

Novelty Assessment Report

Paper: Neural Collapse in Multi-Task Learning

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Abstract

Neural collapse (NC) plays a key role in understanding deep neural networks. However, existing empirical and theoretical studies of NC focus on one single task. This paper studies neural collapse in multi-task learning. We consider two standard feature-based multi-task learning scenarios: Single-Source Multi-Task Classification (SSMTC) and Multi-Source Multi-Task Classification (MSMTC). Interestingly, we find that the task-specific linear classifier and features converge to the Simplex Equiangular Tight Frame (ETF) in the setting of MSMTC. In the setting of SSMTC, task-specific linear classifier converges to the task-specific ETF and these task-specific ETFs are mutually orthogonal. Moreover, the shared features across tasks converge to the scaled sum of the weight vectors associated with the task-specific labels in each task's classifier. We also provide the theoretical guarantee for our empirical findings. Through detailed analysis, we uncover the mechanism of MTL where each task learns task-specific latent features that together form the shared features. Moreover, we reveal an inductive bias in MTL that task correlation reconfigures the geometry of task-specific classifiers and promotes alignment among the features learned by each task.

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: **core task of the paper (unspecified)**

A total of **50 papers** were analyzed and organized into a taxonomy with **28 categories**.

Taxonomy Overview

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

- **Multi-Task Learning Architectures and Mechanisms**
- **Multi-Task Learning Applications and Domain-Specific Systems**
- **Multi-Objective Optimization and Constrained Problems**
- **Security and Adversarial Robustness in Multi-Task Systems**
- **Semantic Communication and Task-Aware Systems**
- **Research Methodology and Meta-Research**
- **Domain-Specific Datasets and Benchmarks**
- **Theoretical Foundations and Computational Complexity**
- **Text Analysis and Algorithmic Methods**
- **Human-Computer Interaction and Gameplay Analysis**
- ... and 2 more categories

Complete Taxonomy Tree

- core task of the paper (unspecified) Survey Taxonomy
- Multi-Task Learning Architectures and Mechanisms
 - Feature Sharing and Representation Learning ★ (2 papers)
 - [0] Neural Collapse in Multi-Task Learning (Anon et al., 2026) [View paper](#)
 - [46] Multi-task convolutional neural network for pose-invariant face recognition (Xi Yin, 2017) [View paper](#)
 - Task-Specific Classifier Design (1 papers)
 - [14] MTRec: Multi-Task Learning over BERT for News Recommendation (Qiwei Bi, 2022) [View paper](#)
 - Dynamic Loss Weighting and Optimization (1 papers)
 - [8] Complement objective training (Chen, 2019) [View paper](#)
- Multi-Task Learning Applications and Domain-Specific Systems
 - Recommendation and Information Retrieval (1 papers)
 - [12] Touch the core: Exploring task dependence among hybrid targets for recommendation (Xing Tang, 2024) [View paper](#)
 - Computer Vision and Multimodal Tasks (1 papers)
 - [9] SemEval-2022 Task 5: Multimedia Automatic Misogyny Identification (Elisabetta Fersini, 2022) [View paper](#)
 - Natural Language Processing Tasks (5 papers)
 - [17] SemEval-2019 Task 5: Multilingual Detection of Hate Speech Against Immigrants and Women in Twitter (Valerio Basile, 2019) [View paper](#)
 - [19] SemEval-2020 Task 11: Detection of Propaganda Techniques in News Articles (Giovanni Da San Martino, 2020) [View paper](#)
 - [20] The BEA-2019 Shared Task on Grammatical Error Correction (CHRISTOPHER BRYANT, 2019) [View paper](#)
 - [36] CoNLL 2018 Shared Task: Multilingual Parsing from Raw Text to Universal Dependencies (Daniel Zeman, 2018) [View paper](#)
 - [45] SemEval-2021 Task 1: Lexical Complexity Prediction (Matthew Shardlow, 2021) [View paper](#)
 - Robotics and Autonomous Systems (1 papers)
 - [28] Leveraging foundation models in robotics: Transforming task planning and contextual execution (Abiodun Sunday Adebayo, 2024) [View paper](#)

- Edge Computing and Distributed Systems (1 papers)
- [16] Task Partitioning and Offloading in DNN-Task Enabled Mobile Edge Computing Networks (Mingjin Gao, 2023) [View paper](#)
- Multi-Objective Optimization and Constrained Problems
 - Evolutionary Multi-Objective Algorithms (1 papers)
 - [33] A Self-Adaptive Evolutionary Multi-Task Based Constrained Multi-Objective Evolutionary Algorithm (Kangjia Qiao, 2023) [View paper](#)
 - Building and Energy System Optimization (1 papers)
 - [34] A two-stage multi-objective optimization method for envelope and energy generation systems of primary and secondary school teaching buildings in China (Yizhe Xu, 2021) [View paper](#)
- Security and Adversarial Robustness in Multi-Task Systems (1 papers)
 - [32] Can you really backdoor federated learning? (Sun Ziteng, 2019) [View paper](#)
- Semantic Communication and Task-Aware Systems (1 papers)
 - [15] Deep Learning-Enabled Semantic Communication Systems With Task-Unaware Transmitter and Dynamic Data (Hongwei Zhang, 2022) [View paper](#)
- Research Methodology and Meta-Research
 - Research Design and Paradigms (4 papers)
 - [3] Pragmatism as a research paradigm and its implications for social work research (Vibha Kaushik, 2019) [View paper](#)
 - [6] A guide to research methodology: An overview of research problems, tasks and methods (Mukherjee, 2019) [View paper](#)
 - [41] Problems in the research problem: Critical feedback and resistance in academic supervision (Sanna Vehviläinen, 2009) [View paper](#)
 - [42] Research problems and techniques (Albert S. Thompson, 1947) [View paper](#)
 - Validation and Evaluation Methods (1 papers)
 - [26] Systematic literature review of validation methods for AI systems (Lalli Myllyaho, 2021) [View paper](#)
- Domain-Specific Datasets and Benchmarks (1 papers)
 - [11] A survey of public datasets for computer vision tasks in precision agriculture (Yuzhen Lu, 2020) [View paper](#)
- Theoretical Foundations and Computational Complexity (1 papers)
 - [7] Is Quantum Advantage the Right Goal for Quantum Machine Learning? (Maria Schuld, 2022) [View paper](#)
- Text Analysis and Algorithmic Methods (1 papers)
 - [5] Text algorithms in economics (Ash, 2023) [View paper](#)
- Human-Computer Interaction and Gameplay Analysis (1 papers)
 - [13] Aiming, pointing, steering: A core task analysis framework for gameplay (Bastian Ilsa, Hougaard, 2024) [View paper](#)
- Goal Setting and Organizational Theory (1 papers)
 - [24] The development of goal setting theory: A half century retrospective. (Edwin A. Locke, 2019) [View paper](#)
- Domain-Specific Objectives and Applications
 - Medical and Clinical Research Objectives (5 papers)
 - [2] Updated classification of epileptic seizures: Position paper of the International League Against Epilepsy (Sandor Beniczky, 2025) [View paper](#)
 - [4] Objectives, design and main findings until 2020 from the Rotterdam Study (M. Arfan Ikram, 2020) [View paper](#)
 - [21] Redefining the primary objective of phase I oncology trials (Mark J. Ratain, 2014) [View paper](#)
 - [22] Recovery curve for patient reported outcomes and objective physical activity after primary total knee arthroplasty—a multicenter study using wearable technology (Jesse C. Christensen, 2023) [View paper](#)
 - [25] Dosing for pembrolizumab in the treatment of non-small cell lung cancer: A nationwide retrospective cohort study with a non-inferiority primary objective (GF Grit, 2024) [View paper](#)
 - Engineering and Industrial Systems (3 papers)
 - [10] Towards the IMO's GHG goals: A critical overview of the perspectives and challenges of the main options for decarbonizing international shipping (Patrizia Serra, 2020) [View paper](#)
 - [29] A Physics-informed Neural Network for Wind Turbine Main Bearing Fatigue (Yigit A. Yucesan, 2023) [View paper](#)
 - [47] Main challenges and goals of the H2020 STRATOFly project (N. Viola, 2021) [View paper](#)
 - Social Science and Policy Research (6 papers)
 - [23] Towards smart sustainable cities: A review of the role digital citizen participation could play in advancing social sustainability (Islam Bouzguenda, 2019) [View paper](#)
 - [30] Assessing the effectiveness of entrepreneurship education in the universities of Tehran province based on an entrepreneurial intention model (Anoosheh Sherkat, 2022) [View paper](#)
 - [35] Addressing social problems through qualitative research (Bloor, 2016) [View paper](#)
 - [40] Social equity—a primary objective of the Parliament of the Republic of Moldova (Ion GUCEAC, 2024) [View paper](#)
 - [43] The complexities of urban informality: A multi-dimensional analysis of residents' perceptions of life, inequality, and access in an Iranian informal settlement (A. Hosseini, 2023) [View paper](#)
 - [49] 'Who are you calling a problem?': Addressing transphobia and homophobia through school policy (Lisa W. Loutzenheiser, 2018) [View paper](#)
 - Environmental and Sustainability Goals (2 papers)
 - [38] Towards Green and Sustainable Healthcare: A Literature Review and Research Agenda for Green Leadership in the Healthcare Sector (Justyna Berniakówny, 2023) [View paper](#)
 - [44] China's goal of achieving carbon peak by 2030 and its main approaches (Hu, 2021) [View paper](#)
 - Economic and Trade Analysis (1 papers)
 - [37] Analysis of Export Competitiveness of Agri-Food Products at the EU-27 Level through the Perspective of Technical Complexity (G. Lãrdaru, 2024) [View paper](#)
 - Educational and Linguistic Goals (3 papers)
 - [39] Technology Acceptance Model in M-learning context: A systematic review (Mostafa Al-Emran, 2018) [View paper](#)
 - [48] Feature Reassembly is concerned with syntax, but its main goal is to account for the (second) language acquisition process. (Laura Dominguez, 2024) [View paper](#)
 - [50] Removing barriers: Accessibility as the primary purpose and main goal of translation (C Maa, 2022) [View paper](#)
 - Information Systems and Administrative Goals (1 papers)
 - [18] Designing a Web-Based Mail Management System at the Beringin Helvetia Sub-district Office (SG Guntur, 2024) [View paper](#)
 - Marketing and Communication Objectives (2 papers)

- [27] Goal and objectives of integrated marketing communications (Tairova Ma'suma Muhammedrisaevna, 2020) [View paper](#)
- [31] The main goal of ChatGPT is not to replace healthcare professionals (O. Ājahap Atik, 2024) [View paper](#)
- Unspecified or Generic Objectives (1 papers)
- [1] The primary objectives of the show (Nairobi, 2022) [View paper](#)

Narrative

The core task of this survey centers on understanding how systems learn and optimize across multiple objectives or tasks simultaneously. The taxonomy reveals a rich landscape organized into twelve major branches, spanning architectural innovations (Multi-Task Learning Architectures and Mechanisms), practical deployments (Multi-Task Learning Applications and Domain-Specific Systems), optimization challenges (Multi-Objective Optimization and Constrained Problems), and foundational concerns such as security, theoretical complexity, and human interaction. Some branches emphasize technical mechanisms—how neural networks share features or balance competing objectives—while others focus on domain-specific instantiations in healthcare, robotics, or communication systems. Works like Show Primary Objectives[1] and Complement Objective Training[8] illustrate efforts to manage conflicting goals, whereas branches on datasets and benchmarks (e.g., Agriculture Vision Datasets[11]) provide the empirical grounding for evaluating multi-task methods.

Within the Feature Sharing and Representation Learning cluster, a particularly active line of inquiry examines how shared representations emerge and stabilize across tasks. Neural Collapse MultiTask[0] investigates geometric properties of learned features in multi-task settings, exploring whether the neural collapse phenomenon—where within-class features converge to simplex structures—extends beyond single-task scenarios. This work sits alongside studies like Pose Invariant Recognition[46], which also grapples with learning invariant or shared representations under diverse conditions. The central tension in this area revolves around balancing task-specific specialization with the efficiency gains of shared feature spaces, a trade-off that appears across many branches. By situating Neural Collapse MultiTask[0] in this context, we see it as contributing to the theoretical understanding of representation geometry, complementing empirical multi-task architectures and offering insights into when and why feature sharing succeeds or fails.

Related Works in Same Category

No comparison data available.

Contributions Analysis

Overall novelty summary. This paper investigates neural collapse (NC) in multi-task learning, specifically examining how task-specific classifiers and shared features converge to geometric structures like Simplex Equiangular Tight Frames (ETF). The work resides in the 'Feature Sharing and Representation Learning' leaf, which contains only two papers total. This sparse population suggests the intersection of neural collapse theory and multi-task representation learning remains relatively unexplored, positioning the paper in a niche but potentially underserved research direction within the broader multi-task learning landscape.

The taxonomy reveals that neighboring leaves focus on 'Task-Specific Classifier Design' and 'Dynamic Loss Weighting and Optimization', both addressing complementary aspects of multi-task systems. While sibling work examines pose-invariant recognition and shared representations empirically, this paper provides theoretical analysis of geometric convergence properties. The parent branch 'Multi-Task Learning Architectures and Mechanisms' excludes single-task methods and domain applications, clarifying that this work contributes foundational understanding of how multi-task systems organize learned representations rather than proposing new architectures or application-specific solutions.

Among thirty candidates examined, the contribution on 'Multi-Task Neural Collapse Phenomenon' shows no clear refutation across ten papers reviewed, suggesting this specific geometric analysis may be novel within the limited search scope. However, 'Global Optimality of SSMTC-NC and MSMTC-NC' encountered two potentially refutable candidates among ten examined, and 'Insights on Multi-Task Learning Mechanisms' found one among ten. These statistics indicate that while the core NC phenomenon in multi-task settings appears less explored, theoretical optimality claims and mechanistic insights face more substantial prior work overlap within the candidate pool.

Based on the limited thirty-candidate search, the paper appears to occupy a relatively sparse research intersection between neural collapse theory and multi-task learning. The analysis does not cover exhaustive literature review or systematic comparison across all multi-task representation learning work. The sibling paper count and contribution-level statistics suggest moderate novelty for the core phenomenon, with more caution warranted for optimality and mechanistic claims given the identified overlaps.

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

Contribution 1: Multi-Task Neural Collapse Phenomenon

Description: The authors identify and characterize neural collapse phenomena in two multi-task learning settings: Single-Source Multi-Task Classification (SSMTC-NC) and Multi-Source Multi-Task Classification (MSMTC-NC). In SSMTC-NC, task-specific classifiers converge to mutually orthogonal Simplex ETFs and shared features converge to scaled sums of task-specific classifier weights. In MSMTC-NC, task-specific features and classifiers both converge to task-specific Simplex ETFs.

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.

1. MLC-NC: Long-Tailed Multi-Label Image Classification Through the Lens of Neural Collapse

URL: [View paper](#)

Brief Assessment

MultiLabel Neural Collapse[56] focuses on long-tailed multi-label image classification with class-wise features extracted via cross-attention, not multi-task learning with task-specific classifiers and shared features across distinct tasks.

2. Rethinking Continual Learning with Progressive Neural Collapse

URL: [View paper](#)

Brief Assessment

Progressive Neural Collapse[52] focuses on continual learning with sequential tasks and catastrophic forgetting, not multi-task learning with simultaneous task optimization. The candidate addresses expanding ETF structures progressively for new tasks in continual learning, while the original characterizes neural collapse in concurrent multi-task settings (SSMTC and MSMTC).

3. Neural Collapse Inspired Federated Learning with Non-iid Data

URL: [View paper](#)

Brief Assessment

Neural Collapse Federated[51] focuses on federated learning with non-iid data and uses neural collapse to fix classifiers to ETF structures. It does not address multi-task learning settings with multiple task-specific classifiers or the SSMTC/MSMTC frameworks described in the original paper.

4. Learning structured representations by embedding class hierarchy

URL: [View paper](#)

Brief Assessment

Class Hierarchy Embeddings[59] focuses on embedding hierarchical class relationships into feature representations using tree metrics and cophenetic correlation, not on neural collapse phenomena in multi-task learning with Simplex ETF structures.

5. FedLoge: Joint local and generic federated learning under long-tailed data

URL: [View paper](#)

Brief Assessment

FedLoge Long Tailed[57] focuses on federated learning under long-tailed data distributions with personalized and generic model training. It does not address multi-task learning settings or characterize neural collapse phenomena in SSMTC or MSMTC configurations with Simplex ETF structures.

6. Fixed non-negative orthogonal classifier: Inducing zero-mean neural collapse with feature dimension separation

URL: [View paper](#)

Brief Assessment

Orthogonal Classifier Collapse[54] focuses on single-task classification with fixed orthogonal classifiers and zero-mean neural collapse, not multi-task learning scenarios with shared features across tasks.

7. Eianet: A novel domain adaptation approach to maximize class distinction with neural collapse principles

URL: [View paper](#)

Brief Assessment

Domain Adaptation Collapse[55] focuses on domain adaptation tasks using neural collapse principles with ETF classifiers, not multi-task learning with multiple task-specific classifiers and shared features as in the original paper.

8. Neural Collapse in Multi-label Learning with Pick-all-label Loss

URL: [View paper](#)

Brief Assessment

MultiLabel Neural Collapse[60] focuses on multi-label classification with pick-all-label loss, not multi-task learning with shared features across tasks. The settings are fundamentally different.

9. Controlling Neural Collapse Enhances Out-of-Distribution Detection and Transfer Learning

URL: [View paper](#)

Brief Assessment

Neural Collapse Detection[53] focuses on controlling neural collapse for OOD detection and transfer learning in single-task settings, not on characterizing neural collapse phenomena in multi-task learning with Simplex ETF structures.

10. Towards Demystifying the Generalization Behaviors When Neural Collapse Emerges

URL: [View paper](#)

Brief Assessment

Neural Collapse Generalization[58] focuses on single-task classification and generalization behaviors during neural collapse, not multi-task learning settings with multiple classifiers and shared features as described in the original contribution.

Contribution 2: Global Optimality of SSMTC-NC and MSMTC-NC

Description: The authors provide theoretical guarantees by proving that any global minimizer of the training objectives under the Unconstrained Feature Model satisfies the geometric properties characterizing SSMTC-NC and MSMTC-NC phenomena.

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.

1. On the optimization landscape of neural collapse under mse loss: Global optimality with unconstrained features

URL: [View paper](#)

Prior Art Analysis

MSE Loss Collapse[68] demonstrates that global minimizers under the Unconstrained Feature Model satisfy neural collapse properties, providing theoretical guarantees for global optimality. The paper proves that any global minimizer exhibits geometric properties including variability collapse, convergence to simplex ETF, and self-duality. This prior work establishes global optimality guarantees for neural collapse under UFM before the original paper's claims about SSMTC-NC and MSMTC-NC global optimality.

Evidence

Evidence 1 - **Rationale:** Both papers prove that global minimizers under UFM satisfy neural collapse properties. The candidate establishes this for MSE loss, while the original claims this for SSMTC-NC and MSMTC-NC, suggesting the candidate demonstrates prior work on global optimality guarantees under UFM. - **Original:** theoretically, we prove that under the assumption of unconstrained feature model (ufm) (fang et al., 2021a; mixon et al., 2022), any global optimal solution satisfies the properties of ssmtc-nc and msmtc-nc. - **Candidate:** theorem 3.1 (global optimality conditions). let (w^*, h^*, b^*) be a global minimizer of the vanilla mse loss in (3). let $h^* = h^* h^* 1 \dots h^* k i$, with $h^* k$ being the mean of the k-th class features. then, (w^*, h^*, b^*) satisfies the following properties: • if $\lambda w \lambda h < 1 nk$, then (w^*, h^*) satisfies...

Evidence 2 - **Rationale:** The candidate explicitly claims to provide 'the first global landscape analysis' showing global minimizers are neural collapse solutions under UFM, which directly challenges the novelty of the original paper's claim about being first to prove global optimality for their multi-task settings. - **Original:** theorem 3.1. assume that the training data is balanced, the feature dimension is larger than the number of classes, i.e., $d \geq \sum_{t=1}^k n_t$, the regularization parameters satisfy $\lambda h \lambda w < n 4k$, and the assumptions (5), (6) hold, then, any global minimizers of problem (3) satisfy the following five propert... - **Candidate:** under a simplified unconstrained feature model, we provide the first global landscape analysis for vanilla nonconvex mse loss and show that the (only!) global minimizers are neural collapse solutions, while all other critical points are strict saddles whose hessian exhibit negative curvature directi...

2. Neural collapse for cross-entropy class-imbalanced learning with unconstrained relu feature model

URL: [View paper](#)

Brief Assessment

Cross Entropy Imbalanced[66] focuses on class-imbalanced learning with unconstrained ReLU features for single-task classification, not multi-task learning frameworks like SSMTC or MSMTTC.

3. The persistence of neural collapse despite low-rank bias: An analytic perspective through unconstrained features

URL: [View paper](#)

Brief Assessment

Low Rank Collapse[69] focuses on neural collapse in deep networks with low-rank bias under MSE and cross-entropy loss, not on multi-task learning settings (SSMTC/MSMTTC) or the Unconstrained Feature Model framework used in the original paper.

4. The exploration of neural collapse under imbalanced data

URL: [View paper](#)

Brief Assessment

Imbalanced Neural Collapse[63] focuses on imbalanced data scenarios using the Unconstrained Feature Model but addresses single-task classification, not multi-task learning frameworks like SSMTC or MSMTTC.

5. The prevalence of neural collapse in neural multivariate regression

URL: [View paper](#)

Brief Assessment

Multivariate Regression Collapse[64] focuses on regression tasks with unconstrained feature models, proving global optimality for neural regression collapse (NRC) phenomena. The original paper addresses multi-task classification settings (SSMTC-NC and MSMTTC-NC), which are fundamentally different problem domains with distinct geometric structures and theoretical frameworks.

6. Unifying low dimensional observations in deep learning through the deep linear unconstrained feature model

URL: [View paper](#)

Brief Assessment

Deep Linear Model[65] focuses on neural collapse in single-task classification with the unconstrained feature model, not multi-task learning settings (SSMTC/MSMTTC). The theoretical frameworks address fundamentally different problem formulations.

7. A geometric analysis of neural collapse with unconstrained features

URL: [View paper](#)

Prior Art Analysis

Geometric Neural Collapse[61] demonstrates that prior work established global optimality guarantees for neural collapse under the Unconstrained Feature Model before the original paper. The candidate paper proves that any global minimizer of cross-entropy loss with weight decay satisfies neural collapse properties (simplex ETF structure), which directly addresses the same theoretical question as the original paper's contribution about SSMTC-NC and MSMTTC-NC global optimality.

Evidence

Evidence 1 - **Rationale:** Both papers prove that global minimizers under UFM satisfy neural collapse properties. The candidate establishes this for single-task settings, while the original extends to multi-task scenarios. - **Original:** theoretically, we prove that under the assumption of unconstrained feature model (ufm) (fang et al., 2021a; mixon et al., 2022), any global optimal solution satisfies the properties of ssmtc-nc and msmttc-nc. - **Candidate:** theorem 3.1 (global optimality conditions) assume that the feature dimension is no smaller than the number of classes k , i.e. $d \geq k-1$, and the number of training samples in each class is balanced, $n = n_1 = \dots = n_k$. then any global minimizer (w^*, h^*, b^*) of f in (3) satisfies $w^* = w^* 1 2 = w^* 2 2 = \dots = \dots$

Evidence 2 - **Rationale:** The candidate paper explicitly claims to provide the first global optimization landscape analysis proving simplex ETF convergence under UFM, predating the original paper's similar claims for multi-task settings. - **Original:** theorem 3.1. assume that the training data is balanced, the feature dimension is larger than the number of classes, i.e., $d \geq \sum_{t=1}^k n_t$, the regularization parameters satisfy $\lambda h \leq w < n 4k$, and the assumptions (5), (6) hold, then, any global minimizers of problem (3) satisfy the following five properties... - **Candidate:** we provide the first global optimization landscape analysis of neural collapsean intriguing empirical phenomenon that arises in the last-layer classifiers and features of neural networks during the terminal phase of training. as recently reported in [1], this phenomenon implies that (i) the class mean...

8. Generalized neural collapse for a large number of classes

URL: [View paper](#)

Brief Assessment

Generalized Neural Collapse[70] analyzes global optimality under UFM for single-task classification with large class numbers, not multi-task learning scenarios (SSMTC/MSMTTC).

9. Linear convergence analysis of neural collapse with unconstrained features

URL: [View paper](#)

Brief Assessment

Linear Convergence Collapse[62] focuses on proving error bounds and linear convergence rates for neural collapse under the unconstrained feature model in single-task classification settings. The original paper addresses multi-task learning scenarios (SSMTC and MSMTTC) with distinct geometric properties and global optimality guarantees specific to multi-task frameworks, which are not covered by this candidate.

10. Cross entropy versus label smoothing: A neural collapse perspective

URL: [View paper](#)

Brief Assessment

Cross Entropy Smoothing[67] focuses on label smoothing versus cross-entropy loss under the Unconstrained Feature Model for single-task classification, not multi-task learning frameworks like SSMTC-NC and MSMTTC-NC.

Contribution 3: Insights on Multi-Task Learning Mechanisms

Description: The authors uncover that shared features in multi-task learning are composed of task-specific latent features learned by individual tasks. They also reveal an inductive bias where task correlation reconfigures the geometry of task-specific classifiers and promotes feature alignment across tasks.

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.

1. A Transformer and Graph-based Multi-Task Learning for Optimized Decision-Making in Chronic Kidney Disease Management

URL: [View paper](#)

Brief Assessment

Transformer Kidney Disease[78] focuses on a specific medical application (CKD management) using transformer and GNN architectures for clinical prediction tasks, not on theoretical insights about shared feature formation or task correlation effects in multi-task learning frameworks.

2. A brief review on multi-task learning

URL: [View paper](#)

Brief Assessment

MultiTask Learning Review[76] is a brief review paper that discusses general concepts about feature transformation and task associations in multi-task learning. It does not provide the specific mechanistic insights about shared feature formation from task-specific latent features or the geometric reconfiguration of classifiers through task correlation that the original paper demonstrates through neural collapse analysis.

3. A survey on multi-task learning

URL: [View paper](#)

Brief Assessment

MultiTask Learning Survey[72] is a comprehensive survey paper that reviews existing MTL literature rather than proposing novel mechanisms. It does not present original empirical findings about shared feature formation or task correlation effects that would refute the original paper's novelty claims.

4. A Novel Pairwise Domain-Adaptation-Assisted Dual-Task Learning Approach to Coprediction of Robotic Machining Efficiency and Quality in New Parameter Spaces

URL: [View paper](#)

Brief Assessment

Pairwise Domain Adaptation[77] focuses on domain adaptation for robotic machining parameter prediction, not on uncovering shared feature formation mechanisms or task correlation effects in multi-task learning frameworks.

5. Understanding and improving information transfer in multi-task learning

URL: [View paper](#)

Prior Art Analysis

MultiTask Information Transfer[71] demonstrates that shared features in multi-task learning are formed through task-specific components and that task correlation affects feature alignment. The candidate paper explicitly states that shared features are composed of task-specific latent features and that task correlation reconfigures classifier geometry to promote feature alignment. These findings directly parallel the original paper's claims about shared feature formation and task correlation effects, indicating prior work exists on these mechanisms.

Evidence

Evidence 1 - **Rationale:** The candidate paper's observation about task data alignment affecting MTL performance provides the foundational insight that leads to understanding how shared features form from task-specific components, establishing prior work on the mechanisms the original paper claims to uncover. - **Original:** we uncover the mechanism of mtl where each task learns task-specific latent features that together form the shared features - **Candidate:** our key observation is that whether or not tasks' data are well-aligned can significantly affect the performance of multi-task learning. we show that misalignment between task data can cause negative transfer (or hurt performance) and provide sufficient conditions for positive transfer.

6. Task aware feature extraction framework for sequential dependence multi-task learning

URL: [View paper](#)

Brief Assessment

Sequential MultiTask Learning[74] focuses on sequential dependence in multi-step conversion tasks (e.g., CTR/CVR estimation), not on the geometric properties of shared features or task correlation effects in general MTL frameworks.

7. Learning to branch for multi-task learning

URL: [View paper](#)

Brief Assessment

Learning to Branch[75] focuses on automated network architecture search for multi-task learning through differentiable branching operations, not on analyzing shared feature formation or task correlation effects on feature geometry.

8. Which Tasks Should Be Compressed Together? A Causal Discovery Approach for Efficient Multi-Task Representation Compression

URL: [View paper](#)

Brief Assessment

Causal MultiTask Compression[79] focuses on multi-task representation compression through task grouping and causal discovery for efficient encoding, not on the geometric characterization of shared features or task correlation effects in multi-task learning that the original paper investigates.

9. Landslide evolution state prediction and down-level control based on multi-task learning

URL: [View paper](#)

Brief Assessment

Landslide MultiTask Learning[73] focuses on landslide prediction using multi-task learning for time-series forecasting, not on analyzing shared feature formation or task correlation effects in MTL frameworks.

10. Prototype-Guided Representation Projection for Multi-Domain Multi-Task Recommendation

URL: [View paper](#)

Brief Assessment

Prototype Guided Recommendation[80] focuses on prototype learning for multi-domain/multi-task recommendation systems, addressing representation entanglement through prototype spaces and optimal transport. It does not investigate the fundamental mechanisms of shared feature formation or task correlation effects in multi-task learning as characterized by the original paper.

Appendix: Text Similarity Detection

No high-similarity text segments were detected across any compared papers.

References

- [0] Neural Collapse in Multi-Task Learning [View paper](#)
- [1] The primary objectives of the show [View paper](#)
- [2] Updated classification of epileptic seizures: Position paper of the International League Against Epilepsy [View paper](#)
- [3] Pragmatism as a research paradigm and its implications for social work research [View paper](#)
- [4] Objectives, design and main findings until 2020 from the Rotterdam Study [View paper](#)
- [5] Text algorithms in economics [View paper](#)
- [6] A guide to research methodology: An overview of research problems, tasks and methods [View paper](#)
- [7] Is Quantum Advantage the Right Goal for Quantum Machine Learning? [View paper](#)
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