Novelty Assessment Report

Paper: Robust Decision-Making with Partially Calibrated Forecasters

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Abstract

Calibration has emerged as a foundational goal in trustworthy machine learning, in part because of its strong decision theoretic semantics. Independent of the underlying distribution, and independent of the decision maker's utility function, calibration promises that amongst all policies mapping predictions to actions, the uniformly best policy is the one that trusts the predictions and acts as if they were correct. But this is true only of fully calibrated forecasts, which are tractable to guarantee only for very low dimensional prediction problems. For higher dimensional prediction problems (e.g. when outcomes are multiclass), weaker forms of calibration have been studied that lack these decision theoretic properties. In this paper we study how a conservative decision maker should map predictions endowed with these weaker (partial) calibration guarantees to actions, in a way that is robust in a minimax sense: i.e. to maximize their expected utility in the worst case over distributions consistent with the calibration guarantees. We characterize their minimax optimal decision rule via a duality argument, and show that surprisingly, trusting the predictions and acting accordingly is recovered in this minimax sense by decision calibration (and any strictly stronger notion of calibration), a substantially weaker and more tractable condition than full calibration. For calibration guarantees that fall short of decision calibration, the minimax optimal decision rule is still efficiently computable, and we provide an empirical evaluation of a natural one that applies to any regression model solved to optimize squared error.

Core Task Landscape

This paper addresses: **Robust Decision Making with Partially Calibrated Forecasts**

A total of **50 papers** were analyzed and organized into a taxonomy with **19 categories**.

Taxonomy Overview

The research landscape has been organized into the following main categories:

- **Theoretical Foundations of Calibration and Decision-Making**
- **Calibration Methodology and Uncertainty Quantification**
- **Domain-Specific Calibration Applications**
- **Calibration Under Distribution Shift and Robustness**
- **Behavioral and Empirical Studies of Calibration**
- **Calibration in Specialized Measurement and Instrumentation**
- **Classical Decision Theory and Forecast Evaluation**

Complete Taxonomy Tree

- Robust Decision Making with Partially Calibrated Forecasts Survey Taxonomy
- Theoretical Foundations of Calibration and Decision-Making
  - Decision-Theoretic Calibration Frameworks ★ (2 papers)
  - [0] Robust Decision-Making with Partially Calibrated Forecasters (Anon et al., 2026) View paper
  - [1] Robust Decision Making with Partially Calibrated Forecasts (Kiyani, 2025) View paper
  - Calibration Metrics and Evaluation Theory (2 papers)
  - [12] From Uncertainty to Precision: Enhancing Binary Classifier Performance through Calibration (Charpentier, 2024) View paper
  - [40] Smooth Calibration and Decision Making (Hartline, 2025) View paper
  - Incentive-Aligned Prediction Mechanisms (2 papers)
  - [5] Persuasive Calibration (Feng, 2025) View paper
  - [20] Right decisions from wrong predictions: A mechanism design alternative to individual calibration (Shengjia Zhao, 2021) View paper
- Calibration Methodology and Uncertainty Quantification
  - Post-Hoc Calibration Techniques (4 papers)
  - [8] Test Time Augmentation Meets Post-hoc Calibration: Uncertainty Quantification under Real-World Conditions (Brinker, 2023) View paper
  - [10] Role of calibration in uncertainty-based referral for deep learning (Ruotao Zhang, 2023) View paper
  - [25] Evaluating the Quality of the Quantified Uncertainty for (Re)Calibration of Data-Driven Regression Models (Rohjans, 2025) View paper
  - [30] Uncertainty-Aware Post-Hoc Calibration: Mitigating Confidently Incorrect Predictions Beyond Calibration Metrics (Gharoun, 2025) View paper
  - Bayesian and Probabilistic Uncertainty Quantification (4 papers)
  - [9] A Bayesian Deep Learning Framework for RUL Prediction Incorporating Uncertainty Quantification and Calibration (Yan-Hui Lin, 2022) View paper
  - [11] Experts don't cheat: Learning what you don't know by predicting pairs (Johnson, 2024) View paper

- [18] On Cost-Sensitive Calibrated Uncertainty in Deep Learning: An application on COVID-19 detection (Biraja Ghoshal, 2021) View paper
- [28] Unlabelled Data Improves Bayesian Uncertainty Calibration under Covariate Shift (Alex J. Chan, 2020) View paper
- Conformal Prediction and Distribution-Free Guarantees (3 papers)
- [3] Uncertainty-Aware Predictive Process Monitoring in Healthcare: Explainable Insights into Probability Calibration for Conformal Prediction (Majlatow, 2025) View paper
- [29] When Robustness Meets Conservativeness: Conformalized Uncertainty Calibration for Balanced Decision Making (Zhou Wenbin, 2025) View paper
- [34] Conformal Prediction: Calibrated Decision-Making (Singh, 2025) View paper
- Training-Time Calibration and Regularization (3 papers)
- [26] Bi-level Meta-Policy Control for Dynamic Uncertainty Calibration in Evidential Deep Learning (Yang, 2025) View paper
- [35] Online Calibrated and Conformal Prediction Improves Bayesian Optimization (Deshpande, 2021) View paper
- [44] FUZZY ENSEMBLE EMBEDDING LEARNING (FEEL): A CLASSIFIER-AGNOSTIC FRAMEWORK FOR UNCERTAINTY-AWARE AND CALIBRATED DECISION-MAKING (Kavitha, 2025) View paper

- Domain-Specific Calibration Applications
  - Healthcare and Medical Decision Support (5 papers)
  - [2] Tackling prediction uncertainty in machine learning for healthcare (Michelle Chua, 2023) View paper
  - [6] Achieving well-informed decision-making in drug discovery: a comprehensive calibration study using neural network-based structure-activity models (Hannah Rosa Friesacher, 2024) View paper
  - [13] Predictive uncertainty estimation in deep learning for lung carcinoma classification in digital pathology under real dataset shifts (Fayjie, 2024) View paper
  - [23] AI-Assisted Decision-Making for Clinical Assessment of Auto-Segmented Contour Quality (Wang, 2025) View paper
  - [36] MiT Loss: medical image-aware transfer-calibrated loss for enhanced classification (Weichao Pan, 2025) View paper
  - Environmental and Climate Forecasting (3 papers)
  - [4] Calibration and uncertainty quantification for deep learning-based drought detection (Meng-xue Zhang, 2025) View paper
  - [14] Influence of subseasonal-to-annual water supply forecasts on many-objective water system robustness under long-term change (Kyla Semmendinger, 2024) View paper
  - [15] Confidence, uncertainty and decision-support relevance in climate predictions (D. A. Stainforth, 2007) View paper
  - Energy Systems and Grid Operations (3 papers)
  - [24] A Probabilistic Forecast-Driven Strategy for a Risk-Aware Participation in the Capacity Firming Market (Sutera, 2021) View paper
  - [31] Probabilistic Forecasting of PV Adjustable Capacity and Twoâ Timescale Voltâ Var Control in Active Distribution Networks (Wei Li, 2025) View paper
  - [32] An End-to-End Approach for Microgrid Probabilistic Forecasting and Robust Operation via Decision-focused Learning (Tingwei Cao, 2025) View paper
  - Autonomous Systems and Perception (2 papers)
  - [22] Investigation of Uncertainty of Deep Learning-based Object Classification on Radar Spectra (Patel, 2021) View paper
  - [46] Uncertainty Calibration and its Application to Object Detection (KÃ¼ppers, 2023) View paper
  - Natural Language and Generative Models (1 papers)
  - [17] Finetuning Language Models to Emit Linguistic Expressions of Uncertainty (Chaudhry Arslan, 2024) View paper
  - Bioacoustics and Ecological Monitoring (1 papers)
  - [39] Uncertainty Calibration of Multi-Label Bird Sound Classifiers (Raphael Schwinger, 2025) View paper
  - Industrial and Engineering Systems (2 papers)
  - [19] Calibration and uncertainty analysis for computer modelsâ a meta-model based approach for integrated building energy simulation (M. Manfren, 2013) View paper
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  - Covariate Shift and Domain Adaptation (2 papers)
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  - [33] From Partial Calibration to Full Potential: A Two-Stage Sparse DOA Estimation for Incoherently-Distributed Sources with Gain-Phase Uncertainty (Xu He, 2025) View paper
  - Robust Optimization Under Uncertainty (2 papers)
  - [37] Constrained Online Decision-Making: A Unified Framework (Hu Haichen, 2025) View paper
  - [47] An integrated approach to apdative anticipatory traffic control and parameter estimation (C. TampÃ¨re, 2015) View paper
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  - [16] Facing uncertainty in the game of bridge: A calibration study (Keren, 1987) View paper
  - [21] Keeping the illusion of control under control: Ceilings, floors, and imperfect calibration (Francesca Gino, 2011) View paper
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  - [43] Evaluation of calibration efficacy under different levels of uncertainty (Yeonsook Heo, 2015) View paper
  - [49] Calibration Method and Uncertainty for the Primordial Inflation Explorer (PIXIE) (Kogut, 2020) View paper
  - [50] Applying Calibration to Improve Uncertainty Assessment (Mark E. Fondren, 2013) View paper
- Classical Decision Theory and Forecast Evaluation (1 papers)
  - [38] Decision making and the value of forecasts in a generalized model of the cost-loss ratio situation (Allan H. Murphy, 1985) View paper

Narrative

Core task: robust decision making with partially calibrated forecasts. The field addresses how decision-makers can act effectively when probabilistic predictions are imperfectly calibrated, meaning the stated confidence levels may not align perfectly with true frequencies. The taxonomy reveals a rich structure spanning theoretical foundations that formalize calibration and decision-theoretic frameworks, methodological branches focused on uncertainty quantification and post-hoc calibration techniques, domain-specific applications ranging from healthcare and climate forecasting to industrial monitoring, and studies of robustness under distribution shift. Classical decision theory and forecast evaluation provide historical grounding, while behavioral studies examine how humans interpret and use uncertain information. Representative works illustrate this breadth: Prediction Uncertainty Healthcare[2] and Drug Discovery Calibration[6] show domain applications, Conformal Prediction Calibrated[34] and Post Hoc Calibration[30] exemplify methodological advances, and Threshold Calibration Decisions[7] bridges theory and practice.

Particularly active lines of work explore the tension between calibration guarantees and decision utility, with some studies emphasizing formal robustness under model misspecification and others focusing on practical recalibration methods for deployed systems. The interplay between calibration metrics and downstream decision costs remains a central open question, as does the challenge of maintaining calibration when data distributions shift over time. Robust Partially Calibrated[0] sits squarely within the decision-theoretic calibration frameworks branch, sharing conceptual ground with Robust Partially Calibrated[1] in formalizing how to make provably good decisions despite partial calibration. Compared to works like Threshold Calibration Decisions[7] that focus on specific threshold-based policies, or Cost Sensitive Calibration[18] that emphasizes asymmetric loss structures, the original paper appears to pursue a more general framework for robustness guarantees, aiming to characterize optimal decision rules when forecasts satisfy weaker calibration properties than perfect probabilistic alignment.

Related Works in Same Category

The following **1 sibling papers** share the same taxonomy leaf node with the original paper:

1. Robust Decision Making with Partially Calibrated Forecasts

Authors: Kiyani, Shayan, Hassani, Hamed, Pappas, et al. (8 authors total) | **Year/Venue**: 2025 | **URL**: View paper

Abstract

Calibration has emerged as a foundational goal in `trustworthy machine learning'', in part because of its strong decision theoretic semantics. Independent of the underlying distribution, and independent of the decision maker's utility function, calibration promises that amongst all policies mapping predictions to actions, the uniformly best policy is the one that` trusts the predictions'' and acts as if they were correct. But this is true only of \emph{fully calibrated} forecasts, which are tr...

⚠ Similarity Notice

These papers share nearly identical titles, abstracts, and technical content. Both develop minimax optimal decision rules for H-calibrated forecasts using the same duality-based characterization (Theorem 3.1), prove that decision calibration recovers best-response optimality (Theorem 4.1), and present the same empirical evaluation on regression datasets. The papers appear to be the same work or very close variants.

Contributions Analysis

Overall novelty summary. The paper develops a minimax optimal decision rule for acting on partially calibrated forecasts, addressing the gap between full calibration (which guarantees decision-theoretic optimality) and weaker calibration notions prevalent in high-dimensional settings. It resides in the Decision-Theoretic Calibration Frameworks leaf, which contains only two papers total including this one. This sparse population suggests the specific intersection of robust decision theory and partial calibration guarantees remains relatively unexplored, despite the broader field's attention to calibration methodology and domain applications across 50 papers spanning 19 leaf nodes.

The taxonomy reveals substantial activity in neighboring areas: Post-Hoc Calibration Techniques (4 papers), Bayesian Uncertainty Quantification (4 papers), and Conformal Prediction (3 papers) focus on achieving or improving calibration, while Robust Optimization Under Uncertainty (2 papers) addresses worst-case guarantees without explicit calibration framing. The original paper bridges these streams by asking how to act optimally given calibration is already partially achieved but not perfect. Its sibling paper in the same leaf likely explores related decision-theoretic properties, but the leaf's scope note emphasizes minimax optimality and robustness guarantees specifically, distinguishing it from general calibration metrics or application-focused work.

Among 19 candidates examined across three contributions, the minimax optimal decision rule contribution shows one refutable candidate among six examined, suggesting some prior work addresses related optimization problems. The decision calibration sufficiency result examined three candidates with none refuting, indicating potential novelty in characterizing when plug-in policies remain optimal. The H-calibration framework contribution examined ten candidates without refutation, though this reflects the limited search scope rather than exhaustive coverage. The statistics suggest the core theoretical contributions may extend existing frameworks in non-trivial ways, particularly regarding the sufficiency conditions for trusting predictions.

Based on top-19 semantic matches, the work appears to occupy a relatively sparse theoretical niche within a field otherwise dominated by methodological advances and domain applications. The limited refutation evidence and small sibling set suggest the specific decision-theoretic angle on partial calibration is less crowded than adjacent areas. However, the search scope leaves open whether related work exists in optimization or game theory literatures not captured by calibration-focused queries.

This paper presents **3 main contributions**, each analyzed against relevant prior work:

Contribution 1: Minimax optimal decision rule for partially calibrated forecasts

Description: The authors derive a closed-form characterization of the minimax optimal decision rule for decision makers using predictions with partial (H-calibration) guarantees. This rule maximizes expected utility in the worst case over distributions consistent with the calibration guarantees, and is efficiently computable via a convex program for finite H.

This contribution was assessed against **6 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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1. Preface to a 100th Birthday Anniversary VolumeÂ²

URL: View paper

Brief Assessment

Birthday Anniversary Preface[64] is a preface to a 100th birthday anniversary volume that only mentions the minimax theorem in passing as a historical reference. It does not present any decision-making framework for partially calibrated forecasts or derive optimal decision rules.

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2. A new minimax theorem for randomized algorithms

URL: View paper

Brief Assessment

Minimax Randomized Algorithms[61] focuses on minimax theorems for randomized algorithms in computational complexity (query/communication complexity, circuits), not on decision-making with partially calibrated forecasts or H-calibration guarantees.

3. Robust forecasting

URL: View paper

Prior Art Analysis

Robust Forecasting[62] demonstrates prior work on deriving minimax optimal decision rules for forecasting under uncertainty about forecast distributions. The candidate paper presents a comprehensive framework for robust forecasting using minimax and minimax regret criteria, with closed-form characterizations derived through duality methods. Both papers address the problem of optimal decision-making when the forecaster faces uncertainty about the true forecast distribution, using minimax optimization and duality arguments to characterize optimal rules. The candidate paper's approach to deriving minimax optimal forecasts through duality methods for discrete outcomes predates and overlaps substantially with the original paper's contribution.

Evidence

Evidence 1 - **Rationale**: Both papers derive optimal decision rules by minimizing maximum risk/regret over a set of forecast distributions and use duality methods to simplify the characterization. This shows the candidate established this approach prior to the original paper. - **Original**: we characterize their minimax optimal decision rule via a duality argument, and show that surprisingly, "trusting the predictions and acting accordingly" is recovered in this minimax sense by decision calibration - **Candidate**: we derive "robust" forecasts which minimize maximum risk or regret over the set of forecast distributions. we show that for a large class of models including semiparametric panel data models for dynamic discrete choice, the robust forecasts depend in a natural way on a small number of convex optimiz...

Evidence 2 - **Rationale**: The candidate paper formally defines minimax and minimax regret forecasting problems that form the foundation for deriving optimal decision rules, establishing this framework prior to the original paper. - **Original**: we characterize their minimax optimal decision rule via a duality argument, and show that surprisingly, "trusting the predictions and acting accordingly" is recovered in this minimax sense by decision calibration - **Candidate**: a minimax forecast solves inf d∈d sup θ∈θ0 eθ[ℓ(y,d)] . the regret of a forecast is its risk in excess of the risk of the θ-optimal forecast. a minimax regret forecast solves inf d∈d sup θ∈θ0 (eθ[ℓ(y,d)] -eθ[ℓ(y,d∗ θ)]) .

4. Mathematics, Game Theory and Economics: Provisional Observations on David Gale's 75-Year Career (1949â2024) 1: Preface to a 100th Birthday Anniversary â¦

URL: View paper

Brief Assessment

Gale Career Mathematics[63] discusses historical applications of the minimax theorem in game theory and linear programming, not decision-making frameworks for partially calibrated machine learning forecasts. The candidate focuses on mathematical history and foundational theorems, whereas the original paper develops a novel robust decision-making framework for H-calibrated predictors with specific computational characterizations via convex programs.

5. Information-Theoretic Minimax Regret Bounds for Reinforcement Learning based on Duality

URL: View paper

Brief Assessment

Information Theoretic Minimax[60] focuses on minimax regret bounds for reinforcement learning in MDPs, not on decision-making with partially calibrated forecasts. The candidate addresses sequential decision-making in uncertain environments with regret minimization, while the original paper addresses one-shot decision-making given predictions with calibration guarantees.

6. Offline Minimax Soft-Q-learning Under Realizability and Partial Coverage

URL: View paper

Brief Assessment

Offline Minimax Soft[65] focuses on offline reinforcement learning with soft Q-functions under partial coverage assumptions, not on decision-making with partially calibrated forecasts or minimax decision rules for predictions with calibration guarantees.

Contribution 2: Decision calibration suffices for plug-in best response optimality

Description: The authors show that decision calibration, a substantially weaker and more tractable condition than full calibration, is sufficient to make the plug-in best response (trusting predictions) minimax optimal. Any calibration guarantee strictly stronger than decision calibration also recovers this property, creating a sharp transition in the hierarchy of robust policies.

This contribution was assessed against **3 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

1. Dimension-Free Decision Calibration for Nonlinear Loss Functions

URL: View paper

Brief Assessment

Dimension Free Calibration[66] focuses on achieving decision calibration with dimension-free sample complexity for nonlinear losses, not on proving that decision calibration suffices for best-response optimality (which it takes as established prior work).

2. Smooth Calibration and Decision Making

URL: View paper

Brief Assessment

Smooth Calibration[40] focuses on post-processing predictors with low distance-to-calibration (DTC) to achieve bounded expected calibration error (ECE) and calibration decision loss (CDL) through differential privacy mechanisms. The candidate does not address the sufficiency of decision calibration for plug-in best response optimality in a minimax sense, which is the core novelty claim of the original paper's contribution.

3. Persuasive Prediction via Decision Calibration

URL: View paper

Brief Assessment

Persuasive Decision Calibration[67] focuses on learning decision-calibrated predictors for persuasive prediction in high-dimensional settings without a common prior, whereas the original paper establishes minimax optimality of plug-in best response under decision calibration constraints in a robust decision-making framework with partial calibration guarantees.

Contribution 3: Framework for robust decision making with H-calibration

Description: The authors formalize a framework where decision makers map predictions with H-calibration guarantees to actions in a minimax sense, treating the forecast as constraining the set of candidate outcome distributions. This framework bridges fully conservative and aggressive decision making strategies based on the strength of calibration guarantees.

This contribution was assessed against **10 related papers** from the literature. Papers with potential prior art are analyzed in detail with textual evidence; others receive brief assessments.

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1. Uncertainty-Aware Deep Learning for Wildfire Danger Forecasting

URL: View paper

Brief Assessment

Wildfire Danger Forecasting[51] focuses on uncertainty quantification in wildfire prediction using epistemic and aleatoric uncertainty, not on robust decision-making frameworks with calibration guarantees for mapping predictions to actions.

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2. Calibrated forecasting and persuasion

URL: View paper

Brief Assessment

Calibrated Forecasting Persuasion[54] focuses on strategic forecasting in sender-receiver games where calibration tests determine credibility, not on robust decision-making frameworks that exploit partial calibration guarantees for downstream decision makers.

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3. From Imperfect Signals to Trustworthy Structure: Confidence-Aware Inference from Heterogeneous and Reliability-Varying Utility Data

URL: View paper

Brief Assessment

Confidence Aware Inference[55] addresses distribution grid topology reconstruction from heterogeneous utility data, not decision-making frameworks for partially calibrated forecasts. The candidate focuses on physical infrastructure modeling and confidence scoring for network connectivity, which is a fundamentally different problem domain from robust decision policies under calibration guarantees.

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4. Conformal decision theory: Safe autonomous decisions from imperfect predictions

URL: View paper

Brief Assessment

Conformal Decision Theory[52] focuses on calibrating decisions directly for low risk in autonomous systems, rather than on robust decision-making frameworks that exploit partially calibrated forecasts for general decision problems. The candidate addresses a different problem domain (autonomous decision-making with conformal prediction) compared to the original's focus on minimax optimal decision rules under H-calibration guarantees.

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5. Robust Decision Making with Partially Calibrated Forecasts

URL: View paper

Brief Assessment

Robust Partially Calibrated[1] addresses the same problem space (robust decision making with partial calibration guarantees) but appears to be the same work or a closely related version. The technical content, notation, and framework are nearly identical, making this a case of self-citation rather than prior work that refutes novelty.

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6. Strategic Calibration AI Framework: Adaptive Imbalance in Dynamic Environments

URL: View paper

Brief Assessment

Strategic Calibration Framework[56] focuses on adaptive imbalance in dynamic environments for risk assessments and scenario planning, while the original paper develops a minimax decision-theoretic framework for acting on partially calibrated forecasts with H-calibration guarantees. The candidate does not address the specific problem of mapping H-calibrated predictions to actions through robust optimization.

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7. Forking uncertainties: Reliable prediction and model predictive control with sequence models via conformal risk control

URL: View paper

Brief Assessment

Forking Uncertainties[53] focuses on time series prediction and model predictive control with conformal risk control, not on decision-theoretic frameworks for partially calibrated forecasts in the sense studied by the original paper.

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8. Artificial Intelligence Based Models for Predicting Foodborne Pathogen Risk In Public Health Systems

URL: View paper

Brief Assessment

Foodborne Pathogen Prediction[57] focuses on AI models for predicting foodborne pathogen risk in public health systems using surveillance data, genomics, and environmental features. It does not address robust decision-making frameworks that exploit partially calibrated forecasts or H-calibration guarantees for mapping predictions to actions.

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9. Quantifying calibration error in modern neural networks through evidence based theory

URL: View paper

Brief Assessment

Calibration Error Quantifying[58] focuses on quantifying calibration error in neural networks using subjective logic and expected calibration error (ECE) metrics. It does not address robust decision-making frameworks that map predictions to actions in a minimax sense, which is the core contribution of the original paper.

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10. Modular Air Quality Calibration and Forecasting Method for Low-Cost Sensor Nodes

URL: View paper

Brief Assessment

Air Quality Calibration[59] focuses on calibrating low-cost air quality sensors for pollutant measurements using machine learning, not on decision-theoretic frameworks for partially calibrated forecasts or minimax optimization strategies.

Appendix: Text Similarity Detection

Textual similarity detection checked 19 papers and found 3 similarity segment(s) across 1 paper(s).

The following **1 paper(s)** were detected to have high textual similarity with the original paper. These may represent different versions of the same work, duplicate submissions, or papers with substantial textual overlap. Readers are advised to verify these relationships independently.

1. Robust Decision Making with Partially Calibrated Forecasts

Detected in: Core Task (sibling), Contribution: contribution_3

⚠ **Note**: This paper shows substantial textual similarity with the original paper. It may be a different version, a duplicate submission, or contain significant overlapping content. Please review carefully to determine the nature of the relationship.

References

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