Reality Vector: A 10-Dimensional Environmental State Model for Autonomous Systems

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Abstract

An autonomous system operating in a physical environment must reason about spatial position, temporal state, subsurface conditions, above-canopy conditions, certainty, compliance state, economic value, and historical trajectory. Existing systems model 3 to 5 axes. The Reality Vector models all 10 orthogonal dimensions simultaneously as $V_R = \{S_X, S_Y, T, Z(-), Z(+), C, L, V_f, E, G\}$. Each dimension is binary: the action is fully governed only when all 10 axes are simultaneously satisfied. The 10D vector enables the Agentic platform to reason about center-pivot irrigation with full environmental context — below-surface compaction, above-canopy microclimate, regulatory compliance, and economic cost simultaneously.

Keywords: reality vector, 10-dimensional state model, environmental reasoning, autonomous systems, spatial-temporal modeling, BX3 Framework, Irrig8

1 The 10 Orthogonal Axes

1. S_X: Horizontal longitude — spatial position on Earth's surface
2. S_Y: Horizontal latitude — complementary spatial coordinate
3. T: Timestamp index — temporal position in operational window
4. $Z(-)$: Subsurface depth — soil conditions from -100cm to 0
5. $Z(+)$: Above-ground height — canopy and microclimate from 0 to +10m
6. C: Certainty and quality metric — confidence in sensor readings
7. L: Decision state (9-Plane DAP plane index) — regulatory compliance posture
8. V_f: Resolution scaling factor — the data resolution at which observations were made
9. E: Economic value and cost function — resource cost of the action
10. G: Compliance and governance status — regulatory authorization state

2 Binary Compliance

An action is fully governed only when all 10 axes are simultaneously satisfied: compliant or non-compliant on each axis. There is no partial credit, no continuous score to optimize. This closes the Governance Hole problem where systems maximize a compliance metric while missing critical axes like spatial hierarchy or temporal boundedness.

3 Irrig8 Application

The 10D Reality Vector drives every irrigation decision. A pivot zone at S_X, S_Y has a $Z(-)$ profile showing compaction at 12 inches. The $Z(+)$ reading shows canopy temperature 8 degrees above ambient. C is 0.94 (high confidence from redundant sensors). L shows P9 Sandbox Gate approved the proposed action. E shows water cost at \$0.003 per gallon against projected yield value of \$0.008 per gallon. G shows water-right allocation active and within permitted volumes. Only when all 10 axes are satisfied does the valve open.

4 Conclusion

The Reality Vector provides the first complete, orthogonal, deterministic state model for autonomous systems operating in complex physical environments. Every decision is traceable to a specific 10D coordinate in environmental state space.