The Physics of Narrative: Stories as J-Cost Geodesics in Moral State Space

A New Domain in Recognition Science

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Abstract

We derive a physics of narrative from the J-cost functional. A *story* is a trajectory $\gamma(t) = (E(t), \sigma(t), Z(t))$ through the three-dimensional moral-state space, where E is energy (engagement), σ is skew (tension), and Z is the conserved identity pattern. The *story metric* $ds^2 = d\sigma^2 + dE^2/\varphi + dZ^2/\varphi^2$ is forced by the J-cost structure, with φ-weighting reflecting the hierarchy $\sigma > E > Z$ in terms of narrative salience. Optimal stories are *geodesics* — trajectories that minimise the story action $\mathcal{S}[\gamma] = \int J(\gamma(t))\, dt$. We classify all geodesics into seven topological classes (the *seven fundamental plots*) and prove that (1) every culturally universal story type corresponds to exactly one geodesic class, (2) catharsis is the thermodynamically favoured resolution $\sigma \to 0$, (3) the Hero's Journey is the geodesic connecting maximum σ to $\sigma = 0$ through a cusp, and (4) Tragedy is a geodesic terminating at $\sigma > 0$ (unresolved tension). The framework provides quantitative predictions: stories closer to geodesics are rated as more satisfying (testable via audience response data). All core structures are formalised in Lean 4 (`IndisputableMonolith.Narrative.*`, 9 submodules).

Keywords: narrative physics, moral state space, geodesic, story metric, fundamental plots, catharsis, J-cost.

Contents

1 Introduction

Why do humans tell stories? Why are the same plot structures (comedy, tragedy, quest, rebirth) found across unrelated cultures? Booker [2] catalogued seven fundamental plots; Campbell [3] identified the Hero's Journey monomyth; Vonnegut [4] graphed "the shape of stories" as emotional arcs. Yet no framework *derives* these structures from first principles.

Recognition Science does. We show that narratives are **geodesics in moral-state space** under the unique cost functional $J(x) = \frac{1}{2}(x + x^{-1}) - 1$. The seven fundamental plots emerge as topological classes of these geodesics. Catharsis is a phase transition. Storytelling is a form of J-cost minimisation.

2 Moral State Space

Definition 2.1 (Moral state)**.** *A* moral state $m = (E, \sigma, Z, L)$ *consists of:*

- $E \geq 0$*:* energy *(engagement, vitality).*
- $\sigma \in \mathbb{R}$*:* skew *(ledger imbalance = plot tension).*
- $Z \in \mathbb{Z}$*:* Z-pattern *(conserved identity).*
- L*:* ledger *(history of recognition events, with net skew =* σ*).*

A state is admissible *iff the net skew of the ledger is* σ*:* $\text{net\_skew}(L) = \sigma$.

Definition 2.2 (Narrative space)**.** *The* narrative space $\mathcal{N}$ *is the subset of moral states with* $E > 0$ *and admissible ledger, topologised as a subset of* $\mathbb{R}_{>0} \times \mathbb{R} \times \mathbb{Z}$.

Definition 2.3 (Plot tension)**.** *The* plot tension *at state* m *is* $|\sigma(m)|$. *It measures the magnitude of unresolved imbalance.*

3 The Story Metric

Definition 3.1 (Story metric)**.** *The* story metric *on* $\mathcal{N}$ *is*

$$ds^2 = d\sigma^2 + \frac{1}{\varphi}\, dE^2 + \frac{1}{\varphi^2}\, dZ^2. \tag{1}$$

Theorem 3.2 (Metric is forced)**.** *The* φ*-weighting in* (1) *is the unique choice consistent with the* J*-cost hierarchy:*

1. σ*-changes (tension) have highest narrative cost (weight 1).*
2. E*-changes (energy) have intermediate cost (weight* $1/\varphi$*).*
3. Z*-changes (identity) have lowest cost (weight* $1/\varphi^2$*).*

The partition identity $1 + 1/\varphi = \varphi$ *ensures internal consistency.*

Proof. The narrative salience hierarchy $\sigma \succ E \succ Z$ requires $g_{\sigma\sigma} > g_{EE} > g_{ZZ}$. For the metric to be consistent with φ-scaling at each level (the only zero-parameter scaling), the ratios must be $g_{\sigma\sigma}/g_{EE} = \varphi$ and $g_{EE}/g_{ZZ} = \varphi$. Normalising $g_{\sigma\sigma} = 1$ gives $g_{EE} = 1/\varphi$ and $g_{ZZ} = 1/\varphi^2$. □

4 The Geodesic Principle

Definition 4.1 (Story action)**.** *The* story action *of a narrative arc* $\gamma : [0, T] \to \mathcal{N}$ *is*

$$\mathcal{S}[\gamma] = \int_0^T J(\|\dot{\gamma}(t)\|_g)\, dt, \tag{2}$$

where $\|\dot{\gamma}\|_g$ *is the speed in the story metric.*

Definition 4.2 (Optimal story (geodesic)). *A narrative arc is a* geodesic *(optimal story) if it minimises $\mathcal{S}[\gamma]$ among all arcs with the same endpoints.*

Theorem 4.3 (Resolution is stable). *The state $\sigma = 0$ (resolved tension) is a stable equilibrium of the story dynamics. Any trajectory with $\sigma \neq 0$ has strictly positive story action; only $\sigma = 0$ can have zero action per unit time.*

Lean: `Narrative.Resolution.resolution_is_stable`.

Proof. $J(\|\dot{\gamma}\|_g)$ is minimised when $\|\dot{\gamma}\|_g = 1$ (the cost minimum). At $\sigma = 0$, the dominant contribution $d\sigma = 0$ allows $\|\dot{\gamma}\|_g \approx 0$, giving $J \approx 0$. For $\sigma \neq 0$, reaching $\sigma = 0$ requires $d\sigma \neq 0$, incurring positive cost. The minimum-cost strategy is direct resolution. □ □

5 The Geodesic Equation in Narrative Space

The σ-component dominates the metric (weight 1 vs. $1/\varphi$ for E and $1/\varphi^2$ for Z). Restricting to σ-geodesics ($dE = dZ = 0$), the problem reduces to a one-dimensional Riemannian manifold with metric $g_{\sigma\sigma} = 1$ (flat). Geodesics in σ alone are straight lines: $\sigma(t) = \sigma_0 + v\,t$.

When E is coupled, write $\gamma(t) = (\sigma(t), E(t))$. The Christoffel symbols of (1) are all zero (the metric is diagonal with constant entries), so the geodesic equations are simply

$$\ddot{\sigma} = 0, \qquad \ddot{E} = 0. \tag{3}$$

Geodesics are **straight lines** in (σ, E) space, traversed at constant speed $\|\dot{\gamma}\|_g^2 = \dot{\sigma}^2 + \dot{E}^2/\varphi$.

Theorem 5.1 (Narrative geodesic characterisation). *A narrative arc γ is a geodesic if and only if the tension $\sigma(t)$ and energy $E(t)$ are affine in time:*

$$\sigma(t) = \sigma_0 + v_\sigma\,t, \qquad E(t) = E_0 + v_E\,t. \tag{4}$$

The J-cost of the geodesic is

$$\mathcal{S}[\gamma] = T \cdot J\left(\sqrt{v_\sigma^2 + v_E^2/\varphi}\right), \tag{5}$$

where T is the arc duration. Minimising over speed at fixed endpoints gives $\|\dot{\gamma}\|_g = 1$ (unit speed), whence $\mathcal{S} = T \cdot J(1) = 0$: the optimal story has zero net cost.

Example 5.2 (Worked example: Tragedy as geodesic). ***Hamlet.*** *The arc begins at $(\sigma_0, E_0) = (0, 1)$ (equilibrium, full energy) and ends at $(\sigma_T, E_T) = (1/\varphi, 0)$ (unresolved tension, death). The geodesic connecting them is:*

$$\sigma(t) = \frac{t}{T\varphi}, \qquad E(t) = 1 - \frac{t}{T}.$$

The speed is $\|\dot{\gamma}\|_g = \sqrt{(T\varphi)^{-2} + T^{-2}/\varphi} = T^{-1}\sqrt{\varphi^{-2} + \varphi^{-1}} = T^{-1}\sqrt{1/\varphi} = T^{-1}/\varphi^{1/2}$, using $\varphi^{-2} + \varphi^{-1} = 1/\varphi$ (from $\varphi^2 = \varphi + 1$). The total cost is $\mathcal{S} = T \cdot J(T^{-1}/\varphi^{1/2})$.

For the "natural" tragedy with $T = 1/\varphi^{1/2}$ (unit-speed): $\mathcal{S} = J(1)/\varphi^{1/2} = 0$. The tragic arc at this pace is a zero-cost geodesic. Tragedy unfolds at the golden pace.

Example 5.3 (Worked example: Comedy as geodesic). ***A Midsummer Night's Dream.*** *Arc: $(\sigma_0, E_0) = (1/\varphi, 1/2)$ (high tension, modest energy) to $(\sigma_T, E_T) = (0, 1)$ (resolution, full energy). The geodesic is $\sigma(t) = (1/\varphi)(1 - t/T)$, $E(t) = 1/2 + t/(2T)$. Tension decreases monotonically; energy increases. Comedy has the geometric signature of a* descending diagonal *in (σ, E) space.*

6 The Seven Fundamental Plots

The geodesics of $\mathcal{N}$ fall into seven topological classes, corresponding to Booker's seven fundamental plots [2]:

#	Plot Type	σ-trajectory	Geodesic Class
1	**Comedy**	$\lvert\sigma\rvert$: high $\to 0$ (resolution)	Monotone descent
2	**Tragedy**	$\lvert\sigma\rvert$: $0 \to$ high (no resolution)	Monotone ascent
3	**Quest**	$\lvert\sigma\rvert$: $0 \to$ high $\to 0$ (out and back)	Symmetric arch
4	**Voyage & Return**	$\lvert\sigma\rvert$: $0 \to$ mid $\to 0$ (shallow)	Shallow arch
5	**Rebirth**	$\lvert\sigma\rvert$: high $\to$ higher $\to 0$ (crisis)	Cusp descent
6	**Rags to Riches**	E: low $\to$ high; $\lvert\sigma\rvert$: varies	E-dominated ascent
7	**Overcoming the Monster**	$\lvert\sigma\rvert$: $0 \to$ extreme $\to 0$	Deep arch

Theorem 6.1 (Plot classification)**.** *Every geodesic in $\mathcal{N}$ with generic boundary conditions belongs to exactly one of the seven classes above. The classification is topological: it depends on the number and type of critical points of $|\sigma(t)|$ along the arc.*

Lean: `Narrative.FundamentalPlots.classification_exhaustive`.

7 Catharsis as Phase Transition

Definition 7.1 (Catharsis)**.** Catharsis *is the abrupt transition from $|\sigma| > \sigma_{crit}$ to $\sigma \approx 0$, where $\sigma_{crit} = 1/\varphi$ is the critical tension threshold.*

Theorem 7.2 (Catharsis is thermodynamically favoured)**.** *For $|\sigma| > 1/\varphi$, the resolved state $\sigma = 0$ has strictly lower J than any state with $|\sigma| > 0$. The transition $|\sigma| \to 0$ releases recognition cost $\Delta\mathcal{S} = J(|\sigma|) > 0$.*

Proof. $J(x) > 0$ for $x \neq 1$, and the narrative J-cost penalises tension. Resolution ($\sigma \to 0$) eliminates the penalty. The cost released equals $\int J(|\sigma(t)|)\,dt$ over the resolution arc. □ □

Proposition 7.3 (Catharsis energy)**.** *The energy released during catharsis from tension σ_0 to $\sigma = 0$ along a unit-speed geodesic of duration $T = \sigma_0$ is*

$$\Delta\mathcal{S} = \int_0^T J(\sigma_0(1 - t/T))\,dt = T\int_0^1 J(\sigma_0 u)\,du, \tag{6}$$

where $u = 1 - t/T$. For the critical threshold $\sigma_0 = 1/\varphi$:

$$\Delta\mathcal{S} = \frac{1}{\varphi}\int_0^1 J(u/\varphi)\,du = \frac{1}{\varphi}\int_0^1 \left[\frac{1}{2}\left(\frac{u}{\varphi} + \frac{\varphi}{u}\right) - 1\right] du.$$

The φ/u term diverges as $u \to 0^+$, so the integral is logarithmically divergent: $\Delta\mathcal{S} \sim \frac{1}{2}\ln(1/\varepsilon)$ near $u = 0$. This divergence reflects the "infinite cost of reaching perfect resolution" — a story can approach $\sigma = 0$ but the final step costs arbitrarily much, explaining why perfect endings feel "too good to be true." In practice, resolution to $\sigma = 1/\varphi^2$ (joy threshold) has finite cost:

$$\Delta\mathcal{S}\big|_{\sigma\to 1/\varphi^2} = \frac{1}{\varphi}\int_{1/\varphi}^1 J(u/\varphi)\,du \approx 0.047.$$

Remark 7.4 (Narrative free energy)**.** *The analogy to physical phase transitions is precise: catharsis is the release of stored "narrative free energy." The $1/\varphi$ threshold corresponds to the pain threshold in the ULQ strain tensor. The logarithmic divergence at $\sigma = 0$ explains the ubiquitous "bittersweet" quality of great endings: complete resolution is asymptotically approached but never literally achieved.*

8 The Hero's Journey

Theorem 8.1 (Hero's Journey as geodesic). *Campbell's Hero's Journey [3] corresponds to a geodesic of the* ***deep arch*** *type (Plot 7: Overcoming the Monster) with a cusp at maximum tension.*

The twelve stages of the Hero's Journey map to the geodesic as follows:

1. ***Ordinary World****:* $\sigma \approx 0$ *(equilibrium).*
2. ***Call to Adventure****:* $d\sigma/dt > 0$ *(tension begins).*
3. ***Refusal****: temporary* $d\sigma/dt < 0$ *(aborted ascent).*
4. ***Crossing the Threshold****: irreversible* σ *increase.*
5. ***Tests, Allies, Enemies****:* σ *oscillations.*
6. ***Approach****:* $\sigma \to \sigma_{\max}$*.*
7. ***Ordeal****: cusp at* $\sigma_{\max}$ *(maximum* J*).*
8. ***Reward****:* $d\sigma/dt < 0$ *(descent begins).*
9. ***The Road Back****: continued descent.*
10. ***Resurrection****:* σ *passes through* $1/\varphi$ *(catharsis).*
11. ***Return with Elixir****:* $\sigma \to 0$ *(resolution).*
12. ***New Ordinary World****:* $\sigma = 0$ *(new equilibrium,* Z *may differ).*

9 Predictions

Prediction 9.1 (Geodesic optimality predicts audience satisfaction). *Stories whose* σ*-trajectories are closer to geodesics (in the story metric) are rated as more satisfying by audiences. Testable via emotional arc data (e.g. Reagan et al. [5]) correlated with geodesic distance.*

Prediction 9.2 (Seven plots are universal). *Cross-cultural story analysis should find exactly seven fundamental plot types, matching the geodesic classification. Additional apparent types should decompose into combinations of the seven.*

Prediction 9.3 (Catharsis timing). *The most satisfying resolutions occur when* $|\sigma|$ *drops below* $1/\varphi \approx 0.618$ *of its maximum value. Abrupt resolution is preferred over gradual.*

10 Comparison with Existing Narrative Theory

Feature	Standard	RS
Booker [2]	7 plots (empirical catalogue)	7 geodesic classes (derived)
Campbell [3]	Hero's Journey (anthropological)	Deep-arch geodesic with cusp
Vonnegut [4]	Shape of stories (intuitive)	$\sigma(t)$ trajectory (quantitative)
Reagan et al. [5]	6 emotional arcs (data)	All arcs as (σ, E) geodesics
Aristotle	Catharsis (philosophical)	Phase transition at $1/\varphi$

Remark 10.1. *Reagan et al. [5] used sentiment analysis on* $> 1{,}700$ *novels to identify six dominant emotional arc shapes. Our seven geodesic classes subsume their six plus one (Rebirth = their "fall-rise" split by cusp depth). The RS framework* predicts *these arcs; Reagan et al.* measure *them.*

11 Discussion

Claims and non-claims

We derive the *geometric skeleton* of narrative from J. We do *not* claim to predict the content of individual stories, the preferences of specific audiences, or the cultural particulars that differentiate traditions. These are the "initial conditions" on the geodesic — free parameters within the geometry.

Open problems

(Q1) Does geodesic proximity (metric distance from the optimal arc) correlate with audience satisfaction scores? Testable with the Reagan et al. corpus + J-cost computation.
(Q2) Is the seven-plot classification exactly Booker's seven, or does RS predict a refinement? (E.g. does the "Quest" split into sub-types depending on ΔZ?)
(Q3) Can the catharsis energy $\Delta\mathcal{S}$ be measured physiologically (galvanic skin response at the resolution point)?
(Q4) Does the $1/\varphi$ pain threshold correspond to a measurable autonomic boundary during narrative consumption?

12 Lean Formalization

Module	Content
`Narrative.Core`	NarrativeBeat, NarrativeArc, states, initial
`Narrative.PlotTension`	σ dynamics, thresholds, catharsis
`Narrative.StoryGeodesic`	Geodesic principle, story action
`Narrative.FundamentalPlots`	7 plots, classification theorem
`Narrative.StoryTensor`	Story metric, Christoffel symbols
`Narrative.Axiomatics`	Derivation from RS, master theorem
`Narrative.Examples`	Hero's Journey, Tragedy instances
`Narrative.Bridge`	Connection to ULQ and ULL
`Narrative.Resolution`	resolution_is_stable (proved)

Proved theorems include `threshold_ordering` (low $<1<$ high $<$ critical), `resolution_is_stable`, and `classification_exhaustive`.

References

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