**《残破动态演化论》**

**---------------复杂性是尺度函数**

**Fragmented Dynamic Evolution**

**---------------Complexity Is a Function of Scale**

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Note on Axiom Redundancy

The axiom set is intentionally not minimal in the sense of logical independence.

Axiom 3 restates, in negated form, a structural consequence of Axiom 0.

This redundancy is preserved to prevent misinterpretation of scale-dependent complexity as implying scale invariance.

关于公理冗余的说明

本公理集合并未刻意追求逻辑独立意义下的最小性。

第 3 条公理以否定形式重述了第 0 条公理的一个结构性推论。

保留该冗余，旨在防止将复杂性的尺度依赖性误解为尺度不变性。

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公理 0丨尺度—复杂性公理(尺度依赖)

复杂性不是系统的内在属性，

而是系统在给定观察尺度下的可区分结构密度。

形式化表述：

对任意系统 $S$，其复杂性 $C$ 定义为尺度 $\sigma$ 的函数：

$$C(S,\sigma) = f(\sigma)$$

其中$f$随尺度变化而变化，与系统是否“本质复杂”无关。

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Axiom 0 | Scale‑Complexity Axiom（scale dependence）

Complexity is not an intrinsic property of a system,

but the density of distinguishable structure under a given observation scale.

Formal statement:

For any system $S$, complexity $C$ is a function of scale $\sigma$:

$$C(S,\sigma)=f(\sigma)$$

where $f$ varies with scale and is independent of any intrinsic notion of “complexity.”

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**推论（不证明） / Corollary (no proof)**

不存在绝对的“简单系统”或“复杂系统”。

There exist no absolute “simple systems” or “complex systems”.

在不同尺度下，同一系统可同时呈现为简单或复杂。

At different scales, the same system may simultaneously appear simple or complex.

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**定义 1 | 差异（$\Delta$）**

差异是系统中可被判定的最小变化量。

没有差异，系统状态不可区分。

形式化定义：

设系统状态为$x_t$，其演化为$x_t+1$，则差异定义为：

$$\Delta t := d(x_{t+1}, x_t)$$

其中$d(\cdot,\cdot)$为状态空间上的度量。

---

Definition 1 | Difference ($\Delta$)

Difference is the minimal change in a system that can be distinguished.

Without difference, system states are indistinguishable.

Formal definition:

Let the system state be $x_t$ and its evolution $x_t + 1$.

The difference is defined as:

$$\Delta t := d(x_{t+1}, x_t)$$

Where $d(\cdot,\cdot)$ is a metric on the state space.

---

**约定 / Convention**

$$\Delta_t = 0 \iff x_{t+1} = x_t$$

---

**注记（不解释） / Note (no elaboration)**

$\Delta_t = 0$ :不可判定 | Undecidable

$\Delta_t > 0$ :可判定 | Decidable

---

**公理 1 | 可判定性公理（判定所需差异）**

系统只有在存在非零差异时，才具有可判定性。
无差异状态下，任何判断与更新都不可发生。

形式化表述：

$$\Delta t > 0 \iff \text{the state } x_t \text{ is decidable}$$

若：

$$\varDelta_t = 0$$

则系统处于不可判定态。

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**Axiom 1 | Decidability Axiom（decidability condition）**

A system is decidable if and only if a non-zero difference exists.

In the absence of difference, no judgment or update can occur.

Formal statement:

$$\Delta_t > 0 \iff \text{the state } x_t \text{ is decidable}$$

If:

$$\varDelta_t = 0$$

the system is undecidable.

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**直接推论 / Immediate Consequences**

不可判定 ⇒ 不可学习

Undecidable ⇒ Unlearnable

不可判定 ⇒ 不可推理

Undecidable ⇒ Uninferable

不可判定 ⇒ 不可演化

Undecidable ⇒ Non-evolvable

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**否定式表述（等价） / Negated Form (Equivalent)**

$$\Delta_t = 0 \Rightarrow x_t + 1 = x_t$$

---

**定义 2 | 死循环（固定点陷阱）**

死循环是指系统进入状态自指，

状态更新不再引入任何可判定差异。

形式化定义：

若存在时间 $T$ ，使得对所有 $t \geq T$:

$$\Delta_t = 0$$

等价地：

$$x_t + 1 = x_t$$

则系统进入死循环。

---

**Definition 2 | Dead Loop (Fixed-Point Trap)**

A dead loop is a state of self-reference in which

state updates introduce no distinguishable difference.

Formal definition:

If there exists a time $T$ such that for all $t \geq T$ :

$$\Delta_t = 0$$

equivalently:

$$x_t + 1 = x_t$$

the system is trapped in a dead loop.

---

**性质 / Properties**

> 死循环是状态层面的停滞，不是错误
>
> A dead loop is stagnation at the state level, not an error
>
> 死循环不产生新信息
>
> Dead loops generate no new information
>
> 死循环不可通过内部推理自发解除
>
> Dead loops cannot be resolved spontaneously through internal reasoning

---

**等价表述 / Equivalent Form**

存在固定点 $x*$，满足：

There exists a fixed point $x*$ such that:

$$x* = F(x*)$$

---

**注记（不扩展） / Note (no elaboration)**

稳定 $\neq$ 演化

Stability $\neq$ evolution

固定点 $\neq$ 生存

A fixed point $\neq$ survival

---

**定义 3 | 演化**

演化是指系统状态在时间序列中持续产生可判定差异的过程。

演化不要求改进，仅要求避免死循环。

形式化定义：

系统在时间区间 $[0, T]$ 内被称为发生演化，当且仅当：

$$\forall t \in \{0, T-1\},\ \Delta_t > 0$$

---

**Definition 3 | Evolution**

Evolution is the process by which a system continuously generates decidable differences over time.

Evolution does not require improvement; it only requires avoidance of dead loops.

Formal definition:

A system is said to evolve over the interval $[0, T]$ if and only if:

$$\forall t \in \{0, T-1\},\ \Delta_t > 0$$

---

**直接含义 / Direct Implications**

演化 $\neq$ 优化

Evolution $\neq$ Optimisation

演化 $\neq$ 目标导向

Evolution $\neq$ Goal-oriented

演化 = 可继续

Evolution = Continuable

---

**否定式 / Negated Form**

若存在 $t$ 使 $\Delta_t = 0$，则演化在 $t$ 处终止。

If there exists $t$ such $\Delta_t = 0$ that, then evolution terminates at $t$.

---

**注记（不展开） / Note (no elaboration)**

演化是最弱的“存活”条件

Evolution is the weakest condition of “survival”

任何更强性质必须以演化为前提

Any stronger property must presuppose evolution

---

**定义 4丨动态**

动态是指系统通过持续调整其状态更新方式，以维持非零差异的能力。

动态不是变化本身，而是对变化的响应结构。

形式化定义：

系统具有动态性，当且仅当存在更新算子$F_t$，使得：

$$x_{t+1} = F_t(x_t)$$

且：

$$F_t \neq F_{t+1} \quad \text{对某些} \; t$$

---

Definition 4 | Dynamics

Dynamics refers to a system’s capacity to adjust its state-update mechanism in order to maintain non-zero differences.

Dynamics is not change itself, but the structural response to change.

Formal definition:

A system is dynamic if and only if there exists a time-dependent update operator $F_t$ such that:

$$x_{t+1} = F_t(x_t)$$

and:

$$F_t \neq F_{t+1} \; \text{for some} \; t$$

---

直接含义 / Direct Implications

**静态更新规则 ⇒ 易陷入死循环**

Static update rules ⇒ prone to dead loops

**动态更新规则 ⇒ 可延缓或避免死循环**

Dynamic update rules ⇒ can delay or avoid dead loops

---

**等价刻画** / Equivalent Characterization

存在至少一个 $t$，使系统对差异作出结构性响应：

There exists at least one $t$ at which the system responds structurally to differences:

$$\frac{\partial F_t}{\partial t} \neq 0$$

---

**注记（不解释）** / Note (no elaboration)

动态是演化的必要条件

Dynamics is a necessary condition for evolution

但不是充分条件

but not a sufficient condition

---

**公理 2丨残破公理(差异不可消除)**

在残破系统中，差异不可被完全消除。

任意演化只能将差异压缩，而不能归零。

形式化表述：

存在常数 $\varepsilon > 0$，使得对任意时间 $t$ ：

$$\Delta_t \geq \varepsilon$$

且不存在可行更新策略，使得：

$$\lim_{t\to\infty} \Delta_t = 0$$

---

Axiom 2 | Fragmentation Axiom (Non-Zero Lower Bound/irreducibility)

In a fragmented system, difference cannot be fully eliminated.

Any evolution may compress difference but cannot reduce it to zero.

Formal statement:

There exists a constant $\varepsilon > 0$ such that for all times $t$:

$$\Delta_t \geq \varepsilon$$

And no admissible update strategy satisfies:

$$\lim_{t\to\infty} \Delta_t = 0$$

---

**直接含义 / Direct Implications**

完全收敛不可达

Complete convergence is unattainable

完美修复不存在

Perfect repair does not exist

残破是演化前提，而非缺陷

Fragmentation is a prerequisite for evolution, not a defect

---

**等价表述 / Equivalent Form**

系统不存在全局吸引子 $x^{\backslash *}$ ，使：

There exists no global attractor x^* such that:

$$x_t \to x^{\backslash *} \text{ 且 } \Delta t \to 0$$

$$x_t \to x^{\backslash *} \text{ and } \Delta t \to 0$$

---

**注记（不扩展） / Note (no elaboration)**

残破保证可判定性

Fragmentation guarantees decidability

残破阻断终态幻想

Fragmentation blocks terminal-state fantasies

---

**定义 5 | 尺度**

尺度是用于区分差异的解析分辨率。

尺度决定哪些差异可被观察，哪些被压缩为零。

形式化定义：

设尺度参数为$\sigma > 0$，在尺度$\sigma$下的可观测差异定义为：

$$\Delta t^{(\sigma)} := \Phi_\sigma(\Delta_t)$$

其中 $\Phi\sigma$为尺度映射算子，满足：

$$\Phi_\sigma(\Delta) \to 0 \text{ 当 } \Delta \ll \sigma$$

$$\Phi_\sigma(\Delta) \approx \Delta \text{ 当 } \Delta \gg \sigma$$

---

Definition 5 | Scale

Scale is the resolution at which differences are parsed.

Scale determines which differences are observable and which collapse to zero.

Formal definition:

Let the scale parameter be $\sigma > 0$.

The observable difference at scale $\sigma$ is:

$$\Delta t^{(\sigma)} := \Phi_\sigma(\Delta_t)$$

where the scale-mapping operator $\Phi\sigma$ satisfies:

$$\Phi_\sigma(\Delta) \to 0 \text{ as } \Delta \ll \sigma$$

$$\Phi_\sigma(\Delta) \approx \Delta \text{ as } \Delta \gg \sigma$$

---

**直接含义** / Direct Implications

差异是否存在，取决于尺度

Whether differences exist depends on scale

零差异可能是尺度产物

Zero difference may be a scale-induced artifact

演化在某尺度下可见，在另一尺度下消失

Evolution may be observable at one scale and disappear at another

---

**等价刻画** / Equivalent Characterization

存在尺度$\sigma 1, \sigma 2$，使得:

There exist scales $\sigma 1$ and $\sigma 2$ such that:

$$\Delta t^{(\sigma_1)} > 0 \ \wedge \ \Delta t^{(\sigma_2)} = 0$$

---

**注记（不解释） / Note (no elaboration)**

尺度不是视角

Scale is not a perspective

尺度是算子

Scale is an operator

---

**定义 6 | 复杂性**

复杂性是在给定尺度下，系统中可被区分的差异结构的密度。

复杂性不是结构本身，而是结构在尺度映射后的显影结果。

形式化定义：

在尺度$\sigma$下，系统的复杂性定义为：

$$C(S,\sigma) := D\left(\{\Delta t^{(\sigma)} > 0\}\right)$$

其中：

$\Delta_t^{(\sigma)}$ 为尺度$\sigma$下的可观测差异

$D(\cdot)$为差异分布的密度或计数函数

---

**Definition 6 | Complexity**

Complexity is the density of distinguishable difference structures in a system under a given scale.

Complexity is not the structure itself, but the manifestation of structure after scale mapping.

Formal definition:

At scale $\sigma$, the complexity of system $S$ is defined as:

$$C(S,\sigma) := D\big(\{\Delta t^{(\sigma)} > 0\}\big)$$

where:

$\Delta_t^{(\sigma)}$ denotes observable differences at scale $\sigma$

$D(\cdot)$ is a density or counting functional over differences

---

**直接含义 / Direct Implications**

复杂性随尺度变化

Complexity varies with scale

不存在绝对复杂度

There is no absolute complexity

简单性是低分辨率下的复杂性塌缩

Simplicity is the collapse of complexity under low resolution

---

**等价表述 / Equivalent Form**

对同一系统 $S$，存在尺度 $\sigma_1 \neq \sigma_2$：

For the same system $S$ ,there exist scales $\sigma_1 \neq \sigma_2$ such that:

$$C(S,\sigma_1) \ll C(S,\sigma_2)$$

---

**注记（不扩展） / Note (no elaboration)**

复杂性不是本体论量

Complexity is not an ontological quantity

复杂性是观测结果

Complexity is an observational result

---

**公理 3丨复杂性—尺度公理**

对任意系统，复杂性完全由尺度决定。

在固定尺度下，复杂性是确定的；

在尺度变化下，复杂性随之变化。

形式化表述：

对任意系统 $S$ ，存在函数 $f$ ，使得：

$$C(S,\sigma) = f(\sigma)$$

且：

$$\frac{\partial C}{\partial \sigma} \neq 0$$ 在一般情形下

---

**Axiom 3 ｜ Complexity‑Scale Axiom (anti-invariance constraint)**

For any system, complexity is fully determined by scale.

At a fixed scale, complexity is determinate;

under scale variation, complexity changes accordingly.

Formal statement:

For any system $S$ , there exists a function $f$ such that:

$$C(S, \sigma) = f(\sigma)$$

and, in general:

$$\frac{\partial C}{\partial \sigma} \neq 0$$

---

**直接推论 / Immediate Consequences**

不存在尺度无关的复杂性

There is no scale-independent complexity

复杂性不可作为系统的本体属性

Complexity cannot be treated as an ontological property of a system

“简单 / 复杂”仅是尺度标签

“Simple / complex” are merely scale labels

---

**否定式（等价） / Negated Form (Equivalent)**

若复杂性在所有尺度下不变，则系统不含可区分结构：

If complexity remains invariant across all scales, then the system contains no distinguishable structure.

$$\forall \sigma,\ C(S, \sigma) = \text{const} \Rightarrow \Delta t^{(\sigma)} = 0$$

**注记（不解释） / Note (no elaboration)**

复杂性不是被发现的

Complexity is not discovered

复杂性是被显影的

Complexity is developed

---

**引理 4 | 简单与复杂的尺度同构**

所谓“简单系统”与“复杂系统”在结构上是同构的，

它们的差异仅来自所采用的观察尺度。

形式化表述：

对任意系统 $S$ ，存在尺度对$\sigma_s$，$\sigma_c$，使得：

$$C(S, \sigma_s) \ll C(S, \sigma_c)$$

但在尺度变换算子 $\Phi$ 下，二者满足：

$$\Phi_{\sigma_c \to \sigma_s}(S) \cong S$$

---

**Lemma 4 | Scale Isomorphism of Simplicity and Complexity**

So-called “simple systems” and “complex systems” are structurally isomorphic;

their difference arises solely from the observation scale.

Formal statement:

For any system $S$ , there exist scales $\sigma_s$, $\sigma_c$ such that:

$$C(S, \sigma_s) \ll C(S, \sigma_c)$$

yet under a scale transformation operator $\Phi$ :

$$\Phi_{\sigma_c \to \sigma_s}(S) \cong S$$

---

**直接含义 / Direct Implications**

简单不是结构性质

Simplicity is not a structural property

复杂不是结构性质

Complexity is not a structural property

二者可通过尺度变换相互映射

The two can be mutually mapped through scale transformation

---

**否定性推论 / Negative Consequence**

不存在在所有尺度下同时“简单”或“复杂”的系统。

There exists no system that is simultaneously “simple” or “complex” across all scales.

---

**注记（不扩展） / Note (no elaboration)**

分类失效于尺度切换

Classification fails under scale switching

标签不随系统走

Labels do not follow the system

---

**定义 7 | 演化失败**

演化失败是指系统无法持续产生可判定差异，

从而使演化在有限时间内终止的状态。

形式化定义：

系统在时间 $t$ 发生演化失败，当且仅当满足以下任一条件：

$$\textbf{(F1)} \quad \Delta_t^{(\sigma)} = 0$$ 对某一有效尺度对某一有效尺度 $\sigma$

或

$$\textbf{(F2)} \quad \Delta_t^{(\sigma)} \to \infty$$

---

Definition 7 | Evolutionary Failure

Evolutionary failure occurs when a system can no longer sustain decidable differences,

causing evolution to terminate in finite time.

Formal definition:

A system undergoes evolutionary failure at time $t$ if and only if at least one of the following holds:

$$\textbf{(F1)} \quad \Delta_t^{(\sigma)} = 0$$ for some admissible scale $\sigma$

Or

$$\text{(F2)} \quad \Delta_t^{(\sigma)} \to \infty$$

---

**两类失败 / Two Failure Modes**

**1.僵死失败 | Deadlock Failure**

差异被尺度压缩为零

Differences are compressed to zero by scale

判定门关闭

The decision gate closes

系统陷入死循环

The system falls into a dead loop

形式条件：

Formal condition:

$$\exists\sigma : \Delta_t^{(\sigma)} = 0$$

---

**2.发散失败 | Divergence Failure**

差异超出任意尺度解析能力

Differences exceed the resolving capacity of any scale

判定失效

Decidability collapses

噪声淹没结构

Noise overwhelms structure

形式条件：

Formal condition:

$$\forall\sigma : \Delta_t^{(\sigma)} \to \infty$$

---

**直接含义 / Direct Implications**

演化失败不等同于崩溃

Evolutionary failure is not equivalent to collapse

演化失败是可判定性的丧失

Evolutionary failure is the loss of decidability

成功演化要求差异落在尺度可解析区间内

Successful evolution requires differences to lie within the scale-resolvable range

---

**注记（不解释） / Note (no elaboration)**

演化不是无限的

Evolution is not infinite

失败是结构事件

Failure is a structural event

---

**定理 1｜零差异系统不可演化**

任意在某一有效尺度下差异为零的系统，

在该尺度下不可发生演化。

形式化表述：

若存在尺度$\sigma$ 与时间 $t$ ，使得：

$$\Delta_t^{(\sigma)} = 0$$

则在尺度 $\sigma$ 下，系统演化终止：

$$\forall t' \geq t\ ,\ \Delta t_{\prime}^{(\sigma)} = 0$$

---

**Theorem 1 | Zero-Difference Systems Cannot Evolve**

Any system whose difference is zero at some admissible scale

cannot evolve at that scale.

Formal statement:

If there exists a scale $\sigma$ and time $t$ such that:

$$\Delta_t^{(\sigma)} = 0$$

then evolution at scale $\sigma$ terminates:

$$\forall t' \geq t\ ,\ \Delta t_{\prime}^{(\sigma)} = 0$$

---

**证明（略） / Proof (omitted)**

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**直接推论 / Immediate Corollaries**

> 静态完美态 ≡ 演化终点
>
> A static perfect state ≡ the endpoint of evolution

---

“完全平衡”在任一尺度上等价于停机

“Complete equilibrium” at any scale is equivalent to halting

---

**否定式（等价） / Contrapositive (Equivalent)**

若系统在尺度 $\sigma$ 上持续演化，则：

If the system continues to evolve at scale $\sigma$ , then:

$$\forall t\,,\ \mathit{\Delta}_t^{(\sigma)} > 0$$

---

**定理 2 | 残破是演化的必要条件**

任意能够持续演化的系统，必然包含不可消除的差异源。

若系统不存在残破结构，则其演化必然在有限时间内终止。

形式化表述：

若系统在尺度 $\sigma$ 下对所有时间 $t$ 满足：

$$\Delta_t^{(\sigma)} > 0$$

则必然存在常数 $\varepsilon > 0$ ，使得：

$$\inf_t \Delta_t^{(\sigma)} \geq \varepsilon$$

---

Theorem 2 | Fragmentation Is a Necessary Condition for Evolution

Any system capable of sustained evolution must contain an irreducible source of difference.

If a system has no fragmented structure, its evolution necessarily terminates in finite time.

Formal statement:

If a system evolves at scale $\sigma$ for all times $t$ :

$$\Delta_t^{(\sigma)} > 0$$

then there exists a constant $\varepsilon > 0$ such that:

$$\inf_t \Delta_t^{(\sigma)} \geq \varepsilon$$

---

**证明要点（不展开） / Proof Sketch (omitted)**

若 $\inf_t \Delta_t^{(\sigma)} = 0$，则存在时间序列使差异趋于零

If $\inf_t \Delta_t^{(\sigma)} = 0$, then there exists a time sequence along which the difference tends to zero

由定理 1，演化在该尺度终止

By Theorem 1, evolution terminates at that scale

矛盾

Contradiction

---

**直接推论 / Immediate Consequences**

**完美修复 ⇒ 演化中断**

Perfect repair ⇒ Evolution halts

**残破不是缺陷，而是条件**

Rupture is not a defect, but a condition

---

**逆否命题** / Contrapositive

若系统不存在非零下界差异，则其演化不可持续。

If a system lacks a non-zero lower bound of difference, its evolution is not sustainable.

---

**注记（不解释）** / Note (no elaboration)

演化依赖缺损

Evolution depends on deficiency

完整性与演化不相容

Integrity is incompatible with evolution

---

**定理 3丨复杂性在中间尺度达到极值**

对任意含可区分结构的系统，复杂性作为尺度函数 $C(S,\sigma)$

在极小尺度与极大尺度处趋于退化，并在中间尺度出现极值区间。

形式化表述：

存在尺度区间 $\sigma \in (\sigma_{\min}, \sigma_{\max})$ ，使得：

$C(S,\sigma)$在该区间内取得极大值或平台值

并满足边界退化：

$$\lim_{\sigma \to 0^+} C(S,\sigma) = 0 \quad , \quad \lim_{\sigma \to \infty} C(S,\sigma) = 0$$

---

**Theorem 3 | Complexity Attains an Extremum at Intermediate Scales**

For any system with distinguishable structure, the scale-function $C(S,\sigma)$ degenerates at extremely small and extremely large scales, and exhibits an extremum (or plateau) at intermediate scales.

Formal statement:

There exists a scale interval $\sigma \in (\sigma_{\min}, \sigma_{\max})$ such that:

$C(S,\sigma)$ attains a maximum or plateau on that interval

with boundary degeneracy:

$$\lim_{\sigma \to 0^+} C(S,\sigma) = 0 \quad , \quad \lim_{\sigma \to \infty} C(S,\sigma) = 0$$

---

**证明要点（不展开） / Proof Sketch (omitted)**

$\sigma \to 0^+$：差异被分解为噪声级碎片，结构密度可区分性崩解

$\sigma \to 0^+$: differences fragment into noise-level shards; structural density becomes indistinguishable

$\sigma \to \infty$：差异被整体平均化，结构被压缩为零

$\sigma \to \infty$: differences are globally averaged; structure is compressed to zero

因此在中间尺度出现结构显影窗口

Hence, a structural visibility window emerges at intermediate scales

---

**直接推论 / Immediate Consequences**

“复杂”不是属性，是窗口

“Complex” is not a property; it is a window

“简单”不是本质，是压缩

“Simple” is not an essence; it is compression

研究活动本质是寻找

The essence of research is to locate $(\sigma_{\min}, \sigma_{\max})$

---

**注记（不解释） / Note (no elaboration)**

极值不必唯一

Extrema need not be unique

可为平台区

They may form a plateau region

---

**引理 5 | 尺度切换可恢复演化**

当系统在某一尺度下发生演化失败时，

存在另一尺度使系统重新获得可判定性，从而恢复演化。

形式化表述：

若存在尺度 $\sigma_1$ 与时间 $t$ ，使得：

$$\Delta_t^{(\sigma_1)} = 0$$

则可能存在尺度 $\sigma_2 \neq \sigma_1$，满足：

$$\Delta_t^{(\sigma_2)} > 0$$

---

Lemma 5 | Scale Switching Can Restore Evolution

When a system undergoes evolutionary failure at one scale,

there may exist another scale at which decidability is restored and evolution resumes.

Formal statement:

If there exists a scale $\sigma_1$ 与时间 $t$ such that:

$$\Delta_t^{(\sigma_1)} = 0$$

then there may exist a different scale $\sigma_2 \neq \sigma_1$ such that:

$$\Delta_t^{(\sigma_2)} > 0$$

---

**直接含义 / Direct Implications**

演化失败是尺度相关的

Evolutionary failure is scale-dependent

“停滞”并非系统终结

“Stagnation” does not imply system termination

尺度切换是最小恢复操作

Scale switching is the minimal recovery operation

---

**限制条件 / Limitations**

不保证存在 $\sigma_2$

The existence of $\sigma_2$ is not guaranteed

若所有尺度下 $\Delta^{(\sigma)} = 0$，则系统整体终止

If $\Delta^{(\sigma)} = 0$ across all scales, the system terminates globally

---

**注记（不解释） / Note (no elaboration)**

尺度切换不是修复

Scale switching is not repair

是重显

It is re-manifestation

---

**定义 8 | 尺度窗口（解析区间）**

尺度窗口是指一组尺度区间，在该区间内系统差异既不塌缩为零，也不发散到不可解析，从而保持可判定性与可演化性。

形式化定义：

存在尺度区间 $\Sigma := [\sigma_{\min}, \sigma_{\max}]$ ，使得对所有

$\sigma \in \Sigma$ :

$$0 < \Delta_t^{(\sigma)} < \infty$$

---

Definition 8 | Scale Window (Resolvable Interval)

A scale window is a range of scales within which system differences neither collapse to zero
nor diverge beyond resolution, thus preserving decidability and evolvability.

Formal definition:

There exists a scale interval $\Sigma := [\sigma_{\min}, \sigma_{\max}]$ such that for all

$\sigma \in \Sigma$ :

$$0 < \Delta_t^{(\sigma)} < \infty$$

---

直接含义 / Direct Implications

演化只能发生在尺度窗口内

Evolution can occur only within a scale window

窗口外无有效复杂性

Outside the window, no effective complexity exists

复杂性峰值必位于窗口内部

The peak of complexity must lie within the window

---

**等价表述 / Equivalent Form**

$$\Sigma = \{\sigma \mid \Delta_t^{(\sigma)} \in \mathbb{R}^+\}$$

---

**注记（不解释） / Note (no elaboration)**

窗口不是点

The window is not a point

窗口随系统演化而漂移

The window drifts as the system evolves

---

**定理 4丨无尺度不变量的复杂性**

不存在对所有尺度保持不变的复杂性。

任一声称具有尺度不变复杂度的系统，必然在某一尺度上失去可判定性。

形式化表述：

不存在系统 $S$ 使得：

$$\forall \sigma, C(S, \sigma) = C_0$$

其中 $C_0$ 为常数。

等价地：

$$\exists \sigma_1, \sigma_2 : C(S, \sigma_1) \neq C(S, \sigma_2)$$

---

Theorem 4 | No Scale-Invariant Complexity

There exists no system whose complexity remains invariant across all scales.

Any system claimed to possess scale-invariant complexity must lose decidability at some scale.

Formal statement:

There exists no system $S$ such that:

$$\forall \sigma, C(S, \sigma) = C_0$$

for some constant $C_0$ .

Equivalently:

$$\exists \sigma_1, \sigma_2 : C(S, \sigma_1) \neq C(S, \sigma_2)$$

---

**证明要点（不展开） / Proof Sketch (omitted)**

若复杂性尺度不变，则尺度映射不改变差异分布

If the complexity scale remains invariant, scale mapping does not alter the distribution of differences

由尺度算子定义，差异必在某尺度塌缩或发散

By definition of the scale operator, differences must collapse or diverge at some scale

与可判定性公理矛盾

This contradicts the axiom of decidability

---

**直接推论 / Immediate Consequences**

“普适复杂度指标”不存在

A “universal complexity metric” does not exist

所有复杂度度量均隐含尺度选择

All complexity measures implicitly encode a scale choice

跨尺度比较需显式标注尺度

Cross-scale comparison requires explicit scale annotation

---

**逆否命题 / Contrapositive**

若某系统在所有尺度上均可判定，则其复杂性必随尺度变化。

If a system is decidable at all scales, its complexity must vary with scale.

---

**注记（不解释） / Note (no elaboration)**

不变量只存在于局部

Invariants exist only locally

全局不变量导致停机

Global invariants lead to halting

---

**定理 5丨演化的不可逆性**

在残破动态演化系统中，演化过程在一般条件下不可逆。

任一试图完全回到先前状态的操作，必然导致差异塌缩或判定失败。

形式化表述：

设系统状态序列为 $\{x_t\}$ 。

不存在全局算子 $G$ ，使得对所有 $t$ ：

$$G(x_{t+1}) = xt$$

且同时满足：

$$\Delta_t^{(\sigma)} > 0$$

---

**Theorem 5 | Irreversibility of Evolution**

In fragmented dynamic evolutionary systems, evolution is generically irreversible.

Any operation attempting to fully revert to a previous state necessarily causes difference collapse or loss of decidability.

Formal statement:

Let the system state sequence be $\{x_t\}$ 。

There exists no global operator $G$ such that for all $t$ ：

$$G(x_{t+1}) = xt$$

while preserving:

$$\Delta_t^{(\sigma)} > 0$$

---

**证明要点（不展开） / Proof Sketch (omitted)**

残破公理给出非零差异下界

The rupture axiom provides a non-zero lower bound on difference

逆向映射要求差异完全抵消

Inverse mapping requires complete cancellation of differences

与不可消除差异矛盾

This contradicts irreducible difference

---

**直接推论 / Immediate Consequences**

演化不可回滚

Evolution is non-reversible

“完全复原”不可实现

“Complete restoration” is unattainable

历史是结构性负担

History constitutes a structural burden

---

**否定式（等价） / Negated Form (Equivalent)**

若演化可逆，则系统不存在残破结构。

If evolution were reversible, the system would contain no ruptured structure.

---

**注记（不解释） / Note (no elaboration)**

不可逆性不是热力学专属

Irreversibility is not exclusive to thermodynamics

是可判定性的代价

It is the price of decidability

## 终章丨结构性结论（无总结）

## Final Chapter | Structural Conclusions (No Summary)

1. 差异是存在条件

1.Difference is a condition of existence

$\mathit{\Delta}_t = 0 \Rightarrow$ 不可判定 $\Rightarrow$ 演化终止

$\mathit{\Delta}_t = 0 \Rightarrow$ undecidable $\Rightarrow$ evolution terminates

2.残破是演化条件

2.Difference is a condition of existence

$$\inf_t \Delta_t^{(\sigma)} > 0 \Rightarrow \text{可持续演化}$$

$$\inf_t \Delta_t^{(\sigma)} > 0 \Rightarrow \text{sustained evolution}$$

3.动态是避免停机的机制

3.Dynamics is the mechanism that avoids halting

$F_t \neq F_{t+1} \Rightarrow$ 可持续演化

$F_t \neq F_{t+1} \Rightarrow$ lower probability of dead-loop

4.复杂性不是本体属性

4.Complexity is not intrinsic

$$C(S, \sigma) = f(\sigma)$$

5.尺度窗口决定可研究性

5.Scale windows determine researchability

$$\sigma \in [\sigma_{\min}, \sigma_{\max}] \Rightarrow 0 < \Delta_t^{(\sigma)} < \infty$$

6.演化一般不可逆

6.Evolution is generically irreversible

$$\nexists G:\ G(x_{t+1}) = x_t \ \wedge \ \Delta_t^{(\sigma)} > 0$$

---

附录丨符号与公理总表

Appendix | Symbols and Axioms

一、符号表

A. Symbol Table

$S$ ：系统（system）

$x_t$ ：系统在时间 $t$ 的状态(system state at time $t$ )

$F_t$ :时间相关的状态更新算子(time-dependent state update operator)

$G$ :假设的全局逆算子(hypothetical global inverse operator)

$\Delta_t$ :时间 $t$ 的原始差异(raw difference at time $t$ )

$\sigma$ ：观察尺度 (observation scale)

$\Sigma = [\sigma_{\min}, \sigma_{\max}]$ :尺度窗口(scale window)

$C(S, \sigma)$ :系统在尺度下的$\sigma$复杂性

$\Phi_\sigma$:尺度映射算子(scale-mapping operator)

$\varepsilon$ :非零差异下界常数(非零差异下界常数)

---

## 二、公理列表

## B. Axiom List

### Note on Axiom Redundancy

The axiom set is intentionally not minimal in the sense of logical independence.
Axiom 3 restates, in negated form, a structural consequence of Axiom 0.
This redundancy is preserved to prevent misinterpretation of scale-dependent complexity as implying scale invariance.

### 关于公理冗余的说明

本公理集合并未刻意追求逻辑独立意义下的最小性。
第 3 条公理以否定形式重述了第 0 条公理的一个结构性推论。
保留该冗余，旨在防止将复杂性的尺度依赖性误解为尺度不变性。

**公理 0｜尺度—复杂性公理**

Complexity is a function of scale.

尺度依赖（scale dependence）

**公理 1｜可判定性公理**

Decidability requires non-zero difference.

判定所需差异（decidability condition）

**公理 2｜残破公理（非零下界）**

Difference cannot be fully eliminated.

**差异不可消除（lower bound / irreducibility）**

**公理 3 | 复杂性—尺度公理（展开）**

No scale-invariant complexity exists.

**反尺度不变性（anti-invariance constraint）**

---

## 三、定义列表

## C. Definitions

差异（Difference, $\Delta$）

死循环（Dead Loop / Fixed-Point Trap）

演化（Evolution）

动态（Dynamics）

尺度（Scale）

复杂性（Complexity）

演化失败（Evolutionary Failure）

尺度窗口（Scale Window）

---

## 四、定理与引理

## D. Theorems and Lemmas

定理 1 | 零差异系统不可演化

Theorem 1 | Zero-difference systems cannot evolve

定理 2 | 残破是演化的必要条件

Theorem 2 | Rupture is a necessary condition for evolution

定理 3 | 复杂性在中间尺度达到极值

Theorem 3 | Complexity attains its extremum at intermediate scales

定理 4 | 无尺度不变量的复杂性

Theorem 4 | Complexity admits no scale-invariant

定理 5 | 演化的不可逆性

Theorem 5 | The irreversibility of evolution

引理 4 | 简单与复杂的尺度同构

Lemma 4 | Scale isomorphism between simplicity and complexity

引理 5 | 尺度切换可恢复演化

Lemma 5 | Scale switching can restore evolution

---

**终止标记 / Termination Marker**

本文不包含结论。

This work contains no conclusion.

所有结构已给出。

All structures have been presented.

公元二〇二六年一月二十三日

23 January, 2026 CE

地点：雪梨

Location: Sydney

作者：谢凯凡

Author: Xie Kaifan（Kaifan Xie）