assigns feasible hires to contexts $U \subseteq X$. A policy π yields a subpresheaf $H_\pi \subseteq H$, restricting feasible hires to those allowed under π. Define the valuation functional

$$J(S) \;=\; \sum_{r\in R} \alpha_r \,\mathbb{E}[\Delta N_r(S)] \;+\; \sum_{e\in E} \beta_e \,\mathbb{E}[N(f_e \mid S)] \;-\; \lambda\,\mathrm{Risk}(S),$$

where the $\alpha_r, \beta_e, \lambda$ are institutional weights. Entropic Futarchy maximizes

$$V_\pi^{\mathrm{div}} \;=\; V\big(\mathrm{Div}(H_\pi)\big).$$

Theorem 2 (Colimit Advantage)**.** *If tears exist, then* $V_\pi^{\mathrm{div}} < V^{\mathrm{div}}$.

Proof. By construction, $\mathrm{Div}(H)$ is the colimit of all compatible local hiring sections across contexts in X. If a tear exists, then there are local sections in H_π that glue in H but fail to glue in H_π, because the policy restriction forbids some amalgams. This produces a proper inclusion

$$\kappa :\; \mathrm{Div}(H_\pi) \hookrightarrow \mathrm{Div}(H).$$

Since V is assumed monotone under inclusions and strictly colimit-superadditive on proper inclusions (as in the Chokepoint Mispricing Theorem, Appendix A), we obtain

$$V(\mathrm{Div}(H_\pi)) < V(\mathrm{Div}(H)).$$

Hence, restricting feasible hires through policy π reduces the epistemic diversity valuation relative to the unrestricted case. This establishes the colimit advantage: greater diversity is always obtained by deferring restriction until after colimit formation. □

Proof. Let A be the baseline presheaf of feasible behaviors and let $A_F \subset A$ be the enforced (chokepointed) subpresheaf with inclusion $\iota : A_F \hookrightarrow A$. By hypothesis, a *tear* exists: there is a cover $\{U_i \to U\}$ and local sections $s_i \in A_F(U_i)$ that agree on overlaps and glue to some $s \in A(U)$, but no section in $A_F(U)$ glues the s_i. By Lemma 1 in Appendix A, this implies that the induced map on diversity objects

$$\kappa :\; \mathrm{Div}(A_F) \;\hookrightarrow\; \mathrm{Div}(A)$$

is a *proper* monomorphism (its image is a strict subset).

The valuation V (or J, as used in adjacent sections) is assumed monotone under inclusions and colimit-superadditive. Monotonicity gives $V(\mathrm{Div}(A_F)) \leq V(\mathrm{Div}(A))$; propriety of κ plus superadditivity yields strict inequality:

$$V(\mathrm{Div}(A_F)) \;<\; V(\mathrm{Div}(A)).$$

This is exactly the claim. Hence, by the Chokepoint Mispricing Theorem, enforcing A_F reduces the diversity valuation compared to A. □

Model. We model the *null wave front* as passive advection by a prescribed RSVP vector field v. The governing PDE is the linear transport equation

$$\partial_t \psi_\varnothing(x,t) + v\,\partial_x \psi_\varnothing(x,t) = 0, \qquad \psi_\varnothing(x,0) = \mathbf{1}_{[x_0,L)}(x),$$

where $\psi_\varnothing$ is a binary indicator encoding the domain of constraint activation (initially 1 on the interval $[x_0, L)$ and 0 elsewhere).

Discretization. We discretize the domain $[0, L)$ into N uniform cells of width $\Delta x = L/N$ and advance in time with a step size Δt chosen to satisfy the Courant–Friedrichs–Lewy (CFL) stability condition. Let ψ_i^n denote the cell-averaged value in cell i at timestep n. An upwind finite-difference scheme is employed:

$$\psi_i^{n+1} = \begin{cases} \psi_i^n - c\left(\psi_i^n - \psi_{i-1}^n\right), & v > 0, \\ \psi_i^n - c\left(\psi_{i+1}^n - \psi_i^n\right), & v < 0, \end{cases} \qquad c \equiv \frac{v\,\Delta t}{\Delta x}.$$

This scheme is first-order accurate and monotone, ensuring that no spurious oscillations are introduced at the advancing front.

Parameter choice (example). For concreteness, take

$$N = 64, \quad L = 1.0, \quad v = 0.8, \quad \text{CFL} = 0.8.$$

Then $\Delta x = L/N$, $\Delta t = \text{CFL} \cdot \Delta x / v$, and a final time $T_{\text{final}} = 0.6$ gives a well-resolved snapshot of the wavefront. The spatial grid is

$$x = \text{linspace}(0,\, L - \Delta x,\, N),$$

with initial condition

$$\psi(x, 0) = \begin{cases} 1, & x \geq x_0, \\ 0, & x < x_0, \end{cases} \qquad x_0 = 0.25.$$

Interpretation. The numerical simulation produces an advancing sharp front that propagates at velocity v without distortion or growth in entropy. This behavior is consistent with interpreting $\psi_\varnothing$ as a *constraint indicator* within RSVP theory: the null wavefront marks the propagation of unavailable or suppressed states, and its monotonic advance demonstrates the conservation of structural constraints under passive advection.

C Deferred Automation as a Monad

Let T be a deferral monad on RSVP with unit η and multiplication μ. Let $a : T \Rightarrow \text{Id}$ be *forcing* (evaluation). For a diagram $D : I \to \mathcal{C}$, define

$$X_T \;:=\; a \circ T(\operatorname{colim} D), \qquad X_E \;:=\; \operatorname{colim}\,(a \circ T \circ D).$$

Theorem 3 (Lazy Dominance)**.** *If T preserves colimits and tears exist, then $J(X_T) > J(X_E)$.*

Proof. Since T preserves colimits there is a canonical isomorphism

$$\phi :\; \operatorname{colim}\,(T \circ D) \xrightarrow{\cong} T(\operatorname{colim} D).$$

Postcomposing with a yields a canonical comparison map

$$\kappa :\; X_E = \operatorname{colim}(a \circ T \circ D) \;\longrightarrow\; a\big(\operatorname{colim}(T \circ D)\big) \xrightarrow{a \circ \phi} a\big(T(\operatorname{colim} D)\big) = X_T,$$

natural in D by functoriality of colimits and naturality of a.

Tears mean: there exists a subdiagram of D whose images in $T \circ D$ admit a jointly compatible cocone that *does not* remain jointly compatible after pointwise forcing by a. Equivalently, some cocone $\lambda : T \circ D \Rightarrow Q$ mediates a map $q : \mathrm{colim}(T \circ D) \to Q$ with no preimage under κ from any cocone of $a \circ T \circ D$. Thus κ is a *proper* monomorphism $X_E \hookrightarrow X_T$: eager forcing prunes amalgams that lazy forcing admits.

By assumption, the valuation J is (i) monotone under inclusions and (ii) strictly colimit-superadditive on proper inclusions induced by lost amalgams. Hence

$$J(X_E) \;=\; J\big(\mathrm{im}(\kappa)\big) \;<\; J(X_T).$$

Therefore $J(X_T) > J(X_E)$. $\square$

Corollary 1 (Default-app chokepoint)**.** *Let F be files, E evaluators. Lazy* $X_T = a \circ T(\mathrm{colim} \sum_e \mathrm{run}(e, f))$*, eager* $X_E = \mathrm{colim}\mathrm{run}(e^\star, f)$*. If no evaluator dominates,* $J(X_T) > J(X_E)$*.*

Proof. Suppose F is the set of files and E the set of evaluators. The lazy pipeline constructs

$$X_T = a \circ T\left(\mathrm{colim} \sum_{e \in E} \mathrm{run}(e, f)\right),$$

which preserves all inequivalent amalgams of evaluations prior to forcing. The eager pipeline instead commits to a single evaluator $e^\star$, giving

$$X_E = \mathrm{colim}\,\mathrm{run}(e^\star, f).$$

If no evaluator $e^\star$ dominates—i.e. there is no $e^\star$ such that $\mathrm{run}(e^\star, f) \simeq \mathrm{run}(e, f)$ for all e—then distinct evaluators produce genuinely inequivalent outputs on some f. These inequivalent amalgams survive in the lazy construction, because colimit formation ranges over all $e \in E$ before forcing. In the eager construction, all but one branch are pruned ex ante. This produces a proper inclusion

$$X_E \hookrightarrow X_T,$$

mirroring the "tear" condition of the Chokepoint Mispricing Theorem.

Since the valuation J is assumed monotone under inclusions and strictly colimit-superadditive, it follows that

$$J(X_E) < J(X_T).$$

Thus, under non-dominance, the eager pipeline loses inequivalent amalgams and undervalues epistemic diversity relative to the lazy pipeline. $\square$

Corollary 2 (Alphabetic Chokepoint)**.** *For Phoenician adaptations, if no script dominates, deferred (Phoenician open) yields*

$$J(\mathrm{Div}(A)) \;>\; J(\mathrm{Div}(A_F)).$$

Proof. Let A be the presheaf of all Phoenician-derived script adaptations, and $A_F \subset A$ the subpresheaf corresponding to a single enforced script (e.g. Greek or Latin, which fix vowels eagerly). If no script dominates, then A_F excludes valid local sections that glue in A but not in A_F, producing a tear as in Lemma A. Thus the induced map $\kappa : \mathrm{Div}(A_F) \hookrightarrow \mathrm{Div}(A)$ is a proper monomorphism. Since J is colimit-superadditive, valuation strictly decreases under restriction:

$$J(\mathrm{Div}(A_F)) < J(\mathrm{Div}(A)).$$

Hence, retaining Phoenician's open consonantal regime (deferred vowel forcing) preserves inequivalent amalgams across cultures, maximizing diversity relative to alphabetic chokepoints. $\square$

D Arabic Morphology as a Deferred-Evaluation Monad

Let **Root** be the category of consonantal roots, and **Word** the category of fully assembled forms. Define a deferral monad T on **Root** with unit $\eta : \mathrm{Id} \Rightarrow T$ and multiplication $\mu : T^2 \Rightarrow T$. Vowels $V = \{, , \}$ are evaluation morphisms $\theta_v : T \Rightarrow \mathrm{Id}$, while measures M_k : **Root** $\to$ **Templ** are functors representing Forms I–X. We define the lexicon of a root R under deferred evaluation as

$$(R) \;=\; \mathrm{colim}_k \,\{M_k(\theta_v(R)) \mid v \in V\}.$$

Corollary 3. *Premature forcing yields*

$$J\big(\mathrm{Lex}_{\mathrm{forced}}(R)\big) \;<\; J\big((R)\big).$$

Proof. Let ${}_{\mathrm{forced}}(R)$ denote the set of forms obtained by applying a chosen vowel θ_v to R before functorial expansion by M_k. In contrast, (R) first aggregates over all measures M_k and then applies the vowel morphisms. Because the order of evaluation affects admissible amalgams, there exists at least one tuple (M_k, v) such that $M_k(\theta_v(R))$ is valid in the deferred pipeline but excluded from any eagerly forced pipeline. This produces a proper monomorphism

$$\iota : \;{}_{\mathrm{forced}}(R) \hookrightarrow (R).$$

Since J is monotone under inclusions and strictly superadditive under colimits (by assumption in §A), we have $J({}_{\mathrm{forced}}(R)) < J((R))$. Thus, deferred evaluation preserves inequivalent amalgams and maximizes lexical diversity. $\square$

E Hebrew Abjad as a Lazy-Evaluation Regime

Objects and functors. Let **Root** be the discrete category of (triconsonantal) Hebrew roots $R = c_1c_2c_3$. Let **Templ** be the category of *templatic assemblies* (binyan skeletons with slot policies), and **Form** the category of fully specified word-forms (orthographic strings with niqqud and dagesh). We model:

$$B_b : \textbf{Root} \to \textbf{Templ} \quad \text{for} \quad b \in \mathcal{B} = \{\text{Qal, Nifal, Piel, Pual, Hifil, Hofal, Hitpael}\}$$

as the *binyanim* (measures), and

$$V_\nu : \textbf{Templ} \to \textbf{Form} \quad \text{for} \quad \nu \in \mathcal{N}$$

as *vocalization* (niqqud/dagesh) functors. For a set of admissible vocalizations $\mathcal{N}(T)$ on $T \in$ **Templ**, we regard $\{V_\nu \mid \nu \in \mathcal{N}(T)\}$ as parallel functors refining T to concrete forms.

Deferral monad. Let T : **Templ** $\to$ **Templ** be a deferral (lazy) monad with unit $\eta : \mathrm{Id} \Rightarrow T$ and multiplication $\mu : T^2 \Rightarrow T$ that keeps vocalization undecided; evaluation is E : **Templ** $\to$ **Form** with $V_\nu = E \circ \widetilde{V}_\nu$ for a lazy lift $\widetilde{V}_\nu$: **Templ** $\to$ **Templ**.

Pipelines (orders of composition). For a root R define two natural "pipelines":

$$\text{(eager)} \qquad {}_{\mathrm{forced}}(R) := \;\mathrm{colim}_{b \in \mathcal{B}} \Big(\coprod_{\nu \in \mathcal{N}(B_b R)} V_\nu(B_b R) \Big),$$

$$\text{(deferred)} \qquad (R) := \coprod_{\nu\in\mathcal{N}^\star} V_\nu\Big(\operatorname{colim}_{b\in\mathcal{B}} B_b R \Big),$$

where $\mathcal{N}^\star$ is the set of vocalizations admissible *after* binyan aggregation (i.e., all niqqud patterns compatible with at least one B_bR and any equivalences induced by the colimit). Intuitively, the eager pipeline fixes niqqud *inside* each binyan before gluing, while the deferred pipeline glues binyan skeletons first, then vocalizes.

Valuation. Let J : **Form** $\to \mathbb{R}_{\geq 0}$ be a diversity/utility valuation that is (i) monotone under inclusions and (ii) colimit-superadditive.[1]

Corollary 4 (Lazy advantage for the Hebrew abjad)**.** *If at least two distinct vocalizations are admissible for some binyan (or across binyanim) of R, then*

$$J\big((R)\big) \;>\; J\big(_{\text{forced}}(R)\big).$$

Proof. Write $D_b(R) := \coprod_{\nu\in\mathcal{N}(B_bR)} V_\nu(B_bR)$. By construction there is a canonical comparison map

$$\iota : \operatorname{colim}_b D_b(R) \longrightarrow \coprod_{\nu\in\mathcal{N}^\star} V_\nu\Big(\operatorname{colim}_b B_b R\Big),$$

induced by the universal property of the colimit on $\{B_bR\}_b$ and functoriality of each V_ν. Whenever at least two distinct vocalizations are admissible (within a binyan or across binyanim) that become jointly compatible *after* templatic gluing, the right-hand side strictly contains amalgams not present on the left (eagerly choosing ν before gluing loses cross-binyan amalgams). Hence ι is a proper mono of attainable forms. By monotonicity and colimit-superadditivity of J, we obtain $J(_{\text{forced}}(R)) < J((R))$. □

Worked example (root , 'K-T-V'). Consider $R =$. In *Qal*, common vocalizations include (kātav, perfective), (kotēv, participle). In *Piel*/*Pual* we obtain (kittēv, causative/intensive) and (kuttav, passive). Eagerly fixing, say, the participial niqqud inside each binyan excludes cross-binyan alignments that only become sensible after templatic gluing (e.g., nominalizations and deverbal patterns that share a skeleton but differ in dagesh/niqqud placement). Deferral preserves these additional amalgams, so J strictly increases by Cor. 4.

Natural-language gloss. Hebrew writing often omits niqqud; readers supply vowels from context and morphology. Our result formalizes the intuition that *not committing to vowels too early* keeps more morphological pathways alive—so when context finally *does* force a reading, there are more well-typed options to choose from.

Proof. Let Root be the set of consonantal skeletons and let T be the deferral monad corresponding to vocalization operators. For each $\rho \in$ Root, the immediate (eager) evaluation applies a specific vowelization θ_v to ρ, producing a single lexical outcome. In categorical terms, this corresponds to composing θ_v before forming colimits of the possible derivations.

By contrast, deferred vocalization leaves ρ as a symbolic thunk until the colimit of all available functorial extensions (binyanim, morphological measures) has been formed. Only then is a vocalization operator applied. Since colimits are colimit-superadditive with respect to valuation

[1]These are the same mild assumptions used elsewhere in the paper: J rewards strictly larger attainable sets of forms/analyses.

V (by assumption), applying θ_v after colimit formation yields a strictly larger or equal diversity object.

Formally, let

$$\mathrm{Lex}_{\mathrm{forced}}(\rho) = \mathrm{colim}\{\theta_v(\rho) \mid v \in V\}, \qquad \mathrm{Lex}(\rho) = \theta_v\Big(\mathrm{colim}\{\rho\}\Big).$$

Because forcing reduces the set of amalgams prior to colimit, $\mathrm{Lex}_{\mathrm{forced}}(\rho) \subsetneq \mathrm{Lex}(\rho)$ whenever multiple θ_v are admissible. Thus $V(\mathrm{Lex}_{\mathrm{forced}}(\rho)) < V(\mathrm{Lex}(\rho))$. Hence deferred vocalization maximizes the colimit in the valuation order. □

Dimension	Phoenician	Hebrew	Arabic	Greek	Latin
RSVP–Φ (capacity)	22 consonants as symbolic skeletons; high entropy potential	Consonantal skeletons; Φ remains unevaluated in writing	Consonantal skeletons + explicit vowel markers	Repurposed consonants as vowels; lower entropy	Latinized Etruscan script; fixed consonant+vowel inventory
RSVP–v (flows)	Morphisms = adoption by different cultures; open mappings	Niqqud/maters added selectively; oral context as flow	Vowel diacritics + templatic measures direct flows	Vowel assignment forces evaluation flows early	Administrative flows standardized across empire

Table 1: Comparative evaluation regimes of Phoenician-derived alphabets under RSVP and lazy/eager functional paradigms.

Form	Template	Perfective Active	Imperfective Active	Perfective Passive
I	فَعَلَ	فَعَلَ (faʿala)	يَفْعَلُ (yafʿalu)	فُعِلَ (fuʿila)
II	فَعَّلَ	فَعَّلَ (faʿʿala)	يُفَعِّلُ (yufaʿʿilu)	فُعِّلَ (fuʿʿila)
III	فَاعَلَ	فَاعَلَ (fāʿala)	يُفَاعِلُ (yufāʿilu)	فُوعِلَ (fūʿila)
IV	أَفْعَلَ	أَفْعَلَ (ʾafʿala)	يُفْعِلُ (yufʿilu)	أُفْعِلَ (ʾufʿila)
V	تَفَعَّلَ	تَفَعَّلَ (tafaʿʿala)	يَتَفَعَّلُ (yatafaʿʿalu)	تُفُعِّلَ (tufuʿʿila)
VI	تَفَاعَلَ	تَفَاعَلَ (tafāʿala)	يَتَفَاعَلُ (yatafāʿalu)	تُفُوعِلَ (tufūʿila)
VII	اِنْفَعَلَ	اِنْفَعَلَ (infaʿala)	يَنْفَعِلُ (yanfaʿilu)	اُنْفُعِلَ (unfuʿila)
VIII	اِفْتَعَلَ	اِفْتَعَلَ (iftaʿala)	يَفْتَعِلُ (yaftaʿilu)	اُفْتُعِلَ (uftaʿila)
IX	اِفْعَلَّ	اِفْعَلَّ (ifʿalla)	يَفْعَلُّ (yafʿallu)	اُفْعِلَّ (ufʿilla)
X	اِسْتَفْعَلَ	اِسْتَفْعَلَ (istafʿala)	يَسْتَفْعِلُ (yastafʿilu)	اُسْتُفْعِلَ (ustufʿila)

Table 2: Arabic verb forms (I–X) showing canonical patterns, rendered with . These function as higher-order combinators in the Arabic Assembler calculus.

Category	Template	Example from Root ف–ع–ل	Semantics / Function
Verbal Noun (Maṣdar)	فَعْل / فِعَال / فُعُول	faʿl, fiʿāl, fuʿūl	Abstract action/event (“doing, deed, action”). Multiple canonical templates per form.
Active Participle	فَاعِل	fāʿil	“Doer” (agent noun); maps verb Verbto function $\iota \to o$.
Passive Participle	مَفْعُول	mafʿūl	“Object” (patient noun); maps verb Verbto result/state.
Instrumental Noun	مِفْعَال / مِفْعَلَة	mifʿāl, mifʿala	Tool/device noun (“instrument of doing”).
Place/Time Noun	مَفْعِل / مَفْعَل	mafʿil, mafʿal	Noun of locus or occasion (“place/time of doing”).
Abstract Noun	فُعُولَة / فَعَالَة	fuʿūla, faʿāla	Nominalization of qualities (“quality/state of doing”).

Table 3: Nominal derivations from triconsonantal roots, exemplified with ف–ع–ل. Each acts as a templatic combinator producing Nounor Partictypes in the Arabic Assembler calculus.

F Arabic Verb Forms (I–X) with Voice and Aspect

G Arabic Nominal Derivations

H Typing Hierarchy for Arabic Assembler

$$
\begin{tikzcd}
 & \mathsf{Verb} \arrow[dl, "P_{\text{masdar}}\ (\Phi\mapsto S)"'] \arrow[d, "P_{\text{actPart}}\ (\Phi\mapsto v)"] \arrow[dr, "P_{\text{passPart}}\ (\Phi\mapsto v^{-1})"] \arrow[drr, bend left, "P_{\text{instr}}\ (v\mapsto\Phi)"] \arrow[drrr, bend left, "P_{\text{loc}}\ (S\mapsto\Phi)"] & & & \\
\mathsf{Noun}_{\text{event}}\ (S) & \mathsf{Partic}_{\text{act}}\ (v) \arrow[d, dashed, "agent\mapsto\mathsf{Noun}\ (\Phi\otimes v)"] & \mathsf{Partic}_{\text{pass}}\ (v^{-1}) \arrow[d, dashed, "patient\mapsto\mathsf{Noun}\ (S\otimes v^{-1})"] & \mathsf{Noun}_{\text{instr}}\ (\Phi) & \\
 & \mathsf{Noun}_{\text{agent}}\ (\Phi\otimes v) & \mathsf{Noun}_{\text{patient}}\ (S\otimes v^{-1}) & &
\end{tikzcd}
$$

Legend.

- Φ = latent postural potential.
- v = directed flow of agency.
- S = entropic resolution.
- Verb = live transformation.
- Maṣdar = $\Phi \mapsto S$.
- Active participle = $\Phi \mapsto v$.
- Passive participle = $\Phi \mapsto v^{-1}$.
- Instrument noun = $v \mapsto \Phi$.
- Place/time noun = $S \mapsto \Phi$.

I Arabic Derivation as RSVP Sheaf Theory

Let Root, Templ, Word be categories of roots, templates, words. Measure functors M_k : Root $\to$ Templ, vowel functors V_δ : Templ $\to$ Word. Composite $F_{k,\vec{\delta}} = V_{\delta_n} \circ \cdots \circ M_k$. Presheaf $\mathcal{D} : \mathrm{Op}(X)^{\mathrm{op}} \to$ Cat assigns local derivations. Natural transformations $\alpha_{k\to k'} : M_k \Rightarrow M_{k'}$, $\beta_{\delta\to\delta'} : V_\delta \Rightarrow V_{\delta'}$.

$$
\begin{tikzcd}
\mathbf{Root} \arrow[r, bend left, "M_k"] \arrow[r, bend right, "M_{k'}"'] \arrow[r, phantom, "\Downarrow \alpha_{k\to k'}"] & \mathbf{Templ} \arrow[loop above, "I"] \arrow[r, bend left, "V_\delta"] \arrow[r, bend right] \arrow[r, phantom, "\Downarrow \beta_{\delta\to\delta'}"] & \mathbf{Word} \arrow[r, "-"] & \mathbf{\Lambda}
\end{tikzcd}
$$

Theorem (Arabic as Sheafed RSVP). Arabic derivation is a presheaf of functorial pipelines whose sheaf gluing realizes lexical diversity. Enforcement reduces RSVP valuation unless dominant.

J Chokepoint Field Theory for Arabic Vocabulary Choice

Let X be context manifold, $\mathcal{L}_g \to X$ concept bundle. Field $\sigma_g : X \to \mathcal{L}_g$ minimizes

$$\mathcal{S}[\sigma_g] = \int_X \big[\alpha C_{\text{comp}}(x, \sigma_g(x)) + \beta C_{\text{prest}}(x, \sigma_g(x)) + \gamma \|\nabla_A \sigma_g(x)\|^2 + \lambda V_{\text{choke}}(x, \sigma_g(x))\big]\, d\mu(x).$$

Local choice softmax on $E(x, w)$. Coupling yields fronts.

J.1 Methods for Estimation

Data: Contexts X, concepts G, variants per g. Decompose $E(x, w)$ with proxies. Fit $\alpha, \beta, \gamma, \lambda, T$ via MLE/MAP. Ablations quantify diversity loss.

J.2 Hierarchical Filtering

$V_{\text{choke}} = \theta_{\text{biz}}\phi_{\text{biz}} + \theta_{\text{media}}\phi_{\text{media}} + \theta_{\text{edu}}\phi_{\text{edu}}$. Fit θ by domain.

J.3 Meta-Language Manifold

Systems as charts on a manifold. Functors translate; curvature obstructs.

Theorem (Universality). Pairwise functors exist where chokepoints compatible, yielding a sheaf of manifolds.

J.4 Worked Example: Functorial Mapping

$F(\text{tail-flag}) = \text{wave}$, $G(\text{wave}) = \text{branch-split}$. Composition shows cross-modality coherence.

K Chokepoint Field Theory Beyond Spoken Language

K.1 Neighbor Spotting as Greeting

Gestures: {duck, sit, look-aside, hide}. Semantics: visibility acknowledgment. Chokepoint: line-of-sight constraints.

K.2 Generative Gestural Languages in Animals

Deer/primate: tail-flags, head-bobs. Φ: repertoire, v: signals, S: ambiguity. Generativity: combinations.

K.3 Stigmergic Path Clearing

Paths as axons, animals as neurons. Φ: routes, v: traffic, S: attractors.

Dimension	Human Gestures	Animal Gestures	Stigmergic Forest
RSVP–Φ	Body repertoire	Gestural inventory	Potential routes
RSVP–v	Recognition flows	Directional signals	Movement flows
RSVP–S	Ambiguity of intent	Gesture meanings	Path convergence
Generativity	Posture sequencing	Combinatorial rules	Trace accumulation
Chokepoints	Visibility constraints	Hierarchy/perception	Terrain bottlenecks
Exogenous Substrate	Built environment	Social hierarchy	Forest floor

Table 4: Gestural and exogenous systems as RSVP fields.

K.4 Comparative Table

K.5 Theorem: Universality of Chokepoints

Nonzero $V_{\text{choke}} + \gamma > 0$ yields lock-in and fronts. Defer reduces action unless dominance.

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