

# Novelty Assessment Report

**Paper:** Private Rate-Constrained Optimization with Applications to Fair Learning

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## Abstract

Many problems in trustworthy ML can be expressed as constraints on prediction rates across subpopulations, including group fairness constraints (demographic parity, equalized odds, etc.). In this work, we study such constrained minimization problems under differential privacy (DP). Standard DP optimization techniques like DP-SGD rely on objectives that decompose over individual examples, enabling per-example gradient clipping and noise addition. Rate constraints, however, depend on aggregate statistics across groups, creating inter-sample dependencies that violate this decomposability. To address this, we develop RaCO-DP, a DP variant of Stochastic Gradient Descent-Ascent (SGDA) that solves the Lagrangian formulation of rate constraint problems. We show that the additional privacy cost of incorporating these constraints reduces to privately estimating a histogram over the mini-batch at each step. We prove convergence of our algorithm through a novel analysis of SGDA that leverages the linear structure of the dual parameter. Empirical results show that our method Pareto-dominates existing private learning approaches under group fairness constraints and also achieves strong privacy-utility-fairness performance on neural networks.

### Disclaimer

This report is **AI-GENERATED** using Large Language Models and WisPaper (a scholar search engine). It analyzes academic papers' tasks and contributions against retrieved prior work. While this system identifies **POTENTIAL** overlaps and novel directions, **ITS COVERAGE IS NOT EXHAUSTIVE AND JUDGMENTS ARE APPROXIMATE**. These results are intended to assist human reviewers and **SHOULD NOT** be relied upon as a definitive verdict on novelty.

Note that some papers exist in multiple, slightly different versions (e.g., with different titles or URLs). The system may retrieve several versions of the same underlying work. The current automated pipeline does not reliably align or distinguish these cases, so human reviewers will need to disambiguate them manually.

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## Core Task Landscape

This paper addresses: **Differentially Private Optimization Under Rate Constraints**

A total of **50 papers** were analyzed and organized into a taxonomy with **24 categories**.

### Taxonomy Overview

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

- **Differentially Private Stochastic Convex Optimization**
- **Federated Learning with Privacy and Communication Constraints**
- **Distributed Optimization with Privacy and Communication Constraints**
- **Private Rate-Constrained Optimization and Fair Learning**
- **Private Sparse Distribution Estimation Under Communication Constraints**
- **Privacy-Preserving Data Aggregation and Offloading**
- **Architectural Reviews and Theoretical Frameworks**

### Complete Taxonomy Tree

- Differentially Private Optimization Under Rate Constraints Survey Taxonomy
- Differentially Private Stochastic Convex Optimization
  - Standard and User-Level Privacy Guarantees (3 papers)
  - [9] Private stochastic convex optimization with optimal rates (Bassily, 2019) [View paper](#)
  - [12] User-level private stochastic convex optimization with optimal rates (R Bassily, 2023) [View paper](#)
  - [39] User-level Differentially Private Stochastic Convex Optimization: Efficient Algorithms with Optimal Rates (Asi, 2023) [View paper](#)
  - Heavy-Tailed Gradient Handling (1 papers)
  - [22] Differential Private Stochastic Optimization with Heavy-tailed Data: Towards Optimal Rates (Puning Zhao, 2025) [View paper](#)
  - Bilevel and Hierarchical Optimization (1 papers)
  - [15] Differentially Private Bilevel Optimization: Efficient Algorithms with Near-Optimal Rates (Lowy, 2025) [View paper](#)
  - Online Convex Optimization with Long-Term Constraints (1 papers)
  - [13] Differentially Private Online Convex Optimization With Long-Term Constraints via Gaussian Mechanism and Virtual Queue (Lin Chen, 2025) [View paper](#)
- Federated Learning with Privacy and Communication Constraints
  - Communication-Efficient Federated Learning
  - Compression and Quantization Techniques (4 papers)
    - [2] Differential privacy meets federated learning under communication constraints (Nima Mohammadi, 2021) [View paper](#)
    - [8] Differentially private federated learning for bandwidth and energy constrained environments (Kerkouche, 2021) [View paper](#)
    - [17] Constrained differentially private federated learning for low-bandwidth devices (Kerkouche, 2021) [View paper](#)
    - [43] Communication efficient privacy-preserving distributed optimization using adaptive differential quantization (Li, 2022) [View paper](#)
  - Knowledge Distillation and Split Learning (2 papers)
    - [10] Communication-Efficient and Privacy-Preserving Federated Learning via Joint Knowledge Distillation and Differential Privacy in Bandwidth-Constrained Networks (Gad Gad, 2024) [View paper](#)
    - [16] An efficient privacy-aware split learning framework for satellite communications (Jianfei Sun, 2024) [View paper](#)

- Over-the-Air Computation and Wireless Optimization (2 papers)
  - [20] Optimizing communication and device clustering for clustered federated learning with differential privacy (Dongyu Wei, 2025) [View paper](#)
  - [24] Private over-the-air federated learning at band-limited edge (Youming Tao, 2024) [View paper](#)
- Privacy-Preserving Federated Learning Frameworks
- Differential Privacy in Federated Averaging (3 papers)
  - [7] Privacy-preserving and communication-efficient federated learning in internet of things (Chen Fang, 2021) [View paper](#)
  - [14] Privacy-Preserving and Communication-Efficient Federated Learning for Cloud-Scale Distributed Intelligence (Heyao Liu, 2025) [View paper](#)
  - [23] Privacy-preserving medical data collaborative modeling: A differential privacy enhanced federated learning framework (H Xie, 2024) [View paper](#)
- Hybrid Privacy Mechanisms and Adaptive Strategies (2 papers)
  - [28] Privacy-preserving low-rank instruction tuning for large language models via DP-LoRA (Yao, 2024) [View paper](#)
  - [29] Privacy-preserving federated learning for industrial edge computing via hybrid differential privacy and adaptive compression (Bin Jiang, 2021) [View paper](#)
- Domain-Specific Federated Learning Applications (3 papers)
  - [32] Privacy-Preserving AI in Agriculture: A Review of Federated Learning Approaches (Jigar A Soni, 2025) [View paper](#)
  - [37] Approximate to be great: Communication efficient and privacy-preserving large-scale distributed deep learning in Internet of Things (Wei Du, 2020) [View paper](#)
  - [38] Differential Privacy Enabled Federated LSTM Model for Decentralized Active User Detection in 6G Cell-Free mMIMO Networks (A Kumar, 2025) [View paper](#)
- Personalized and Meta-Learning Approaches (1 papers)
  - [47] Personalized Online Federated Learning With Differential Privacy in Constrained Environments: A Meta-Learning Approach (Olusola T. Odeyomi, 2024) [View paper](#)
- Collaborative Learning with Linear Communication Complexity (1 papers)
- [19] Privacy-Preserving Collaborative Learning With Linear Communication Complexity (Lu Xingyu, 2023) [View paper](#)
- Large Pre-Trained Models in Federated Learning (1 papers)
- [36] Conquering the communication constraints to enable large pre-trained models in federated learning (Guangyu Sun, 2022) [View paper](#)
- Federated Learning with Graph Neural Networks (2 papers)
- [33] A graph network model for distributed learning with limited bandwidth links and privacy constraints (Juan Parras, 2020) [View paper](#)
- [49] Convergence Analysis and Optimisation of Privacy-Preserving Federated Learning for Hierarchical Graph Neural Networks in Distributed Cloud Anomaly Detection (C Lawal, 2025) [View paper](#)
- Federated Evaluation and Metric Computation (2 papers)
- [41] FedRec12C: A Novel Federated Recommendation Framework Integrating Communication and Computation to Accelerate Convergence Under Communication Constraints (Qizhong Zheng, 2025) [View paper](#)
- [48] Federated Computation of ROC and PR Curves (Xu XueFeng, 2025) [View paper](#)
- Distributed Optimization with Privacy and Communication Constraints
  - Privacy-Preserving Consensus and Coordination (4 papers)
    - [3] Differential Privacy Consensus in Dynamic Topologies: Performance Analysis and Optimization (Jiayu Zhou, 2025) [View paper](#)
    - [26] Privacy-preserving distributed consensus over directed networks with limited communication (Yang Song, 2025) [View paper](#)
    - [30] Privacy-Preserving Coverage Control for Multiagent Systems with Limited Communication Ranges (Peng Wang, 2024) [View paper](#)
    - [35] Multiagent consensus subject to communication and privacy constraints (Maity, 2021) [View paper](#)
  - ADMM-Based Distributed Optimization (1 papers)
    - [5] Privacy-preserving distributed ADMM with event-triggered communication (Zhen Zhang, 2022) [View paper](#)
  - Distributed Estimation and Detection (3 papers)
    - [1] Privacy-preserving distributed estimation with limited data rate (Ke, 2025) [View paper](#)
    - [27] Secure Reduced-dimensional Coding Scheme for Distributed Estimation with Communication Constraints (Longyu Li, 2025) [View paper](#)
    - [45] Research on Fusion Detection of FDI Attacks in WSNs with Privacy Preservation Under Communication Constraints (Jinming Liu, 2024) [View paper](#)
  - Application-Specific Distributed Optimization (3 papers)
    - [4] Privacy-preserving communication-efficient federated multi-armed bandits (Li Tan, 2022) [View paper](#)
    - [11] Distributed privacy preserving algorithm for economic dispatch over time-varying communication (Duqiao Zhao, 2023) [View paper](#)
    - [50] Orchestration Governance Frameworks For Agentic Supply Chains: Resolving Agent Conflicts Under Uncertainty. (Garg, 2025) [View paper](#)
  - General Communication-Efficient and Privacy-Preserving Frameworks (2 papers)
    - [40] Privacy-preserving and Communication-efficient Distributed Cooperative/Competitive Optimization (Chen Xiaomeng, 2023) [View paper](#)
    - [42] Communication-Efficient and Privacy-Preserving Algorithms for Distributed Optimization (Wangli He, 2025) [View paper](#)
- Private Rate-Constrained Optimization and Fair Learning ★ (1 papers)
  - [0] Private Rate-Constrained Optimization with Applications to Fair Learning (Anon et al., 2026) [View paper](#)
- Private Sparse Distribution Estimation Under Communication Constraints (3 papers)
  - [18] Estimating sparse distributions under joint communication and privacy constraints (Surin Ahn, 2022) [View paper](#)
  - [21] Estimating sparse discrete distributions under privacy and communication constraints (Jayadev Acharya, 2021) [View paper](#)
  - [34] Estimating sparse discrete distributions under local privacy and communication constraints (Acharya, 2020) [View paper](#)
- Privacy-Preserving Data Aggregation and Offloading (2 papers)
  - [6] Personalized and differential privacy-aware video stream offloading in mobile edge computing (Ping Zhao, 2024) [View paper](#)
  - [25] A Robust Privacy-Preserving Data Aggregation Scheme for Edge-Supported IIoT (Shuai Shang, 2024) [View paper](#)

- Architectural Reviews and Theoretical Frameworks (3 papers)
  - [31] Mathematical bounds on differential privacy in heterogeneous federated IoT environments: W. Abbas et al. (W Abbas, 2025) [View paper](#)
  - [44] A Review on Federated Learning Architectures for Privacy-Preserving AI: Lightweight and Secure Cloud-Edge-End Collaboration (Shanhao Zhan, 2025) [View paper](#)
  - [46] Federated Learning and Graph Neural Networks for Transmission System Stability: A Privacy-Preserving Artificial Intelligence Framework for Smart Grids (Imoh Isaiiah Udofot, 2025) [View paper](#)

## Narrative

Core task: differentially private optimization under rate constraints. This field addresses the dual challenge of protecting sensitive data through differential privacy while operating under communication or bandwidth limitations. The taxonomy reveals a rich structure spanning seven main branches. Differentially Private Stochastic Convex Optimization establishes foundational theory for private learning with constrained resources, exemplified by works like Private Stochastic Convex[9]. Federated Learning with Privacy and Communication Constraints forms a dense branch exploring decentralized training scenarios where clients must balance privacy guarantees with limited upload capacity, as seen in Differential Privacy Federated[2] and Private Federated Bandwidth[8]. Distributed Optimization branches examine multi-agent coordination under privacy and rate limits, including consensus-based approaches like Privacy Consensus Dynamic[3] and Privacy ADMM Event-Triggered[5]. Private Rate-Constrained Optimization and Fair Learning tackles direct optimization problems where communication budgets interact with privacy mechanisms. Additional branches cover sparse distribution estimation under local privacy, privacy-preserving data aggregation for IoT and edge computing, and architectural reviews synthesizing theoretical frameworks.

Particularly active lines of work explore trade-offs between privacy strength, communication efficiency, and convergence rates. Many studies in federated settings investigate gradient compression, quantization schemes as in Privacy Adaptive Quantization[43], and over-the-air aggregation methods like Private Over-the-Air Federated[24]. Contrasting approaches emerge between centralized privacy accounting versus local privacy models, and between synchronous versus event-triggered communication protocols. Private Rate-Constrained Optimization[0] sits within the branch addressing explicit rate constraints in optimization, closely related to works examining consensus under communication limits such as Privacy Consensus Dynamic[3] and distributed methods like Privacy ADMM Event-Triggered[5]. While neighboring papers often focus on iterative distributed algorithms, the original work emphasizes direct optimization formulations where rate budgets are first-class constraints rather than implementation details, offering a complementary perspective on how communication costs fundamentally shape achievable privacy-utility frontiers.

## Related Works in Same Category

No sibling papers were found in the same taxonomy leaf. A taxonomy-subtopic-level comparison will be produced instead.

## Taxonomy-Level Summary

The original leaf focuses on optimization methods that incorporate rate constraints (e.g., group fairness constraints across subpopulations) while maintaining differential privacy. The sibling subtopics address related but distinct aspects: architectural surveys/theory, privacy-preserving data protocols in edge/IoT settings, and sparse distribution estimation under communication constraints. While all involve privacy considerations, they differ in their core optimization objectives and constraint types.

**Similarities:** - All subtopics operate within the differential privacy framework - All address constrained optimization or estimation problems where privacy must be preserved - Communication or computational efficiency considerations appear across multiple subtopics

**Differences:** - The original leaf specifically targets rate constraints (fairness metrics, group-level constraints) in optimization, while siblings focus on communication protocols, architectural frameworks, or sparse estimation - Private Rate-Constrained Optimization addresses fairness across subpopulations, whereas Private Sparse Distribution Estimation focuses on sparsity in discrete distributions - Architectural Reviews provides meta-level analysis rather than algorithmic contributions, unlike the original leaf which develops optimization methods - Privacy-Preserving Data Aggregation emphasizes edge/IoT protocols and offloading rather than constrained optimization objectives

**Suggested Search Directions:** - Fairness-aware federated learning with differential privacy guarantees - Group-level privacy constraints in distributed optimization - Rate-distortion theory applied to differentially private learning

## Sibling Subtopics

- **Architectural Reviews and Theoretical Frameworks** (leaves: 1, papers: 3)
  - Scope: Survey papers and theoretical frameworks reviewing federated learning architectures, privacy-utility trade-offs, or mathematical bounds.
  - Exclude: Excludes algorithmic contributions; see respective algorithmic categories.
- **Privacy-Preserving Data Aggregation and Offloading** (leaves: 1, papers: 2)
  - Scope: Privacy-preserving protocols for data aggregation or offloading in edge computing and IoT with communication constraints.
  - Exclude: Excludes distributed optimization or federated learning; see Distributed Optimization with Privacy and Communication Constraints.
- **Private Sparse Distribution Estimation Under Communication Constraints** (leaves: 1, papers: 3)
  - Scope: Algorithms for estimating sparse discrete distributions under joint differential privacy and communication constraints.
  - Exclude: Excludes continuous optimization or non-sparse estimation; see Differentially Private Stochastic Convex Optimization.

## Contributions Analysis

**Overall novelty summary.** The paper introduces RaCO-DP, a differentially private algorithm for optimization under rate constraints across subpopulations, with applications to group fairness. It resides in the 'Private Rate-Constrained Optimization and Fair Learning' leaf, which contains only this single paper in the taxonomy. This isolation suggests the specific combination of differential privacy with explicit rate constraints (e.g., demographic parity, equalized odds) represents a relatively sparse research direction within the broader field of private optimization, which spans 50 papers across 36 topics.

The taxonomy reveals dense activity in neighboring areas: Differentially Private Stochastic Convex Optimization (5 papers across 4 sub-branches) addresses foundational private learning theory, while Federated Learning with Privacy and Communication Constraints (26 papers) explores decentralized training with bandwidth limits. Distributed Optimization (13 papers) examines multi-agent coordination under privacy and communication constraints. The original work diverges by treating rate constraints as first-class optimization objectives rather than implementation details, bridging fairness-constrained learning with privacy mechanisms in a way that neighboring branches do not directly address.

Among 25 candidates examined, no papers clearly refute the three core contributions. The RaCO-DP algorithm (10 candidates examined, 0 refutable) appears novel in its approach to handling inter-sample dependencies via histogram privatization. The generalized rate constraints framework (10 candidates, 0 refutable) and convergence analysis for biased SGDA with linear dual structure (5 candidates, 0 refutable) similarly show no substantial prior overlap within the limited search scope. This suggests the specific technical combination—private Lagrangian formulation for rate constraints with provable convergence—has not been directly addressed in closely related work.

Based on the top-25 semantic matches and taxonomy structure, the work appears to occupy a genuinely underexplored niche at the intersection of fairness-constrained learning and differential privacy. However, the limited search scope means broader connections to fairness literature without privacy or privacy work without explicit rate constraints may exist beyond this analysis. The single-paper leaf status and absence of refuting candidates within examined work support a preliminary assessment of novelty, though exhaustive validation would require deeper exploration of fairness and constrained optimization communities.

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

### **Contribution 1: RaCO-DP algorithm for private rate-constrained optimization**

**Description:** The authors introduce RaCO-DP, a differentially private algorithm that extends SGDA to handle rate-constrained optimization problems. The algorithm uses private histogram computation to enable per-sample gradient decomposition and constraint evaluation while maintaining differential privacy 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. Optimal algorithms for differentially private stochastic monotone variational inequalities and saddle-point problems**

URL: [View paper](#)

##### **Brief Assessment**

Private Monotone Variational[66] focuses on differentially private algorithms for stochastic variational inequalities and saddle-point problems with monotone operators, not rate-constrained optimization with histogram-based constraint evaluation as in the original paper.

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#### **2. Differentially private algorithms for linear queries via stochastic convex optimization**

URL: [View paper](#)

##### **Brief Assessment**

Private Linear Queries[68] focuses on answering linear queries via saddle-point optimization for data release, not on rate-constrained optimization problems with per-sample gradient decomposition for fairness constraints.

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#### **3. The saddle-point accountant for differential privacy**

URL: [View paper](#)

##### **Brief Assessment**

Saddle-Point Accountant[62] focuses on privacy accounting methods for composing DP mechanisms, not on algorithms for rate-constrained optimization. The candidate addresses a different technical problem (efficient privacy loss computation) rather than constrained optimization with rate constraints.

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#### **4. Adaptive Batch Size for Privately Finding Second-Order Stationary Points**

URL: [View paper](#)

##### **Brief Assessment**

Private Second-Order Stationary[70] focuses on finding second-order stationary points in non-convex optimization using adaptive batch sizes and the binary tree mechanism. The original paper addresses rate-constrained optimization with fairness constraints using SGDA, which is a fundamentally different problem domain and algorithmic approach.

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#### **5. Laplacian smoothing stochastic ADMMs with differential privacy guarantees**

URL: [View paper](#)

##### **Brief Assessment**

Laplacian Private ADMM[61] addresses equality-constrained optimization problems using ADMM framework, while the original paper focuses on rate-constrained optimization (inequality constraints on prediction rates) using SGDA. These are fundamentally different problem formulations and algorithmic approaches.

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#### **6. Differentially private algorithms for the stochastic saddle point problem with optimal rates for the strong gap**

URL: [View paper](#)

##### **Brief Assessment**

Private Saddle Point[64] focuses on differentially private stochastic saddle point problems with convex-concave objectives, not rate-constrained optimization with histogram-based constraint evaluation. The technical approaches differ fundamentally.

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#### **7. Private Algorithms for Stochastic Saddle Points and Variational Inequalities: Beyond Euclidean Geometry**

URL: [View paper](#)

##### **Brief Assessment**

Private Saddle Beyond[69] focuses on stochastic saddle point problems and variational inequalities in non-Euclidean geometries, not on rate-constrained optimization problems with per-sample gradient decomposition via private histograms. The technical approaches and problem domains differ fundamentally.

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#### **8. Differentially Private Linearized ADMM Algorithm for Decentralized Nonconvex Optimization**

URL: [View paper](#)

##### **Brief Assessment**

Private Linearized ADMM[63] focuses on decentralized nonconvex optimization using ADMM, not on rate-constrained optimization problems with SGDA. The candidate addresses a different problem domain (decentralized optimization) with a different algorithmic approach (linearized ADMM vs. SGDA).

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#### **9. Improved rates of differentially private nonconvex-strongly-concave minimax optimization**

URL: [View paper](#)

##### **Brief Assessment**

Private Nonconvex-Concave Minimax[67] addresses differentially private minimax optimization in nonconvex-strongly-concave settings, not rate-constrained optimization with group fairness constraints. The candidate focuses on gradient descent-ascent for minimax problems, while the original introduces a framework specifically for rate constraints that decompose over dataset partitions.

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## 10. Second-Order Convergence in Private Stochastic Non-Convex Optimization

URL: [View paper](#)

### Brief Assessment

Private Nonconvex Convergence[65] focuses on finding second-order stationary points in non-convex optimization using perturbed stochastic gradient descent with Gaussian noise. The original paper addresses rate-constrained optimization (e.g., fairness constraints) using stochastic gradient descent-ascent with private histogram computation. These are fundamentally different problem formulations and algorithmic approaches.

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### Contribution 2: Generalized rate constraints framework

**Description:** The authors introduce a generalized formulation of rate constraints that extends beyond binary classification to multi-class settings and exploits shared structure through a global partition of the dataset. This formulation enables efficient private estimation while supporting a broad range of constraints including fairness, robust optimization, and cost-sensitive learning.

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. An Analytical Framework for Bias Mitigation in Credit Scoring Systems through Fairness-Constrained Neural Optimization

URL: [View paper](#)

#### Brief Assessment

Fair Credit Scoring[55] focuses on fairness constraints in credit scoring using neural networks with Lagrangian relaxation, not on a generalized rate constraints framework for multi-class classification or private estimation as in the original paper.

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### 2. Beyond adult and compas: Fair multi-class prediction via information projection

URL: [View paper](#)

#### Brief Assessment

Fair Multiclass Projection[52] focuses on multi-class fairness constraints via information projection and post-processing, not on the broader framework of rate constraints for robust optimization and cost-sensitive learning that the original paper addresses.

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### 3. Consistent multiclass algorithms for complex metrics and constraints

URL: [View paper](#)

#### Brief Assessment

Multiclass Complex Metrics[51] focuses on multiclass classification with complex performance metrics and constraints expressed as functions of confusion matrices. The original paper addresses rate constraints for fairness and robust optimization in multi-class settings with differential privacy, which is a distinct problem formulation not covered by the candidate paper.

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### 4. Towards fair class-wise robustness: class optimal distribution adversarial training

URL: [View paper](#)

#### Brief Assessment

Fair Class-Wise Robustness[60] focuses on adversarial training for class-wise robustness in deep learning, not on rate constraints for fairness or multi-class classification optimization under differential privacy.

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### 5. Set to Be Fair: Demographic Parity Constraints for Set-Valued Classification

URL: [View paper](#)

#### Brief Assessment

Fair Set-Valued Classification[57] focuses on set-valued classification under demographic parity constraints for multiclass settings, not on a general framework for rate constraints across diverse applications like robust optimization and cost-sensitive learning.

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### 6. Risk-averse Fair Multi-class Classification

URL: [View paper](#)

#### Brief Assessment

Risk-Averse Fair Classification[53] focuses on multi-class classification using coherent risk measures and systemic risk theory, not on rate constraints for fairness or robust optimization. The candidate addresses fairness through risk-averse optimization rather than through rate constraint formulations.

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### 7. Learning Optimal Fair Scoring Systems for Multi-Class Classification

URL: [View paper](#)

#### Brief Assessment

Optimal Fair Scoring[56] focuses on multi-class classification using MILP-based scoring systems with fairness constraints, not on a generalized rate constraints framework for differentially private optimization across diverse applications like robust optimization and cost-sensitive learning.

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### 8. Novel Data, Algorithm and Metric for Fairness-aware Machine Learning

URL: [View paper](#)

#### Brief Assessment

Fairness-Aware Machine Learning[59] focuses on fairness-constrained optimization and distributionally robust optimization for multi-class settings, but does not present a generalized rate constraints framework that extends to robust optimization, cost-sensitive learning, or private estimation as described in the original paper.

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### 9. A single-loop SPIDER-type stochastic subgradient method for expectation-constrained nonconvex nonsmooth optimization

URL: [View paper](#)

#### Brief Assessment

SPIDER Expectation-Constrained[54] focuses on expectation-constrained optimization with exact penalty methods and SPIDER-type stochastic subgradient approaches. While it addresses fairness-constrained problems as an application, it does not propose a generalized rate constraints framework that extends to multi-class settings with shared structure through global dataset partitions, which is the core novelty of the original paper's contribution.

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## 10. FairPO: Robust Preference Optimization for Fair Multi-Label Learning

URL: [View paper](#)

### Brief Assessment

Fair Preference Optimization[58] focuses on multi-label classification fairness through preference optimization (DPO-inspired loss), not on rate constraints for general constrained optimization problems. The candidate addresses fairness via preference signals and group robustness, while the original paper develops a generalized framework for rate constraints across multiple applications including fairness, robust optimization, and cost-sensitive learning with differential privacy guarantees.

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### Contribution 3: Convergence analysis for biased SGDA with linear dual structure

**Description:** The authors provide a novel convergence analysis for SGDA that handles biased gradient estimates and exploits the linear structure of the dual update to achieve faster convergence rates ( $1/T^{1/4}$  instead of  $1/T^{1/6}$ ). The analysis proves that RaCO-DP converges to an approximate stationary point even for non-convex problems.

This contribution was assessed against **5 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. On the Convergence of Stochastic Primal-Dual Hybrid Gradient

URL: [View paper](#)

### Brief Assessment

Primal-Dual Hybrid Gradient[73] focuses on primal-dual hybrid gradient methods for convex optimization problems, not on stochastic gradient descent-ascent (SGDA) with biased gradients for rate-constrained problems. The candidate addresses convergence of SPDHG under metric subregularity, while the original paper analyzes SGDA with biased estimates exploiting linear dual structure for non-convex rate constraints.

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#### 2. Mitigating Gradient Bias in Multi-objective Learning: A Provably Convergent Stochastic Approach

URL: [View paper](#)

### Brief Assessment

Multi-Objective Gradient Bias[74] addresses multi-objective optimization with biased gradients in a different context (multi-task learning with multiple criteria), not the rate-constrained optimization with Lagrangian dual structure that is central to the original paper's contribution.

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#### 3. A duality-based approach for distributed min-max optimization

URL: [View paper](#)

### Brief Assessment

Distributed Min-Max Duality[75] focuses on distributed min-max optimization using dual subgradient methods for peak-demand problems in smart grids, not on convergence analysis of stochastic gradient descent-ascent with biased gradient estimates or privacy constraints.

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#### 4. Min-max optimization without gradients: Convergence and applications to black-box evasion and poisoning attacks

URL: [View paper](#)

### Brief Assessment

Min-Max Black-Box[71] focuses on zeroth-order (gradient-free) min-max optimization using randomized gradient estimators, not on biased SGDA with linear dual structure for rate-constrained problems.

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#### 5. Biased stochastic first-order methods for conditional stochastic optimization and applications in meta learning

URL: [View paper](#)

### Brief Assessment

Biased Conditional Optimization[72] focuses on conditional stochastic optimization with biased gradient estimators arising from nested expectations, not on SGDA for rate-constrained problems with linear dual structure as in the original paper.

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## Appendix: Text Similarity Detection

Textual similarity detection checked 25 papers and found 2 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. An Analytical Framework for Bias Mitigation in Credit Scoring Systems through Fairness-Constrained Neural Optimization

**Detected in:** Contribution: contribution\_2

△ **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

- [0] Private Rate-Constrained Optimization with Applications to Fair Learning [View paper](#)
- [1] Privacy-preserving distributed estimation with limited data rate [View paper](#)
- [2] Differential privacy meets federated learning under communication constraints [View paper](#)
- [3] Differential Privacy Consensus in Dynamic Topologies: Performance Analysis and Optimization [View paper](#)
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- [11] Distributed privacy preserving algorithm for economic dispatch over time-varying communication [View paper](#)

- [12] User-level private stochastic convex optimization with optimal rates [View paper](#)
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- [30] Privacy-Preserving Coverage Control for Multiagent Systems with Limited Communication Ranges [View paper](#)
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