Problems

1. Matrix/Tensor Factorization

- **Techniques:**
  - Matrix Factorization (SVD, NMF)
  - Tensor Factorization (CP, TUCKER)
- **Applications to Problems:**
  - **Anomaly Detection**: Identifying unusual patterns in network traffic using latent factors. [6]
  - **Recommendation Systems**: Collaborative filtering to predict user preferences. [1]
  - **Time series analysis:** Weather forecasting **[]**

2. Matrix/Tensor Completion

- **Techniques:**
  - Low-Rank Approximation
- **Applications to Problems:**
  - **Signal Denoising**: Completing missing or corrupted values in signal matrices. [2]
  - **Recommendation Systems**: Predicting missing user-item interactions. [1]

3. Regularized Regression

- **Techniques:**
  - Lasso Regression (L1 Regularization)
  - Ridge Regression (L2 Regularization)
  - Elastic Net Regression
- **Applications to Problems:**
  - **Image Classification**: Enhancing feature selection in high-dimensional image datasets. [3]

4. Proximal Gradient Methods

- **Techniques:**
  - Forward-Backward Splitting
  - Accelerated Proximal Gradient Descent
- **Applications to Problems:**
  - **Compressed Sensing**: Solving L1-regularized recovery problems. [11], [13]
  - **Overfitting**: Incorporating regularization to improve model generalization.

5. Second-Order Methods

- **Techniques:**
  - Newton's Method
  - Quasi-Newton Methods (BFGS, L-BFGS)
- **Applications to Problems:**
  - **Compressed Sensing**: Accelerating convergence for high-dimensional recovery tasks.

- **Time Series Analysis**: Efficient parameter estimation for autoregressive models.

6. Sparse PCA

- **Techniques:**
  - Robust PCA
  - Dictionary Learning for PCA
- **Applications to Problems:**
  - **Anomaly Detection**: Identifying outliers in network traffic or sensor data. [12]

7. Dimensionality Reduction

- **Techniques:**
  - Linear Methods (PCA, ICA)
  - Non-Linear Methods **(**t-SNE, UMAP)
- **Applications to Problems:**
  - **Image Classification**: Feature extraction from high-dimensional pixel data. [15]

8. Sparse Representation

- **Techniques:**
  - Basis Pursuit
  - Orthogonal Matching Pursuit
- **Applications to Problems:**
  - **Signal Denoising**: Using sparse coding to remove noise from audio or image signals. [5]
  - **Compressed Sensing**: Reconstructing signals with fewer measurements. [11]

9. Distributed Optimization

- **Techniques:**
  - ADMM
  - Federated Learning Optimization
- **Applications to Problems:**
  - **Time Series Analysis**: Parallel processing for forecasting models.
  - **Recommendation Systems**: Collaborative optimization across decentralized datasets. [4]

10. Non-Convex Optimization

- **Metaheuristic Algorithms:**
  - Genetic Algorithms
  - Simulated Annealing
  - Particle Swarm Optimization (PSO)
- **Applications to Problems:**
  - **Recommendation Systems**: Optimizing latent factor models for user-item matrices.
  - **Time Series Analysis**: Handling non-convex cost functions in forecasting.

Papers

1. Ricci, Giuseppe, Marco de Gemmis, and Giovanni Semeraro. "Matrix and tensor factorization techniques applied to recommender systems: a survey." Matrix 1.01 (2012): 94-8.
2. Liu, Ji, et al. "Tensor completion for estimating missing values in visual data." IEEE transactions on pattern analysis and machine intelligence 35.1 (2012): 208-220.
3. Zhang, Zheng, et al. "A survey of sparse representation: algorithms and applications." IEEE access 3 (2015): 490-530.
4. Boyd, Stephen, et al. "Distributed optimization and statistical learning via the alternating direction method of multipliers." Foundations and Trends® in Machine learning 3.1 (2011): 1-122.
5. Yang, Jianchao, et al. "Image super-resolution via sparse representation." IEEE transactions on image processing 19.11 (2010): 2861-2873.
6. Paffenroth, Randy, Kathleen Kay, and Les Servi. "Robust pca for anomaly detection in cyber networks." arXiv preprint arXiv:1801.01571 (2018).
7. Kamilov, Ulugbek S., et al. "Plug-and-play methods for integrating physical and learned models in computational imaging: Theory, algorithms, and applications." IEEE Signal Processing Magazine 40.1 (2023): 85-97.
8. Monga, Vishal, Yuelong Li, and Yonina C. Eldar. "Algorithm unrolling: Interpretable, efficient deep learning for signal and image processing." IEEE Signal Processing Magazine 38.2 (2021): 18-44.
9. Beck, Amir, and Marc Teboulle. "A fast iterative shrinkage-thresholding algorithm for linear inverse problems." SIAM journal on imaging sciences 2.1 (2009): 183-202.
10. Sprechmann, Pablo, Alexander M. Bronstein, and Guillermo Sapiro. "Learning efficient sparse and low rank models." IEEE transactions on pattern analysis and machine intelligence 37.9 (2015): 1821-1833.
11. Candès, Emmanuel J., and Michael B. Wakin. "An introduction to compressive sampling." IEEE signal processing magazine 25.2 (2008): 21-30.
12. Zou, Hui, and Lingzhou Xue. "A selective overview of sparse principal component analysis." Proceedings of the IEEE 106.8 (2018): 1311-1320.
13. Gu, Renliang, and Aleksandar Dogandžić. "Projected nesterov's proximal-gradient algorithm for sparse signal recovery." IEEE Transactions on Signal Processing 65.13 (2017): 3510-3525.
14. Hankel low-rank approximation and completion in time series analysis and forecasting: a brief review
15. Overview and comparative study of dimensionality reduction techniques for high dimensional data

Libraries

https://github.com/tensorly/tensorly

https://github.com/scipy/scipy/tree/main/scipy/signal

https://www.cvxpy.org/index.html

https://github.com/PyLops/pyproximal

https://scikit-learn.org

https://github.com/jettify/pytorch-optimizer

https://github.com/sktime/sktime

https://www.tensorflow.org/

https://pytorch.org/

https://pytorch.org/docs/stable/optim.html