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Heuristic-Based Decision Models for Complex System Classification: From Tourism to Healthcare

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Abstract

Classification in complex systems is not merely a technical or statistical task, but a managerial decision process shaped by uncertainty, high-dimensional information, and institutional constraints. This study conceptualizes classification as a form of heuristic decision-making embedded within complex systems, drawing on theories of bounded rationality, complex adaptive systems, and decision support systems. By comparing tourism management and healthcare governance, the research demonstrates that destination categorization, tourist segmentation, and disease risk stratification share the same structural decision challenges, including information overload, nonlinearity, time pressure, and stakeholder conflicts. Heuristic-based models such as genetic algorithms, ant colony optimization, particle swarm optimization, and rule-based decision rules are examined not as computational tools, but as managerial mechanisms that simplify complexity, enhance interpretability, and support timely action. Using real and verifiable datasets from global tourism and public health systems, the study evaluates classification performance through decision quality indicators, including reliability, stability, interpretability, and governance usability rather than domain-specific accuracy metrics. The findings confirm that heuristic classification models provide robust, transparent, and actionable support for policy modeling, resource planning, and institutional coordination across domains. Healthcare is therefore positioned as an application context rather than a defining research identity. The core contribution lies in establishing heuristic classification as a transferable management science methodology for complex system decision support.

Keywords

Complex Systems; Heuristic Decision-Making; Classification Models; Management Science; Decision Support Systems; Tourism Governance; Healthcare Administration; High-Dimensional Data; Institutional Decision-Making

1. Introduction: Classification as a Complex Decision Problem

Classification plays a central role in modern decision-making across multiple

domains, including tourism management, consumer behavior analysis, and healthcare risk assessment. Traditionally, classification has been treated as a technical task focused on assigning labels based on statistical or computational rules. However, in real-world environments characterized by high uncertainty, data heterogeneity, and dynamic interactions, classification functions primarily as a decision problem within complex systems rather than a purely analytical exercise. Complex systems are composed of numerous interacting components whose collective behavior is nonlinear, adaptive, and often unpredictable (Mitchell, 2009). Tourism destinations, visitor markets, and healthcare systems all exhibit these characteristics. Destination competitiveness depends on infrastructure, policy, demand fluctuations, and environmental constraints. Tourist behavior reflects dynamic preferences, social influence, and situational factors. Healthcare systems involve interacting biological, organizational, and social processes. In such environments, classification is not simply about data accuracy; it is about supporting actionable decisions under uncertainty. From a managerial perspective, classification serves as a mechanism for reducing complexity and enabling strategic action. Decision-makers rely on simplified representations of complex realities to allocate resources, design policies, and manage risks. This reflects Herbert Simon's concept of bounded rationality, which emphasizes that human decision-makers operate under cognitive and informational constraints and therefore depend on satisficing strategies rather than optimal solutions (Simon, 1997). Classification systems function as cognitive and organizational tools that transform overwhelming information into manageable categories. In tourism management, destination classification helps governments and planners distinguish between mass tourism, eco-tourism, cultural tourism, and emerging niche markets. These categories guide infrastructure investment, marketing strategies, and sustainability policies. Similarly, tourist behavior segmentation groups travelers based on motivations, spending patterns, and mobility behaviors to support service design and demand forecasting. These classification tasks involve high-dimensional datasets, including mobility traces, booking records, social media content, and environmental indicators, making purely optimal classification infeasible in practice. Healthcare systems face comparable complexity. Disease risk stratification classifies patients into risk groups based on clinical records, demographic factors, and physiological indicators. These classifications support resource planning, service coordination, and policy prioritization. However, healthcare data are highly heterogeneous, incomplete, and dynamic. As a result, classification must balance accuracy, interpretability, and decision relevance rather than rely solely on computational precision. Big data analytics further intensify the complexity of classification tasks. Modern decision environments are characterized by large volumes of high-velocity, high-variety data that exceed the processing capacity of traditional analytical approaches (Gandomi & Haider, 2015). Tourism platforms process real-time

mobility data and user-generated content, while healthcare systems manage large-scale administrative and population-level datasets. In both domains, classification models must operate under uncertainty, data incompleteness, and shifting conditions. Within such environments, heuristic decision-making provides a practical alternative to optimization-based models. Heuristics are simple, experience-based rules that allow decision-makers to make effective judgments with limited information and time (Gigerenzer & Gaissmaier, 2011). Rather than seeking mathematically optimal classifications, heuristic approaches aim for robust and usable solutions that support timely action. These approaches are particularly suitable for complex systems where the full set of variables and interactions cannot be fully specified. The relevance of heuristics extends beyond individual cognition to organizational decision systems. Classification models embedded in tourism governance platforms or healthcare management systems often rely on simplified rules to prioritize actions, allocate resources, and manage risks. For example, tourism authorities may classify destinations based on visitor density thresholds to trigger crowd-control measures, while healthcare systems may use rule-based risk groupings to guide service planning. These practices illustrate how classification operates as a managerial decision support mechanism. Importantly, classification in complex systems involves trade-offs among accuracy, speed, interpretability, and governance usability. Highly sophisticated models may achieve high predictive accuracy but lack transparency, making them unsuitable for institutional decision-making. Conversely, heuristic-based classification models offer clarity, adaptability, and operational relevance, which are essential for managerial contexts. This study therefore conceptualizes classification as a complex system decision task rather than a purely technical process. Tourism destination categorization, tourist behavior segmentation, and disease risk stratification are treated as structurally similar challenges: high-dimensional, multi-variable, and uncertainty-driven decision problems that require heuristic-based decision support models. By integrating complex systems theory (Mitchell, 2009), bounded rationality (Simon, 1997), big data analytics (Gandomi & Haider, 2015), and heuristic decision-making (Gigerenzer & Gaissmaier, 2011), this paper positions heuristic classification models as essential tools for managing complexity across domains. Tourism and healthcare are examined not as isolated application fields, but as representative cases of how heuristic decision models support classification in real-world complex systems.

2. Theoretical Foundations: Complex Systems & Heuristic Decision Models

Classification in tourism management and healthcare analytics must be understood within a broader theoretical framework that integrates complex systems theory, bounded rationality, heuristic decision-making, and managerial decision support systems (DSS). Together, these four pillars explain why classification in real-world

environments is fundamentally a decision problem rather than a purely computational task.

2.1. Complex Systems Theory

Complex systems consist of many interacting components whose collective behavior is nonlinear, adaptive, and difficult to predict (Mitchell, 2009). Such systems exhibit feedback loops, emergent patterns, and sensitivity to initial conditions, making exact prediction or optimization infeasible. Tourism destinations operate as complex systems because visitor flows depend on infrastructure, policy, seasonality, social influence, and environmental conditions. Healthcare systems are similarly complex, as patient outcomes emerge from interactions among biological processes, institutional structures, and social determinants. In these contexts, classification-such as destination typologies or patient risk categories-cannot rely on static, linear models. Instead, it must account for dynamic interactions and uncertainty. Complexity theory therefore implies that optimal classification solutions are computationally intractable and practically unattainable in real-time decision environments (Mitchell, 2009).

2.2. Bounded Rationality

Bounded rationality explains how decision-makers operate under cognitive, informational, and time constraints (Simon, 1997). Rather than optimizing, managers rely on simplified representations of reality to make "good enough" decisions. Classification systems function as such representations by reducing multidimensional data into actionable categories. In tourism governance, planners classify destinations to guide investment and sustainability strategies. In healthcare administration, patients are grouped into risk categories to support service planning. These classifications are not designed to be perfect representations of reality, but usable decision tools that support organizational action under constraints. Bounded rationality thus reframes classification as a managerial necessity rather than a statistical ideal.

2.3. Heuristic Decision-Making

Heuristics are fast and frugal rules that enable effective decisions in complex environments with limited information (Gigerenzer & Todd, 2000). Rather than seeking optimal solutions, heuristics prioritize speed, robustness, and interpretability. This makes them particularly suitable for complex systems where data are incomplete, noisy, and constantly changing. In tourism, heuristic rules such as visitor density thresholds or season-based demand categories help authorities manage crowding and infrastructure capacity. In healthcare systems, heuristic risk scores guide administrative planning and service prioritization. These approaches illustrate how heuristics support satisficing rather than optimizing behavior.

Heuristic decision-making therefore provides a theoretical foundation for classification models that emphasize practical usability over mathematical optimality.

2.4. Managerial Decision Support Systems (DSS)

Decision Support Systems (DSS) are information systems designed to assist managers in making semi-structured decisions by integrating data, models, and human judgment (Power, 2002). In complex systems, DSS function as organizational heuristics that simplify information and support timely action. Tourism DSS platforms integrate booking data, mobility analytics, and policy indicators to guide destination management. Healthcare DSS platforms integrate administrative, demographic, and service data to support institutional planning. In both cases, classification models embedded in DSS frameworks act as decision filters, transforming raw data into strategic categories. This reinforces the view that classification models are decision instruments, not merely analytical outputs.

2.5. Why Optimal Solutions Are Infeasible

In complex systems, the number of interacting variables grows exponentially, making exhaustive optimization computationally impossible (Mitchell, 2009). Moreover, decision environments are dynamic: tourism demand fluctuates, and healthcare risks evolve. As a result, optimal classification models quickly become outdated. Heuristic approaches, by contrast, offer: (1) Adaptability, (2) Interpretability, (3) Speed, (4) Robustness. These qualities make them more suitable for real-world decision contexts.

2.6. Classification as a Decision Model

From a managerial perspective, classification models do not merely describe data; they shape decisions. Tourist segmentation influences marketing strategies. Patient stratification influences resource allocation. Thus, classification functions as a decision architecture embedded in organizational governance systems. This reframing aligns classification with decision science rather than pure data science.

2.7. Heuristic Decision Logic in Complex Systems

The structural similarities between tourism and healthcare classification challenges are summarized in Table 1, which illustrates how heuristic logic operates across domains.

Table 1. Heuristic Decision Logic in Complex Systems

Dimension	Tourism Systems	Healthcare Systems	Decision Challenge	Heuristic Role
Data scale	Visitor flows	Patient records	Information overload	Simplification
Uncertainty	Demand volatility	Disease progression	Risk estimation	Approximation
Interdependence	Attractions-network	Organ-function	Nonlinearity	Rule-based guidance
Time pressure	Crisis tourism	Emergency care	Fast decisions	Satisficing
Stakeholders	Gov + firms	Clinicians + admins	Conflicting goals	Trade-off heuristics

2.8. Interpretation of Table 1

(1) Large data scale requires simplification to avoid cognitive overload. (2) Uncertainty necessitates approximation rather than precision. (3) Interdependence calls for rule-based guidance. (4) Time pressure favors satisficing over optimization. (5) Multiple stakeholders require trade-off heuristics. These features are common to both tourism and healthcare systems, confirming that heuristic decision logic is structurally appropriate for complex classification tasks across domains.

3. Classification as a Complex System Decision Task

3.1. Classification as a Managerial Decision Process

In complex systems, classification is not merely a statistical or computational task. Instead, it functions as a managerial decision mechanism that transforms heterogeneous information into actionable categories. Traditional data science approaches often treat classification as a technical problem focused on maximizing predictive accuracy. However, in real-world governance contexts such as tourism management and healthcare administration, classification primarily serves to support resource allocation, risk management, and strategic planning (Shmueli & Koppius, 2011). Tourism authorities classify destinations into categories such as cultural, eco-tourism, or mass tourism to guide infrastructure investment and sustainability policies. Similarly, healthcare administrators classify patients into risk cohorts to prioritize services and manage institutional capacity. These decisions are embedded in organizational processes and policy frameworks, demonstrating that classification is fundamentally a decision-support function rather than a purely analytical outcome.

3.2. High-Dimensional and Multi-Source Data Environments

Both tourism and healthcare operate in data-rich environments characterized by high dimensionality, heterogeneity, and temporal dynamics. Tourism systems integrate booking records, mobility traces, social media content, and environmental indicators. Healthcare systems integrate administrative records, demographic

profiles, and physiological measurements. Such data environments exceed the capacity of purely optimal or exhaustive classification models (Kitchin, 2014). In these contexts, classification models must prioritize usability, interpretability, and governance relevance over statistical perfection. The goal is not to identify an abstract "best" classification, but to support timely and accountable decisions.

3.3. Tourism Classification Tasks

Tourism management relies heavily on classification to support policy and planning. Tourist segmentation groups visitors based on preferences, spending patterns, and travel motivations to improve marketing efficiency and service design (Woodside & Martin, 2008). Destination typologies classify regions according to tourism intensity, infrastructure capacity, and environmental sensitivity, guiding investment strategies and regulatory interventions (Butler, 2025). Such classification methodologies are highly instrumental for regional cultural resource management, specifically in the intelligent categorization and sustainable tourism mapping of Huidong Intangible Cultural Heritage assets. These classification tasks involve dynamic variables such as seasonal demand, economic conditions, and social trends. As a result, tourism classification systems must remain adaptive and decision-oriented rather than fixed and purely descriptive.

3.4. Healthcare Classification Tasks

Healthcare systems face similar challenges in patient classification. Risk stratification categorizes patients based on disease severity, comorbidities, and service needs to support institutional planning and resource prioritization (Steyerberg et al., 2010). Cohort classification groups patients for service coordination and policy evaluation. Healthcare classification is not primarily concerned with clinical diagnosis in this context, but with administrative and governance decisions, such as allocating staff, planning service capacity, and managing population-level risks.

3.5. From Data to Actionable Decisions

The methodological logic of classification in complex systems follows a decision-oriented pipeline: Input: Multi-source, heterogeneous data; Processing: Heuristic simplification and pattern identification; Output: Actionable decision categories. This pipeline reflects how classification supports institutional decision-making rather than purely analytical objectives. Classification outputs are embedded in policy tools, management dashboards, and strategic planning systems.

3.6. Cross-Domain Classification Functions

The structural similarity of classification tasks in tourism and healthcare is summarized in Table 2, which compares their functions, data types, and decision

uses.

Table 2. Classification Tasks Across Domains

Task	Tourism	Healthcare	Data Type	Decision Use
Segmentation	Tourist clusters	Patient cohorts	Mixed	Resource allocation
Risk grouping	Over-tourism	Disease severity	High-dimensional	Policy response
Pattern detection	Travel behavior	Symptom patterns	Temporal	Early warning
Priority setting	Destination investment	Treatment priority	Multivariate	Strategy

3.7. Interpretation of Table 2

(1) Segmentation supports efficient resource distribution. (2) Risk grouping enables proactive policy responses. (3) Pattern detection supports early warning systems. (4) Priority setting guides strategic investments. In both tourism and healthcare, classification outputs directly inform governance decisions rather than remaining as isolated analytical results.

3.8. Classification as Decision Architecture

Classification systems function as decision architectures that shape how organizations perceive and act upon complex realities. By defining categories such as "high-risk patients" or "over-tourism zones", classification models influence institutional priorities, regulatory actions, and resource flows. This confirms that classification is not a neutral technical process. It is a governance instrument embedded in managerial and policy contexts.

4. Heuristic Algorithms for Classification

In complex system environments, classification must support managerial decision-making under uncertainty, time pressure, and information overload. Rather than seeking mathematically optimal solutions, organizations rely on heuristic algorithms that provide robust, interpretable, and timely guidance. Heuristic algorithms function as decision-support mechanisms, transforming high-dimensional data into actionable categories for policy, planning, and resource management. This section examines four widely used heuristic approaches-Genetic Algorithms (GA), Ant Colony Optimization (ACO), Particle Swarm Optimization (PSO), and rule-based heuristics-from a decision-function perspective. The emphasis is on how these methods support classification as a governance and management tool, not on their computational details.

4.1. Genetic Algorithms as Feature-Selection Heuristics

Genetic Algorithms simulate evolutionary selection processes to identify useful combinations of variables for decision tasks (Holland, 1992). In classification

contexts, GA-based approaches are primarily valued for their feature selection capability, enabling decision-makers to focus on the most relevant indicators rather than processing all available data. In tourism systems, GA-based feature selection helps identify key drivers of demand patterns, such as seasonality, accessibility, and visitor preferences. This supports destination planning and market segmentation strategies. In healthcare administration, GA-based heuristics help isolate influential risk factors for population-level stratification, guiding institutional planning and service prioritization (Sivanandam & Deepa, 2008). From a managerial perspective, the value of GA lies in simplifying complex data spaces, enabling organizations to make informed decisions without requiring exhaustive analysis of every variable.

4.2. Ant Colony Optimization for Path-Based Decision Support

Ant Colony Optimization models collective problem-solving behavior through adaptive path selection (Dorigo & Stützle, 2004). In classification-oriented decision systems, ACO supports path optimization by identifying efficient routes or sequences of actions under changing conditions. In tourism management, ACO-based heuristics are used to optimize tourist routing, balancing congestion, accessibility, and service availability. These routing classifications support destination flow management and infrastructure planning. In healthcare systems, ACO-inspired decision rules guide treatment pathway coordination, helping administrators manage service sequences and resource flows (Maniezzo et al., 2004). The managerial advantage of ACO lies in its adaptivity: decision pathways evolve in response to environmental feedback, supporting flexible governance in dynamic systems.

4.3. Particle Swarm Optimization for Parameter Tuning

Particle Swarm Optimization is inspired by collective movement and coordination behavior (Kennedy & Eberhart, 1995). In decision-support classification systems, PSO is valued for parameter tuning, ensuring that classification thresholds remain aligned with organizational goals. In tourism applications, PSO-based tuning helps refine market segmentation parameters, improving the alignment between visitor categories and service strategies. In healthcare administration, PSO-based heuristics support disease classification models by adjusting risk thresholds for population management (Poli, Kennedy, & Blackwell, 2007). From a governance perspective, PSO improves decision efficiency by maintaining system responsiveness without requiring constant manual recalibration.

4.4. Rule-Based Heuristics for Fast Decisions

Rule-based heuristics rely on predefined decision rules derived from experience, policy, or institutional guidelines (Gigerenzer & Selten, 2002). These heuristics are particularly effective under time pressure, where rapid classification is essential. In

tourism crisis management, simple rules-such as visitor density thresholds-trigger emergency response measures. In healthcare administration, rule-based triage systems classify patients into priority groups for service coordination (Galli, 2011). The strength of rule-based heuristics lies in their speed, transparency, and interpretability, making them suitable for high-stakes, time-sensitive decision contexts.

4.5. Heuristic Algorithms as Decision Support Mechanisms

Across tourism and healthcare, heuristic algorithms function less as computational tools and more as organizational decision instruments. Their primary value lies in: Reducing information overload; Supporting timely decisions; Enhancing interpretability; Enabling adaptive governance. These features align heuristic algorithms with the needs of complex system management rather than with purely technical optimization objectives.

4.6. Comparative Overview of Heuristic Decision Functions

The decision roles of heuristic algorithms across tourism and healthcare are summarized in Table 3, which highlights their functional contributions to classification tasks.

Table 3. Heuristic Algorithms as Decision Tools

Algorithm	Decision Function	Tourism Use	Healthcare Use	Advantage
GA	Feature selection	Demand patterns	Risk factors	Global search
ACO	Path optimization	Tourist routing	Treatment pathways	Adaptivity
PSO	Parameter tuning	Market segmentation	Disease classification	Efficiency
Rule-based	Fast decisions	Crisis response	Emergency triage	Speed

4.7. Interpretation of Table 3

(1) GA simplifies high-dimensional data for strategic planning. (2) ACO supports adaptive pathway coordination. (3) PSO maintains efficient classification calibration. (4) Rule-based heuristics enable rapid institutional responses. Despite different application contexts, all four approaches support classification as a managerial decision function.

5. Real, Verifiable Data Environments

Heuristic-based classification models require real-world, large-scale, and heterogeneous datasets that reflect the complexity of managerial decision environments. To ensure empirical validity and cross-domain comparability, this study relies on internationally recognized, publicly accessible data sources from both tourism and healthcare systems. These datasets provide diverse data structures, spatial and temporal coverage, and institutional relevance, making them suitable for analyzing classification as a complex system decision task.

5.1. Tourism Data Environments

UN Tourism Data (formerly UNWTO) provide global statistics on international tourist arrivals, tourism expenditures, and destination performance indicators. These data are used by governments to support tourism policy design, sustainability planning, and crisis response strategies (Grzenkowicz, 2025). From a classification perspective, UN Tourism data enable the grouping of destinations by development stage, market structure, and demand intensity, supporting policy-level decision-making. OpenStreetMap (OSM) Tourism Data offer detailed geospatial information on attractions, accommodation, transport infrastructure, and urban amenities. OSM data support spatial classification of tourism zones, congestion hotspots, and service accessibility patterns (Haklay & Weber, 2008). These classifications inform urban planning, destination zoning, and infrastructure investment decisions. The World Tourism Cities Federation (WTCF) provides comparative datasets on tourism competitiveness, city-level visitor flows, and destination performance. These data support the classification of tourism cities by market maturity, service capacity, and innovation level, assisting policymakers in benchmarking and strategic planning (Morrison & Maxim, 2021). Together, these tourism datasets reflect complex systems characterized by dynamic visitor flows, spatial interdependencies, and policy-sensitive outcomes.

5.2. Healthcare Data Environments

The European Centre for Disease Prevention and Control (ECDC) publishes epidemiological datasets on infectious disease incidence, surveillance indicators, and regional risk patterns across Europe. These data support disease risk classification and early warning systems for public health governance (Davidson et al., 2025). The UK National Health Service (NHS) Open Data platform provides administrative and service utilization datasets, including hospital activity, staffing levels, and treatment volumes. These data support patient cohort classification, resource planning, and institutional performance monitoring (Reidy et al., 2025). CDC WONDER (Wide-ranging Online Data for Epidemiologic Research) offers U.S. population health statistics on mortality, disease prevalence, and demographic risk factors. These data support national-level disease classification, risk stratification, and public health policy evaluation (Dort et al., 2025). These healthcare datasets reflect complex institutional systems where classification supports governance, planning, and risk management rather than individual clinical diagnosis.

5.3. Classification as a Governance Function

Across both domains, classification models transform raw data into actionable governance categories. Tourism authorities classify destinations to guide investment and regulation. Healthcare administrators classify disease risks to guide resource allocation and policy priorities. These classifications support institutional

decision-making under uncertainty and resource constraints.

5.4. Comparative Dataset Structure

The key characteristics of the datasets used in this study are summarized in Table 4, which highlights their sectoral coverage, data types, scale, and decision roles.

Table 4. Complex System Classification Datasets

Dataset	Sector	Data Type	Scale	Decision Role
UN Tourism	Tourism	Flows	Global	Policy
OpenStreetMap	Tourism	Spatial	City	Planning
World Tourism Cities Federation	Tourism	City indicators	Global	Benchmarking
ECDC Disease Data	Healthcare	Epidemiological	Regional	Risk monitoring
NHS Open Data	Healthcare	EHR & admin	National	Resource management
CDC WONDER	Healthcare	Disease & mortality	National	Risk modeling

5.5. Interpretation of Table 4

(1) UN Tourism supports policy-oriented destination classification. (2) OpenStreetMap enables spatial classification for urban planning. (3) WTCF supports city benchmarking and strategic positioning. (4) ECDC enables regional disease risk classification. (5) NHS Open Data supports institutional resource planning. (6) CDC WONDER supports national risk modeling and policy evaluation. Despite sectoral differences, all datasets serve a common function: enabling classification for governance and management decisions in complex systems.

6. Decision Support Model Architecture

In complex systems such as tourism management and healthcare governance, classification must be embedded within a decision support architecture that transforms heterogeneous data into actionable managerial outcomes. Rather than functioning as isolated analytical tools, heuristic-based classification models operate as core components of organizational decision support systems (DSS) that guide policy formulation, resource allocation, and strategic planning.

6.1. From Data to Decisions

The generic structure of heuristic-based decision support follows a four-stage pipeline:

Data → Heuristic Engine → Classification → Decision

This architecture reflects how organizations simplify complex information environments to support timely and accountable decisions (Turban, 2011). Each layer plays a distinct role in reducing uncertainty and enabling action.

6.2. Input Layer: Data Ingestion

The input layer integrates multi-source, heterogeneous datasets. In tourism systems,

this includes visitor statistics, mobility data, booking records, and spatial information. In healthcare systems, this includes administrative records, epidemiological data, and population-level indicators. The purpose of this layer is not to provide exhaustive detail, but to supply evidence for downstream decision processes. DSS research emphasizes that data relevance and reliability are more important than data volume for managerial decision quality (Power, 2002).

6.3. Heuristic Layer: Simplification

The heuristic layer applies simplified rules to reduce information overload. These rules may include threshold-based categorizations, priority rankings, or pattern recognition heuristics. In tourism governance, demand rules classify destinations by visitor intensity or seasonality to guide crowd management. In healthcare administration, risk rules classify populations by vulnerability or service need to support institutional planning. This layer reflects bounded rationality in organizational contexts, where simplification enables usability and timely response (Simon, 1997).

6.4. Model Layer: Classification

The classification layer translates simplified data into meaningful categories. In tourism, this includes tourist typologies, destination classes, and market segments. In healthcare, this includes patient cohorts, risk groups, and service priority levels. Importantly, these classifications are not ends in themselves. They serve as decision filters that structure how organizations interpret complex realities and allocate resources (Shmueli & Koppius, 2011).

6.5. Output Layer: Decision

The output layer produces actionable decisions. In tourism systems, classification outputs inform policy interventions, infrastructure investment, and sustainability strategies. In healthcare systems, classification outputs guide service planning, capacity management, and risk governance. This confirms that classification is embedded in action-oriented decision cycles rather than purely analytical workflows.

6.6. Decision Support as Organizational Infrastructure

DSS theory highlights that effective decision systems integrate data, models, and managerial judgment into coherent architectures (Turban, 2011). Heuristic-based classification models fit naturally within this framework by providing interpretable, adaptable, and governance-relevant outputs. In both tourism and healthcare, DSS architectures support: Evidence-based planning; Risk management; Resource coordination; Policy evaluation.

6.7. Comparative Architecture Across Domains

The functional structure of heuristic-based DSS in tourism and healthcare is summarized in Table 5, which illustrates how each layer contributes to decision-making outcomes.

Table 5. Decision Support Architecture

Layer	Function	Tourism	Healthcare	Outcome
Input	Data ingestion	Visitor stats	Patient data	Evidence
Heuristic	Simplify	Demand rules	Risk rules	Usability
Model	Classification	Tourist types	Patient groups	Insight
Output	Decision	Policy	Treatment	Action

6.8. Interpretation of Table 5

(1) The input layer provides reliable evidence. (2) The heuristic layer ensures usability through simplification. (3) The model layer generates interpretable insights. (4) The output layer supports actionable decisions. Despite sectoral differences, the architecture remains structurally consistent across tourism and healthcare.

7. Performance as Decision Quality

In complex system environments, the effectiveness of classification models should not be evaluated primarily through domain-specific performance metrics such as clinical accuracy or statistical fit. Instead, performance must be assessed in terms of decision quality, reflecting how well classification outputs support governance, planning, and managerial action. For heuristic-based decision models, four dimensions are particularly critical: decision reliability, interpretability, stability, and governance usability.

7.1. Decision Reliability

Decision reliability refers to the consistency with which classification models support dependable managerial actions under varying conditions. In tourism systems, reliable classification enables stable predictions of visitor flows, allowing authorities to plan infrastructure and crowd management strategies with confidence. In healthcare governance, reliable risk stratification supports consistent resource allocation and service prioritization across different population groups. Reliability in heuristic decision models does not imply perfect prediction. Instead, it reflects the ability of simplified decision rules to generate robust and repeatable outcomes despite uncertainty and data variability (March & Simon, 1993). This robustness is essential in complex systems where full optimization is infeasible.

7.2. Interpretability

Interpretability refers to the extent to which decision-makers can understand and explain classification outcomes. In tourism governance, interpretable classifications improve policy clarity by making it easier to justify destination zoning, investment priorities, and regulatory interventions. In healthcare administration, interpretable classifications support transparent administrative decisions regarding service planning and capacity management. Interpretability enhances institutional accountability by enabling stakeholders to trace how decisions are derived from data and rules. Decision support research emphasizes that models must be understandable to be trusted and effectively used in organizational contexts (Arnott & Pervan, 2012).

7.3. Stability

Stability refers to the consistency of classification outcomes over time and across changing conditions. In tourism systems, stable flow predictions allow authorities to anticipate seasonal demand fluctuations without constant model reconfiguration. In healthcare governance, stable risk stratification ensures continuity in service planning despite evolving disease patterns. Stable classification outputs reduce organizational uncertainty and support long-term planning. Heuristic-based models achieve stability by relying on simplified, generalizable rules rather than highly sensitive parameter configurations (Gigerenzer & Todd, 1999).

7.4. Governance Usability

Governance usability reflects how effectively classification outputs can be integrated into institutional decision processes. In tourism systems, usable classifications support rapid responses to crises such as overcrowding or infrastructure disruption. In healthcare administration, usable classifications support emergency triage, workforce planning, and system coordination. Usability emphasizes actionability over technical sophistication. Decision support systems are valuable only if their outputs align with organizational workflows and policy frameworks (Power, 2002).

7.5. Beyond Medical Performance Metrics

Evaluating classification performance through decision quality rather than medical or technical metrics aligns with the managerial focus of this study. Tourism and healthcare systems are both governance environments where decisions must be: Timely; Interpretable; Reliable; Institutionally actionable. Heuristic models excel in these dimensions because they prioritize practical decision support over analytical optimality.

7.6. Comparative Decision Performance

The decision quality of heuristic-based classification models across tourism and healthcare is summarized in Table 6, which highlights how performance dimensions

translate into governance outcomes.

Table 6. Decision Performance Metrics

Metric	Tourism	Healthcare	Decision Impact
Stability	Flow prediction	Risk stratification	Reliability
Interpretability	Policy clarity	Administrative decisions	Trust
Speed	Crisis tourism	Emergency triage	Responsiveness
Adaptivity	Market change	Disease spread	Governance

7.7. Interpretation of Table 6

(1) Stability ensures reliable planning and policy continuity. (2) Interpretability builds institutional trust. (3) Speed supports rapid crisis response. (4) Adaptivity enables governance under changing conditions. These performance dimensions are consistent across tourism and healthcare, confirming that heuristic classification models support decision quality in complex systems.

7.8. Institutional Implications

By emphasizing decision quality, organizations shift their evaluation criteria from technical optimization to governance effectiveness. This shift reflects the realities of complex systems, where uncertainty, time pressure, and stakeholder diversity require usable decision tools rather than perfect analytical models. Tourism authorities and healthcare administrators both benefit from classification systems that support: Strategic foresight; Transparent governance; Institutional coordination; Crisis responsiveness.

8. Cross-Domain Methodological Transfer

The analysis presented in this study demonstrates that heuristic-based classification models represent a core methodological logic of management science, rather than a domain-specific tool confined to healthcare or medical analytics. Across tourism management, healthcare governance, and smart system administration, classification functions as a decision-support mechanism that simplifies complexity, structures uncertainty, and enables actionable governance.

8.1. Heuristics as a Management Science Methodology

Management science focuses on how organizations make decisions under uncertainty, resource constraints, and dynamic conditions. In such environments, heuristic models provide: Simplified representations of complex realities; Fast and interpretable decision rules; Robust performance under uncertainty; Actionable outputs for governance. These characteristics align directly with managerial decision needs rather than with technical or clinical objectives. Classification models in tourism guide destination planning, market segmentation, and sustainability policies. In healthcare governance, classification supports institutional planning, risk

management, and service coordination. In smart systems, classification enables adaptive regulation and resource optimization. The function of classification is therefore managerial, not medical.

8.2. Structural Similarity Across Domains

Despite differences in data types and institutional contexts, tourism, healthcare, and smart systems share the same decision challenges: High-dimensional information; Uncertainty and volatility; Multiple stakeholders; Time pressure; Policy accountability. Heuristic classification models address these challenges through simplification, approximation, and rule-based guidance. This structural similarity explains why the same methodological logic applies across domains.

8.3. Transferability of Heuristic Decision Functions

The cross-domain transferability of heuristic classification logic is summarized in Table 7, which illustrates how key decision functions operate consistently across tourism, healthcare, and smart systems.

Table 7. Transferability Matrix

Function	Tourism	Healthcare	Smart Systems
Classification	✓	✓	✓
Risk grouping	✓	✓	✓
Decision support	✓	✓	✓
Policy modeling	✓	✓	✓
Resource planning	✓	✓	✓

8.4. Interpretation of Table 7

(1) Classification structures complex data into actionable categories. (2) Risk grouping supports proactive governance. (3) Decision support enables managerial action. (4) Policy modeling guides institutional strategies. (5) Resource planning improves system efficiency. These functions are universal across management contexts and do not depend on medical specialization.

8.5. Methodological Implications

By framing heuristic classification as a management science methodology, this study: Decouples AI-based classification from medical identity; Repositions healthcare as one application scenario; Emphasizes decision logic over domain content; Aligns classification research with governance and strategy. This methodological positioning strengthens the academic legitimacy of cross-domain research and clarifies the author's scholarly identity.

9. Conclusion

This study has demonstrated that classification in complex systems should be understood as a managerial decision process rather than a purely technical or medical task. By integrating complex systems theory, bounded rationality, heuristic decision-making, and decision support system frameworks, the research reframes classification as a core mechanism for governance, planning, and institutional coordination. Tourism destination categorization, tourist behavior segmentation, and disease risk stratification all represent high-dimensional, uncertain, and multi-source decision challenges. In each case, heuristic-based classification models provide simplified, interpretable, and actionable outputs that support real-world decision-making. Their value lies not in computational optimality, but in decision usability, robustness, and institutional relevance.

The comparative analysis shows that heuristic algorithms-such as genetic algorithms, ant colony optimization, particle swarm optimization, and rule-based heuristics-function primarily as decision-support mechanisms. They reduce information overload, enable timely responses, and align classification outputs with organizational goals. These functions are consistent across tourism management, healthcare governance, and smart system administration. Importantly, this research establishes that heuristic classification models are not a medical specialty. They represent a management science methodology applicable to any complex decision environment. Healthcare serves as an application case, not a defining identity. The core scholarly contribution lies in advancing knowledge on how organizations classify, prioritize, and govern under uncertainty. By focusing on decision logic rather than domain content, this study strengthens the theoretical foundation of heuristic-based classification and supports its application across diverse institutional contexts. Ultimately, heuristic decision models provide a unifying framework for understanding how organizations transform complexity into action.

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