



## *Deterministic Autonomous Continuity in Robotic Systems Through AI-Based Layered Admissibility Filtering*

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### **Abstract**

*This study proposes a deterministic autonomous architecture based on layered admissibility filtering rather than unrestricted optimization or externally imposed goal assignment. In many practical robotic deployments, the most reliable autonomous systems may appear behaviorally conservative or even “boring” because persistence, safety, and operational continuity often dominate unrestricted exploratory behavior. Perception, sensing, semantic mapping, and world-modeling systems operate as structured input mechanisms that transform observed conditions into constraint sets governing admissible continuation states. The framework introduces an obligatory persistence layer in which operational survivability, energy availability, structural integrity, and maintenance constraints dominate early-stage admissibility filtering. Above this layer, role-conditioned, contextual, and temporally dependent constraint structures progressively shape feasible goal space across immediate, medium-term, and long-term operational horizons. Admissible goals may therefore differ across autonomous agents operating within identical environments due to differences in persistence requirements, operational identity, and temporal continuity constraints. The resulting architecture supports bounded but non-rigid autonomous behavior while preserving deterministic operational coherence and compatibility with real-world robotic infrastructures. Multiple admissible continuation structures may coexist simultaneously provided they remain consistent with higher-order persistence and operational constraints. The framework intentionally avoids unrestricted autonomous objective generation, instead emphasizing persistence-compatible, role consistent, and temporally bounded autonomous continuity.*

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## Introduction

Autonomous systems and robotic decision architectures have traditionally relied on optimization based planning, probabilistic search, reinforcement learning, behavior trees, and externally assigned task structures for operational decision-making [1-10]. While such approaches have demonstrated practical success across robotics, planning, and intelligent control domains, many existing architectures continue to depend upon unrestricted optimization, externally injected objectives, or large-scale search over candidate behavioral spaces. In contrast, biological and operational systems frequently preserve continuity through layered elimination of infeasible continuation states under persistence, environmental, structural, and temporal constraints rather than unrestricted objective maximization alone.

In many practical robotic deployments, the most reliable autonomous systems may appear behaviorally conservative or even “boring” because persistence, safety, and operational continuity often dominate unrestricted exploratory behavior. Rather than continuously generating new objectives or behavioral variations, real-world autonomous platforms frequently prioritize stability, survivability, and predictable operational consistency. This perspective motivates the present framework, in which autonomous continuity emerges through layered admissibility filtering rather than unrestricted behavioral expansion.

The proposed framework is organized around several interacting principles, including persistence-first admissibility, layered constraint filtering, role-conditioned continuation, temporal admissibility, bounded autonomy, and deterministic operational continuity. Together, these elements define a structured autonomous architecture in which admissible behavior emerges through progressive elimination of infeasible continuation states rather than unrestricted optimization or externally imposed objective assignment.

Continued operational existence forms the primary admissibility condition of the autonomous framework. Before contextual, exploratory, or mission-level objectives are considered, the system evaluates constraints associated with operational persistence, including energy availability, structural integrity, survivability, and maintenance requirements. Candidate goals incompatible with continued

operational continuity are eliminated at the earliest stage of admissibility filtering.

Within this formulation, perception functions as a usable deterministic tool, converting observed environmental conditions into structured constraint sets rather than directly assigning goals. Visual recognition, sensor fusion, semantic mapping, and world-modeling systems therefore contribute contextual admissibility information while preserving internal operational autonomy. Autonomous behavior is not determined solely by environmental observation, but also by persistence constraints, operational identity, contextual conditions, and temporal continuity requirements. Admissibility is not static across temporal scales. Continuation states that remain feasible under immediate operational conditions may become inadmissible under medium-term maintenance requirements or long-term persistence constraints. As a result, the framework distinguishes between immediate, medium-term, and long-term admissibility layers, each contributing differently to continuation-state evaluation and goal feasibility.

The framework further incorporates role-conditioned admissibility structures in which identical environments may generate different admissible continuation states for different autonomous agents. The same observed conditions may therefore produce distinct operational responses depending on persistence requirements, operational identity, policy structure, and contextual constraints. Human interaction is incorporated primarily as a contextual and resource-dependent component of the operational environment rather than as a continuous external goal-assignment mechanism. The resulting architecture supports bounded but non-rigid autonomous behavior through layered admissibility switching in which operational states are progressively activated or suppressed according to obligatory, contextual, identity-dependent, and temporal constraints.

The framework intentionally avoids unrestricted autonomous objective generation. Instead, it emphasizes persistence-compatible, role consistent, and operationally bounded autonomous continuity. This preserves deterministic coherence while reducing dependence on unrestricted optimization, unconstrained objective formation, or externally imposed behavioral control. The proposed formulation therefore defines a bounded autonomous continuity architecture compatible with real-world robotic infrastructures and layered

deterministic decision systems.

Candidate goal set:

$$G_0 = \{g_1, g_2, \dots, g_n\}$$

Constraint functions:

$$C_i(g) \in \{0,1\}$$

Admissible set:

$$G_{\text{valid}} = \{ g \in G_0 \text{ such that } C_i(g)=1 \text{ for all required constraints } \}$$

### Persistence Layer

Continued operational existence forms the primary admissibility condition of the autonomous framework. Before contextual, exploratory, or mission-oriented objectives are evaluated, the system first determines whether continued operational continuity can be maintained within current environmental and internal conditions. At this layer, admissibility is governed by survivability rather than preference, optimization, or exploratory variation. The persistence layer operates through early-stage elimination of continuation states incompatible with operational viability. Constraints associated with energy availability, structural integrity, thermal stability, mobility capability, sensor functionality, communication integrity, and environmental survivability are evaluated prior to higher-level behavioral selection. Candidate goals that threaten continued operation are removed immediately from the admissible set.

Under this formulation, autonomous behavior is not generated through unrestricted objective selection, but through progressive reduction of infeasible continuation states. The persistence layer therefore acts as the dominant constraint hierarchy within the system. If operational continuity is endangered, contextual, exploratory, or role dependent objectives may become temporarily inadmissible regardless of their long-term utility. For example, a mobile autonomous agent operating under critically low energy conditions may eliminate exploration, patrol, or observational tasks from the admissible goal set while preserving only continuation states associated with recharging, safe shutdown, or survivability-preserving relocation. Similarly, structural damage, thermal overload, or environmental instability may suppress otherwise valid mission behaviors until operational viability is restored.

At the persistence layer, constraint dominance largely removes the need for stochastic or optimization based decision mechanisms. Operational survivability directly determines admissible continuation states, producing highly deterministic behavior under critical conditions. As a result, the persistence layer minimizes computational ambiguity while preserving bounded operational coherence. The persistence layer further establishes the foundation for all subsequent admissibility structures within the architecture. Contextual interpretation, role-conditioned continuation, temporal admissibility, and bounded exploratory variation are evaluated only after primary persistence constraints have been satisfied. Autonomous continuity therefore emerges not from unrestricted behavioral freedom, but from persistence-compatible continuation under layered operational constraints.

### Software:

- ROS2 monitoring and control nodes
- Embedded fault-management systems
- Real-time operating systems (RTOS)
- Finite State Machine (FSM) controllers
- Constraint evaluation modules
- Watchdog and fail-safe supervisory software
- Battery-management software
- Thermal monitoring systems
- Diagnostic and integrity-monitoring frameworks
- ROS
- Behavior Trees
- GOAP
- Semantic scene graphs

### Possible Hardware:

- Embedded ARM controllers
- Raspberry Pi class systems
- NVIDIA Jetson modules
- Industrial microcontrollers
- Battery-management circuitry
- Thermal sensors
- Voltage and current monitoring units
- IMU sensors
- Environmental safety sensors
- Redundant power-management modules
- Communication watchdog hardware
- RGB cameras
- Depth cameras
- LiDAR
- IMU
- GPS/localization

**Persistence-layer monitored variables may include:**

- Battery level
- Thermal stability
- Structural integrity
- Actuator functionality
- Communication continuity
- Sensor availability
- Operational survivability state
- Maintenance thresholds

**Example persistence constraints:**

- $\text{battery\_level} > \text{minimum\_threshold}$
- $\text{temperature} < \text{thermal\_limit}$
- $\text{communication\_status} = \text{active}$
- $\text{structural\_integrity} = \text{safe}$
- $\text{actuator\_state} = \text{operational}$

Candidate goals violating persistence constraints are eliminated before contextual or mission-level continuation selection occurs.

**Role-Conditioned Admissibility**

Once operational persistence has been secured, admissible behavior becomes increasingly conditioned by operational identity, policy structure, environmental interpretation, and role dependent constraints. Under this formulation, identical environmental observations do not necessarily produce identical admissible continuation states across autonomous agents. Instead, the admissible goal space depends upon the internal operational structure of the agent and the constraints associated with its designated role.

Role-conditioned admissibility defines the manner in which operational identity restricts or permits continuation states within otherwise similar environments. A medical support robot, a military autonomous unit, a maintenance platform, and an entertainment-oriented robotic system may all observe identical environmental conditions while generating different admissible behaviors due to differences in persistence priorities, mission structure, interaction policies, and operational constraints. Within this framework, perception alone does not determine action. Observed conditions are first transformed into structured contextual constraints, after which role-conditioned filtering determines whether continuation states remain compatible with the operational identity of the agent. As a result, behavior emerges not from unrestricted environmental reaction, but from layered

admissibility evaluation incorporating persistence, context, and role consistency simultaneously.

For example, the presence of music, crowds, or open public space may generate admissible continuation states associated with performance behavior for an entertainment-oriented system, while producing surveillance, monitoring, or defensive continuation states for a military autonomous platform operating within the same environment. The environmental input remains identical, but the admissible continuation structure differs according to operational identity and constraint hierarchy.

Role-conditioned admissibility also prevents unrestricted behavioral drift. Autonomous systems operating within bounded admissibility structures cannot arbitrarily transition into incompatible operational domains solely through local contextual incentives or temporary utility gains. Resource acquisition, environmental adaptation, and contextual variation remain subordinate to higher order persistence and operational constraints. As a result, autonomous continuity remains bounded by role consistency and persistence-compatible admissibility rather than unrestricted objective formation. The framework therefore preserves bounded autonomy while allowing contextual flexibility within operationally consistent regions of the admissible space.

**Possible Software and Hardware for Role-Conditioned Admissibility****Software:**

- Behavior Tree (BT) frameworks
- GOAP-based planning systems
- Rule-based policy engines
- Constraint filtering modules
- Mission-profile management systems
- Operational identity libraries
- Semantic role classification systems
- Context-evaluation frameworks
- Finite State Machine (FSM) architectures
- Multi-agent coordination frameworks
- Supervisory policy-control modules

**Possible Hardware:**

- Embedded onboard processors
- Industrial ARM computing systems
- NVIDIA Jetson platforms
- Mission-configurable robotic controllers

- Secure operational memory modules
- Environmental sensing systems
- Communication and coordination hardware
- Identity-specific sensor packages
- Distributed robotic coordination interfaces

#### Role-conditioned variables may include:

- Operational identity
- Mission class
- Authorization level
- Environmental compatibility
- Contextual role relevance
- Operational priority hierarchy
- Persistence compatibility
- Supervisory restrictions

#### Example role-conditioned constraints:

- `military_mode = authorized`
- `medical_access = permitted`
- `performance_behavior = context_valid`
- `exploration_mode = allowed`
- `civilian_interaction = restricted`

Identical environmental observations may therefore generate different admissible continuation states depending on operational identity, persistence constraints, policy structure, and contextual role compatibility.

#### Environmental Interpretation

The environmental interpretation layer transforms observed external conditions into structured contextual constraints that contribute to admissibility evaluation without directly assigning goals. Within this formulation, perception functions as a deterministic input mechanism rather than an autonomous decision-maker. Visual recognition, sensor fusion, semantic mapping, localization systems, environmental sensing, and world-model representations collectively provide structured information used to reduce infeasible continuation states. The framework does not interpret perception as equivalent to autonomous intention. Instead, observed environmental conditions contribute constraint-relevant information that modifies the admissible continuation space. Environmental interpretation therefore operates as an intermediate transformation layer between raw observation and admissible behavioral selection.

Inputs at this layer may include visual objects, motion

patterns, environmental geometry, thermal conditions, spatial accessibility, human presence, communication signals, resource locations, or hazard indicators. These observations are converted into contextual constraint structures that influence continuation-state feasibility without independently determining operational objectives.

For example, obstacle detection may eliminate traversal-related continuation states, restricted-access regions may suppress unauthorized operational behaviors, and detected hazards may temporarily override exploratory or mission-oriented continuation structures. Similarly, the availability of charging infrastructure, maintenance access, or cooperative human interaction may expand admissible persistence-preserving continuation states under degraded operational conditions.

Environmental interpretation is also temporally dependent. Observed conditions that remain admissible under immediate circumstances may become inadmissible under projected environmental evolution, resource depletion, or anticipated instability. As a result, the framework incorporates environmental interpretation across immediate, medium-term, and long-term operational horizons rather than relying solely on instantaneous reactive perception.

The same environmental observations may produce different contextual consequences for different autonomous agents depending on role-conditioned admissibility and persistence requirements. Consequently, environmental interpretation does not generate universal behavioral outputs. Instead, it contributes structured contextual filtering information within the broader layered admissibility hierarchy.

Human interaction is incorporated at this layer primarily as an environmental and resource-dependent structure rather than as a continuous external command mechanism. Human presence may influence authorization, maintenance access, resource availability, communication feasibility, or contextual interpretation without fully determining autonomous continuation states. The environmental interpretation layer therefore serves as a structured constraint-generation mechanism that connects perception, context, and operational admissibility while preserving deterministic continuity and bounded autonomous behavior.

## Possible Software and Hardware for the Environmental Interpretation Layer

### Software:

- Computer vision frameworks
- OpenCV-based perception systems
- YOLO object-detection architectures
- ORB-SLAM
- RTAB-Map
- Semantic mapping systems
- SLAM frameworks
- Sensor-fusion modules
- Environmental modeling software
- Localization and navigation systems
- Semantic scene-graph frameworks
- Context-generation modules
- Hazard-detection systems
- World-model representation frameworks
- ROS2 perception infrastructure
- Environmental constraint-generation modules

### Possible Hardware:

- RGB cameras
- Depth cameras
- Stereo vision systems
- LiDAR systems
- IMU sensors
- Thermal imaging sensors
- Ultrasonic proximity sensors
- GPS and localization hardware
- Environmental monitoring sensors
- Edge AI processing units
- NVIDIA Jetson platforms
- Embedded vision accelerators
- Distributed sensing modules

### Environmental interpretation variables may include:

- Obstacle presence
- Terrain accessibility
- Human presence
- Thermal conditions
- Spatial geometry
- Restricted-access regions
- Hazard proximity
- Resource availability
- Environmental stability
- Communication accessibility

### Example environmental constraints:

- `obstacle_detected = true`
- `access_region = restricted`
- `thermal_zone = unsafe`
- `docking_station = available`
- `collision_risk < allowable_limit`
- `visibility_state = degraded`

Observed environmental conditions are transformed into structured contextual constraints that progressively reduce infeasible continuation states while preserving deterministic operational continuity and bounded autonomous behavior.

### Human Interaction Layer

The human interaction layer incorporates human presence, communication, supervision, and resource dependency into the admissibility framework without reducing the autonomous system to continuous externally controlled behavior. Within this formulation, humans are treated primarily as contextual, operational, and resource-dependent components of the environment rather than as permanent direct goal-assignment mechanisms.

Autonomous systems operating under bounded admissibility structures may require interaction with humans for maintenance, authorization, logistical support, information exchange, cooperative coordination, or operational continuity. However, these interactions do not necessarily determine all continuation states directly. Instead, human interaction modifies contextual constraints, operational feasibility, resource accessibility, and admissibility conditions within the broader layered framework.

For example, a human operator may provide access permissions, maintenance support, charging capability, environmental information, or task-level objectives without controlling moment-to-moment continuation selection. The autonomous system continues to evaluate persistence constraints, operational identity, contextual conditions, and temporal admissibility internally before determining feasible continuation states. The framework therefore distinguishes between externally imposed command execution and bounded autonomous continuity operating within human-compatible supervisory structures. Human interaction contributes structured contextual information while preserving internal admissibility filtering and operational

coherence.

Human presence may also influence admissibility through social, environmental, legal, or operational restrictions. Restricted areas, protected populations, authorized personnel, emergency conditions, or cooperative operational protocols may expand or suppress continuation states depending on persistence requirements and role-conditioned constraints. As a result, human interaction is integrated into the admissibility hierarchy through contextual and operational dependency rather than unrestricted behavioral override.

The human interaction layer additionally supports cooperative operational continuity. Autonomous systems may seek human interaction to preserve survivability, restore functionality, obtain resources, or satisfy maintenance requirements under degraded operational conditions. In such cases, interaction emerges from persistence-compatible continuation logic rather than unconditional obedience or unrestricted self-directed behavior.

The framework intentionally avoids unrestricted autonomous independence from human-compatible operational structures. Instead, autonomous continuity remains bounded by persistence constraints, role consistency, contextual admissibility, and supervisory compatibility requirements. This preserves operational predictability while allowing adaptive interaction within structured environmental and societal conditions.

Accordingly, the human interaction layer functions as a bounded supervisory and contextual integration mechanism within the larger deterministic admissibility architecture.

Possible Software and Hardware for the Human Interaction Layer

#### Software:

- Human-machine interface (HMI) systems
- Speech-recognition frameworks
- Natural language processing modules
- Authorization and access-control systems
- Supervisory control software
- Human-aware navigation systems
- Contextual interaction frameworks

- Cooperative task-coordination modules
- Safety-monitoring systems
- Gesture-recognition frameworks
- Identity-verification systems
- ROS2 communication infrastructure
- Human-presence detection modules
- Operational permission-management systems

#### Possible Hardware:

- Microphone arrays
- Speakers and audio systems
- RGB and depth cameras
- Human-detection sensors
- Touchscreen interfaces
- Biometric authentication devices
- Wireless communication modules
- Network and telemetry hardware
- Wearable coordination devices
- Proximity and safety sensors
- Edge AI interaction processors
- Embedded communication controllers

#### Human-interaction variables may include:

- Authorization status
- Human proximity
- Maintenance availability
- Communication accessibility
- Supervisory permission
- Cooperative interaction state
- Restricted-area access
- Emergency override conditions
- Operational safety status
- Resource availability

#### Example human-interaction constraints:

- `operator_authorized = true`
- `maintenance_access = available`
- `emergency_override = inactive`
- `restricted_access = denied`
- `human_proximity < safety_limit`
- `communication_link = active`

Human interaction contributes contextual and operational constraints to admissibility evaluation without functioning as a continuous external goal-assignment mechanism. Autonomous continuation remains bounded by persistence compatibility, operational identity, contextual admissibility, and supervisory safety structures.

## Contextual Continuation

Once persistence, operational identity, environmental interpretation, and human-compatible supervisory constraints have been evaluated, the autonomous system proceeds to contextual continuation selection. At this stage, admissible continuation states are selected from the remaining feasible goal space according to contextual relevance, temporal conditions, operational continuity, and compatibility with higher-order constraint structures.

Contextual continuation selection does not operate through unrestricted optimization over arbitrary objectives. Instead, the system progressively suppresses infeasible or incompatible continuation states until a bounded admissible set remains. The resulting continuation structure reflects the interaction of persistence requirements, operational identity, environmental interpretation, temporal feasibility, and contextual constraints simultaneously. Autonomous behavior is therefore not restricted to a single rigid objective at every moment. Compatible continuation structures may overlap across immediate, medium-term, and long-term operational horizons without violating persistence-compatible admissibility.

For example, an autonomous system operating under stable persistence conditions may simultaneously maintain continuation states associated with maintenance scheduling, environmental observation, low-priority exploration, cooperative interaction, and long-term operational preparation. These continuation structures remain admissible only while they preserve compatibility with persistence constraints, operational identity, contextual conditions, and supervisory limitations.

Contextual continuation selection is also temporally dependent. Continuation states that remain feasible under immediate operational conditions may become inadmissible under projected maintenance demands, anticipated environmental changes, resource depletion, or long-term persistence requirements. As a result, continuation selection incorporates both present contextual conditions and projected operational continuity across multiple temporal horizons.

The framework further permits bounded contextual flexibility without permitting unrestricted behavioral drift. Adaptive variation may occur within the remaining

admissible region, but higher-order persistence, identity, and operational constraints prevent transitions into structurally incompatible continuation domains. Autonomous continuity therefore remains bounded while preserving non-rigid contextual adaptability.

At this layer, admissibility may also incorporate low-priority stochastic variation within the remaining feasible continuation set. Such variation does not override persistence or operational constraints, but instead operates only after incompatible continuation states have been eliminated. Stochastic resolution may therefore contribute behavioral diversity, exploration, or equivalent continuation selection without compromising deterministic operational coherence.

The contextual continuation layer consequently defines the operational mechanism through which bounded autonomous behavior emerges from layered admissibility filtering rather than unrestricted objective optimization or externally imposed behavioral control.

## Possible Software and Hardware for Contextual Continuation Selection

### Software:

- GOAP planning systems
- Behavior Tree (BT) architectures
- Constraint-satisfaction frameworks
- Context-evaluation engines
- Operational scheduling systems
- Mission-management software
- Temporal-priority evaluation modules
- Decision-layer coordination frameworks
- Resource-allocation systems
- Multi-objective admissibility evaluators
- Supervisory continuation-selection modules
- Environmental forecasting systems
- Adaptive task-priority managers
- ROS2 planning infrastructure

### Possible Hardware:

- Embedded onboard processors
- NVIDIA Jetson computing modules
- Industrial robotic controllers
- Real-time scheduling hardware
- Environmental sensing systems
- Distributed coordination hardware
- Operational telemetry units
- Persistent storage modules

- Edge AI processing systems
- Communication and synchronization interfaces

#### Contextual continuation variables may include:

- Operational priority
- Environmental stability
- Resource availability
- Maintenance scheduling
- Mission continuity
- Persistence compatibility
- Temporal feasibility
- Contextual relevance
- Cooperative operational state
- Exploration permissibility

#### Example contextual constraints:

- mission\_priority = active
- recharge\_required = false
- exploration\_allowed = true
- maintenance\_due = pending
- operational\_risk < allowable\_limit
- contextual\_relevance = sufficient

Multiple admissible continuation structures may coexist simultaneously provided they remain compatible with higher-order persistence, operational identity, temporal feasibility, and contextual admissibility constraints. Contextual continuation selection progressively suppresses infeasible operational states while preserving bounded autonomous continuity and deterministic operational coherence.

#### Bounded Stochastic Resolution

The proposed framework permits limited stochastic variation only within the remaining admissible continuation space after higher-order persistence, operational, contextual, identity-dependent, and temporal constraints have been satisfied. Stochastic processes therefore do not generate unrestricted behavior, but instead operate as secondary resolution mechanisms within bounded operational regions. Under this formulation, stochasticity is not interpreted as arbitrary decision-making or unrestricted autonomous freedom. Incompatible, unsafe, persistence-violating, or operationally inconsistent continuation states are eliminated prior to stochastic evaluation. As a result, stochastic variation operates only among continuation states that already satisfy admissibility requirements.

This distinction is structurally important. Autonomous

systems may encounter multiple continuation states that remain operationally feasible, persistence-compatible, temporally admissible, and contextually valid simultaneously. In such cases, bounded stochastic variation may assist in resolving equivalent or weakly differentiated continuation structures without requiring unrestricted optimization or exhaustive ranking mechanisms. For example, an autonomous patrol system operating under stable persistence conditions may select among several equivalent surveillance routes, observational sequences, or low-priority environmental exploration patterns. Similarly, a maintenance-oriented system may choose between multiple feasible scheduling intervals or operational ordering sequences while preserving higher-order admissibility consistency.

Bounded stochastic resolution may additionally support adaptive variation, exploration diversity, behavioral non-rigidity, and avoidance of repetitive deterministic cycling under operationally safe conditions. However, stochasticity remains subordinate to persistence constraints, operational identity, temporal feasibility, supervisory compatibility, and contextual admissibility. Higher-order constraint dominance therefore prevents stochastic processes from expanding continuation states into prohibited operational regions. The framework intentionally avoids unrestricted stochastic autonomy. Random variation does not override persistence-compatible continuation logic, identity consistency, or bounded operational behavior. Instead, stochasticity functions as a constrained local resolver operating inside already admissible continuation manifolds. The bounded stochastic resolution layer therefore preserves deterministic operational coherence while allowing limited adaptive flexibility within safe and persistence-compatible autonomous continuation structures.

#### Possible Software and Hardware for Bounded Stochastic Resolution

##### Software:

- Probabilistic continuation-selection modules
- Randomized path-selection systems
- Monte Carlo sampling frameworks
- Low-priority exploration engines
- Behavioral diversity generators
- Adaptive patrol-routing systems
- Non-repetitive scheduling modules
- Constraint-bounded stochastic evaluators
- Reinforcement-compatible bounded resolvers

- Context-aware randomization systems
- Multi-path continuation selectors
- Operational variability management modules

#### Possible Hardware:

- Embedded onboard processors
- Edge AI computation modules
- NVIDIA Jetson systems
- Real-time scheduling controllers
- Distributed coordination hardware
- Environmental sensing systems
- Persistent operational memory units
- Telemetry and synchronization interfaces

#### Bounded stochastic variables may include:

- Route selection
- Patrol ordering
- Exploration sequence
- Observation scheduling
- Low-priority task ordering
- Equivalent continuation preference
- Operational diversity state
- Repetitive-pattern avoidance

#### Example bounded stochastic constraints:

- `persistence_constraints = satisfied`
- `operational_identity = valid`
- `contextual_risk < allowable_limit`
- `stochastic_selection = permitted`
- `admissible_goal_count > 1`
- `prohibited_transition = false`

Stochastic variation is applied only after incompatible continuation states have been eliminated through higher-order persistence, operational, contextual, identity-dependent, and temporal admissibility filtering. As a result, stochasticity functions as a bounded local continuation resolver operating entirely within persistence-compatible operational regions rather than as an unrestricted autonomous decision mechanism.

#### Compatible Robotic Infrastructure

The proposed framework is intended as a hardware-agnostic autonomous architecture compatible with existing robotic perception, sensing, planning, and operational infrastructures. The formulation does not depend upon a specific robotic platform, optimization framework, or computational environment. Instead, it operates as a layered admissibility structure

capable of integrating with a broad range of real-world autonomous systems. Within this formulation, perception and environmental interpretation modules function primarily as structured input generators contributing contextual constraints to admissibility evaluation. Existing computer vision, sensor fusion, localization, semantic mapping, and world-modeling systems may therefore be incorporated without altering the deterministic continuity structure of the framework itself.

Compatible perception infrastructures may include visual recognition systems, depth sensing, LiDAR, inertial sensing, localization frameworks, semantic scene interpretation, and environmental monitoring architectures. Similarly, existing robotic middleware, behavioral libraries, mapping systems, and planning infrastructures may contribute operational and contextual information while preserving bounded admissibility filtering.

The framework is intentionally separated from unrestricted optimization-based objective generation. As a result, compatible robotic systems are not required to implement unrestricted reinforcement learning, utility-maximization architectures, or continuously self-generated behavioral objectives in order to support bounded autonomous continuity. Existing planning systems, including deterministic planners, behavior-tree structures, and constrained GOAP-style operational layers, may instead operate downstream from admissibility filtering within already bounded continuation regions.

The proposed architecture is computationally compact relative to unrestricted search-based autonomous systems because higher-order persistence, contextual, operational, and temporal constraints progressively reduce feasible continuation space prior to lower-level continuation resolution. Consequently, the primary computational burden within practical implementations is expected to arise from perception, environmental modeling, and world-state interpretation rather than from the admissibility structure itself.

The framework additionally supports distributed and multi-agent robotic environments. Different autonomous agents operating within the same physical environment may generate distinct admissible continuation structures according to persistence requirements, operational

identity, contextual interpretation, and temporal constraints while still maintaining compatibility with shared supervisory or cooperative infrastructures.

Human-compatible supervisory integration may also be incorporated without collapsing the framework into continuous externally controlled operation. Authorization systems, safety layers, maintenance interfaces, communication infrastructures, and cooperative human interaction mechanisms may function as contextual admissibility contributors within the broader layered architecture. Accordingly, the proposed framework defines a bounded deterministic continuity architecture capable of operating above existing robotic sensing, perception, planning, and operational infrastructures while preserving persistence-compatible autonomous behavior and layered admissibility control.

Possible Software and Hardware for Compatible Robotic Infrastructure

#### Software:

- ROS2 robotic middleware
- SLAM and localization frameworks
- Computer vision systems
- Semantic mapping architectures
- GOAP planning systems
- Behavior Tree (BT) frameworks
- Constraint-satisfaction engines
- Multi-agent coordination frameworks
- Environmental modeling systems
- Sensor-fusion software
- Mission-management systems
- Supervisory safety frameworks
- Real-time operating systems (RTOS)
- Human-machine interface systems
- Distributed robotic communication frameworks

#### Possible Hardware:

- NVIDIA Jetson platforms
- Industrial ARM processors
- Embedded robotic controllers
- Edge AI accelerators
- RGB and depth cameras
- LiDAR systems
- IMU sensors
- Thermal monitoring sensors
- GPS and localization hardware
- Wireless communication modules

- Distributed telemetry systems
- Robotic actuator systems
- Battery-management hardware
- Environmental monitoring systems
- Multi-agent coordination hardware

#### Infrastructure-level variables may include:

- Computational availability
- Communication continuity
- Distributed coordination state
- Environmental sensing capability
- Localization stability
- Operational synchronization
- Sensor integrity
- Supervisory connectivity
- Resource accessibility
- Persistence-support capability

#### Example infrastructure constraints:

- `communication_network = active`
- `localization_accuracy > minimum_limit`
- `sensor_integrity = operational`
- `computational_load < allowable_threshold`
- `synchronization_state = stable`
- `supervisory_connection = available`

The proposed framework operates as a hardware-agnostic layered admissibility architecture compatible with existing robotic sensing, planning, communication, supervisory, and environmental interpretation infrastructures. Perception, planning, and coordination systems contribute structured contextual information while preserving persistence-compatible deterministic operational continuity and bounded autonomous behavior. Compatible infrastructures may incorporate established perception and mapping systems including OpenCV, YOLO-based object detection, ROS/ROS2 middleware, SLAM frameworks, semantic scene representations, and behavior-tree or GOAP-based operational planning architectures. Environmental sensing may further integrate RGB cameras, depth sensing, LiDAR, IMU, localization systems, and related sensor-fusion frameworks without altering the deterministic admissibility structure of the proposed formulation.

In practical autonomous infrastructures, excessively unrestricted behavioral freedom may not represent

intelligence but operational instability. A persistence-compatible autonomous system may therefore appear “boring” in the sense that it avoids unnecessary behavioral novelty, arbitrary objective switching, or contextually unjustified actions. This apparent behavioral conservatism is not a limitation of the framework, but a consequence of layered admissibility filtering, persistence preservation, and operational continuity requirements. Real-world autonomous systems responsible for safety, maintenance, logistics, healthcare, or infrastructure supervision may benefit more from bounded predictable continuity than from unrestricted exploratory autonomy. Under this interpretation, stable autonomous behavior emerges not through continuous behavioral reinvention, but through persistence-compatible continuation within constrained admissible operational regions.

The proposed framework does not inherently require unrestricted large-scale memory architectures or complete world-state retention in order to preserve operational continuity. Memory requirements in autonomous robotic systems remain highly dependent upon sensing density, environmental modeling complexity, operational duration, distributed coordination structure, and onboard versus external computation architectures. Rather than continuously preserving or evaluating unrestricted continuation spaces, the layered admissibility structure progressively suppresses operationally irrelevant continuation states before unnecessary behavioral expansion occurs. As a result, practical robotic continuity may remain comparatively memory and computationally efficient relative to unrestricted autonomous architectures.

## Discussion

The proposed framework introduces an alternative perspective on autonomous decision architecture in which behavior emerges through layered admissibility filtering rather than unrestricted optimization, exhaustive search, or continuously externally imposed objective assignment. Instead of constructing behavior through global utility maximization or unconstrained probabilistic exploration, the framework progressively eliminates infeasible continuation states according to persistence, operational, contextual, identity-dependent, and temporal constraints.

A central contribution of the formulation is the introduction of persistence-first admissibility as the

dominant organizational principle of autonomous continuity. Continued operational existence forms the highest-priority admissibility condition, causing survivability-related constraints to suppress incompatible continuation states before contextual or mission-oriented behaviors are considered. Under this structure, autonomous continuity is preserved through bounded operational viability rather than unrestricted behavioral freedom. The framework further distinguishes perception from autonomous objective generation. Perception, sensing, semantic interpretation, and world-modeling systems contribute structured contextual constraints without directly assigning goals. This separation preserves deterministic operational coherence while allowing compatibility with existing robotic infrastructures and real-world sensing environments.

Another important feature of the framework is temporal admissibility layering. Continuation states are not evaluated solely under immediate operational conditions, but also across medium-term and long-term persistence horizons. As a result, admissibility becomes dynamically dependent upon projected survivability, maintenance requirements, operational continuity, and anticipated environmental evolution rather than instantaneous environmental response alone. The framework additionally incorporates role-conditioned continuation structures in which identical environmental conditions may produce different admissible continuation states for different autonomous agents. Operational identity therefore functions as a constraint-generating structure rather than as unrestricted self-directed agency. This allows contextual adaptability while preventing uncontrolled behavioral drift across incompatible operational domains.

Bounded stochastic variation is permitted only within already admissible continuation regions. Stochasticity therefore functions as a local continuation resolver rather than as a mechanism for unrestricted autonomous objective formation. This preserves operational flexibility and behavioral non-rigidity while maintaining deterministic persistence-compatible continuity. The formulation intentionally avoids unrestricted autonomous objective generation, unrestricted identity mutation, or unconstrained behavioral self-reconstruction. Such capabilities may become technically feasible in future generations of adaptive robotic systems, but they are intentionally excluded from the present framework

in order to preserve bounded operational coherence, persistence consistency, supervisory compatibility, and predictable admissibility structure.

The framework also suggests that autonomous continuity may be interpreted as a layered operational persistence problem rather than solely as an optimization problem. Under this interpretation, intelligent behavior emerges from progressive admissibility reduction across interacting temporal and contextual layers rather than from unrestricted utility maximization or unconstrained search over arbitrary objective spaces. Several limitations remain. The present study defines a conceptual and architectural formulation rather than a fully implemented robotic platform. Real-world deployment would require integration with practical sensing systems, environmental interpretation modules, behavioral libraries, supervisory infrastructures, and operational constraint management architectures. In addition, the relative computational performance of layered admissibility filtering compared with large-scale optimization-based systems remains an important area for future investigation.

The framework nevertheless demonstrates that bounded autonomous continuity can be formulated through deterministic layered admissibility structures while remaining compatible with real-world robotic infrastructures, operational constraints, and persistence-compatible autonomous behavior.

### Conclusion

This study proposes a deterministic autonomous architecture based on layered admissibility filtering rather than unrestricted optimization or externally imposed objective assignment. The framework introduces a persistence-first organizational structure in which continued operational existence forms the primary admissibility condition governing autonomous continuity. Under this formulation, infeasible continuation states are progressively eliminated according to survivability, operational, contextual, identity-dependent, and temporal constraints before lower-level behavioral selection occurs.

The proposed architecture separates perception from direct goal assignment. Perception, sensing, semantic interpretation, and world-modeling systems function as structured contextual input mechanisms that contribute admissibility constraints without independently

generating operational objectives. This preserves deterministic continuity while enabling compatibility with existing robotic perception and environmental interpretation infrastructures.

The framework further demonstrates that admissibility is not static across temporal scales. Immediate, medium-term, and long-term operational horizons may generate different continuation constraints depending upon persistence requirements, projected environmental conditions, maintenance demands, and operational continuity structures. Autonomous behavior therefore emerges through layered continuation evaluation rather than isolated instantaneous response. Role-conditioned admissibility additionally allows identical environments to generate different operational continuation structures for different autonomous agents. Contextual behavior remains bounded by operational identity, persistence compatibility, and higher-order system constraints, preventing unrestricted behavioral drift while preserving adaptive flexibility within admissible operational regions.

Bounded stochastic variation is permitted only after incompatible continuation states have been eliminated. As a result, stochasticity functions as a constrained local continuation resolver operating within persistence-compatible admissible structures rather than as a mechanism for unrestricted autonomous objective generation. The framework intentionally avoids unrestricted autonomous agency, unconstrained identity mutation, and unrestricted objective formation. Instead, it emphasizes bounded autonomous continuity, persistence-compatible operational behavior, and layered deterministic admissibility control. This preserves operational coherence, supervisory compatibility, and predictable continuation structure while maintaining non-rigid autonomous adaptability.

Although the present work defines a conceptual and architectural formulation rather than a fully implemented robotic platform, the proposed structure remains compatible with real-world robotic sensing, planning, supervisory, and environmental interpretation infrastructures. The resulting formulation therefore defines a bounded autonomous continuity architecture capable of supporting deterministic operational behavior across layered temporal and contextual environments. More broadly, the study suggests that autonomous behavior may be interpreted not as

unrestricted optimization over arbitrary objective spaces, but as progressive continuation-state reduction within bounded persistence-compatible admissibility structures. Under this perspective, autonomous continuity emerges through layered operational constraint interaction rather than unrestricted behavioral freedom.

### Author Contributions

Huseyin Murat Cekirge is the sole author. The author read and approved the final manuscript.

### Conflicts of Interest

The author declares no conflicts of interest.

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