On the Origin of Ensemble Structure in Collapse-Selection Dynamics

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Abstract

Previous notes have shown that collapse-selection dynamics produce definite outcomes in a two-state system and that outcome frequencies arise from an ensemble of initial configurations. Additional constraints on this ensemble lead to Born-like scaling. However, the origin of the ensemble distribution itself has not been specified. In this note, we show that ensemble structure arises as a consequence of incomplete resolution of relational configurations under collapse constrained by finite invariance. We show that multiple admissible configurations may persist under collapse, and that this multiplicity naturally induces an effective distribution over initial conditions. This provides a minimal account of the origin of ensemble structure without introducing intrinsic stochasticity or hidden variables.

1 Introduction

In previous notes, collapse-selection dynamics were shown to produce definite outcomes through convergence to fixed-point sectors, and statistical behavior was shown to arise from repeated application of collapse across an ensemble of initial configurations.

While this provides a minimal account of measurement and outcome frequencies, it leaves open a key question:

> What determines the ensemble distribution over initial configurations?

In this note, we propose that ensemble structure arises as a consequence of finite invariance constraints on collapse, which prevent complete resolution of relational configurations.

2 Finite Invariance and Admissibility

Collapse-selection dynamics operate under finite constraints, meaning that not all distinctions between configurations can be resolved.

We define the set of admissible configurations:

$$\mathcal{A} \subset \Sigma \tag{1}$$

where Σ denotes the full space of relational configurations.

Configurations in $\mathcal{A}$ are those that remain stable under collapse within the limits imposed by finite invariance.

3 Incomplete Collapse Resolution

Collapse does not, in general, uniquely select a single fully resolved configuration under finite invariance constraints. This non-uniqueness is not incidental, but a direct consequence of finite resolution limits imposed on collapse dynamics. Instead, multiple configurations may remain admissible:

$$|\mathcal{A}| > 1 \tag{2}$$

This reflects the fact that collapse operates under finite resolution, and that certain distinctions between configurations cannot be eliminated.

Thus, the outcome of collapse is not always a single configuration, but a set of admissible configurations.

4 Emergence of Ensemble Structure

4.1 Effective Distribution

We define an effective distribution:

$$\rho(w_0, w_1) \tag{3}$$

over the admissible set $\mathcal{A}$.

This distribution does not represent intrinsic randomness, but rather the structure of unresolved configurations.

4.2 Interpretation

The ensemble arises as a representation of the multiplicity of admissible configurations:

$$\rho \sim \text{measure over } \mathcal{A} \tag{4}$$

Here, ρ represents an effective measure over admissible configurations induced by the multiplicity of collapse-stable states, rather than an externally imposed probability distribution.

Thus, ensemble structure reflects the geometry of admissible configuration space under collapse.

4.3 Key Statement

Ensemble structure is a direct consequence of the multiplicity of admissible configurations that remain unresolved under collapse constrained by finite invariance.

5 Connection to Measurement and Statistics

In the measurement model, each measurement corresponds to a trajectory within the admissible set $\mathcal{A}$.

Outcome frequencies arise from the distribution of configurations within $\mathcal{A}$:

$$f_i = \int_{\mathcal{B}_i} \rho \, d\Sigma \tag{5}$$

where $\mathcal{B}_i$ denotes the basin of attraction of a given fixed point.

Thus, statistical behavior reflects the structure of admissible configurations rather than intrinsic stochasticity.

6 Relation to Born-Like Scaling

In the previous note, symmetry and consistency constraints on ρ were shown to produce Born-like scaling.

In the present framework, these constraints apply to the distribution over admissible configurations:

$$\rho = \rho_{\mathcal{A}} \tag{6}$$

that is, the ensemble distribution is determined by the structure of the admissible set.

Thus, Born-like scaling arises from structural constraints on admissibility, rather than from an externally imposed probability rule.

7 Interpretation

7.1 No Hidden Variables

The ensemble does not represent hidden classical states. Instead, it reflects unresolved relational structure within the admissible set.

7.2 No Intrinsic Randomness

Randomness arises from the multiplicity of admissible configurations, not from stochastic collapse dynamics.

7.3 Measurement Reinterpreted

Measurement outcomes correspond to fixed-point sectors, while probabilities reflect the structure of admissible configurations leading to those sectors.

8 Limitations and Open Questions

This construction is minimal and does not yet provide:

- a dynamical derivation of the admissible set $\mathcal{A}$,
- a full characterization of the measure ρ,
- extension to continuous or higher-dimensional systems.

Future work will investigate whether admissibility structure can be derived from deeper properties of collapse dynamics.

9 Conclusion

We have proposed that ensemble structure arises from incomplete resolution of relational configurations under collapse constrained by finite invariance. This provides a minimal account of the origin of distributions in collapse-selection models and completes the conceptual chain linking collapse dynamics, measurement outcomes, statistical behavior, and Born-like scaling.