Sparse Double Descent: Where Network Pruning Aggravates Overfitting

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Zheng is actively looking for PhD opportunities.
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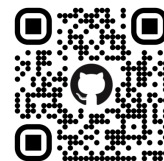
Motivation

- Deep neural networks are overparameterized

- As the model capacity increases, the double descent phenomenon occurs

- Network pruning could also affect model capacity

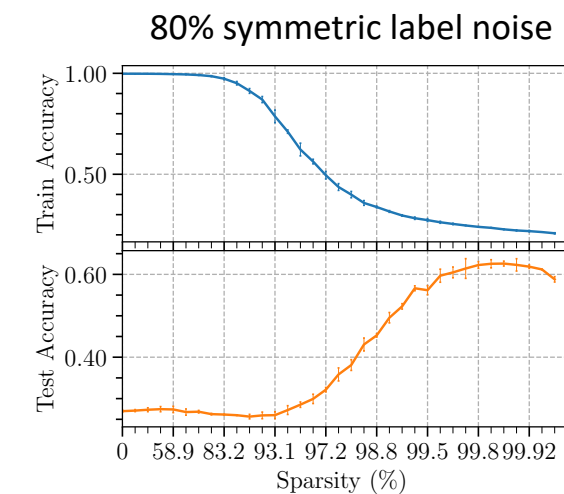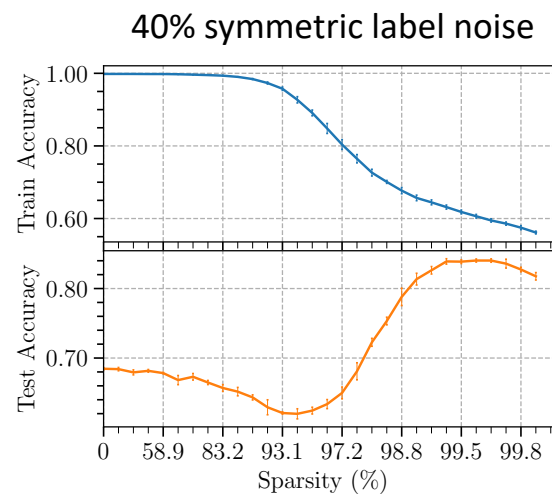*Q*: May the sparsification of DNNs also cause double descent?

Deep Double Descent

Error

Train
Test

Number of parameters
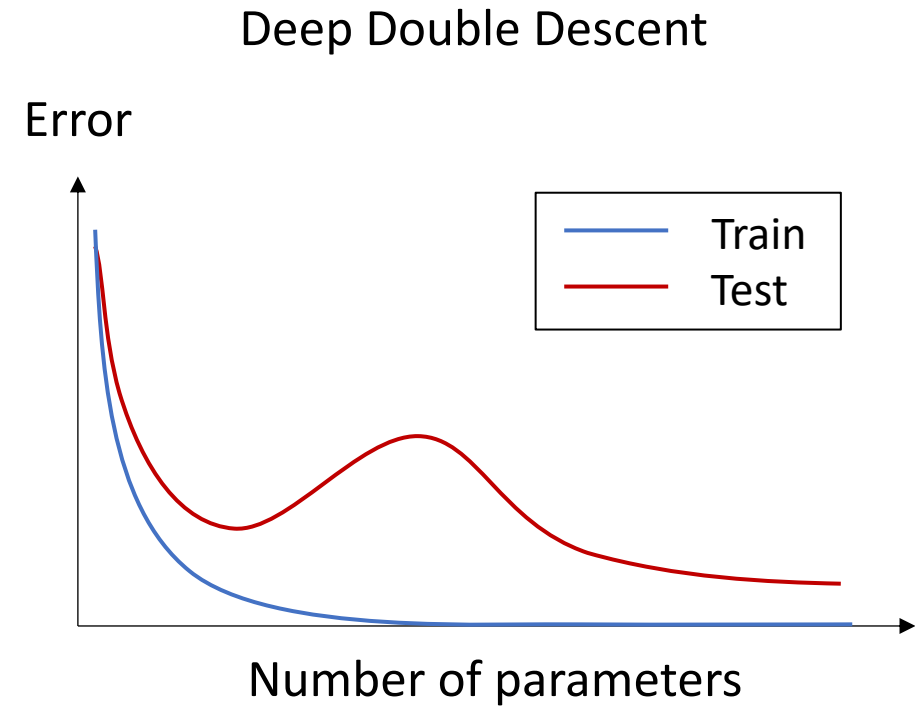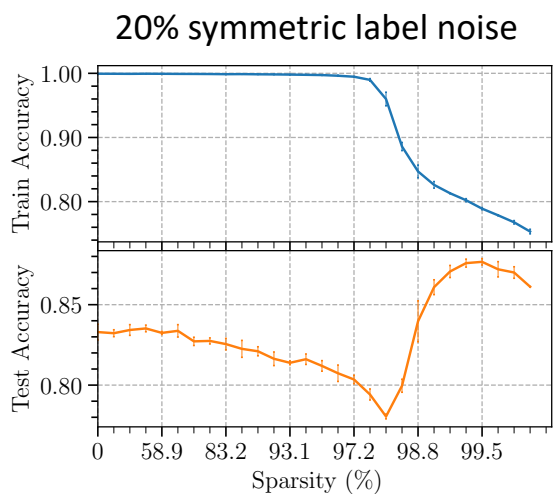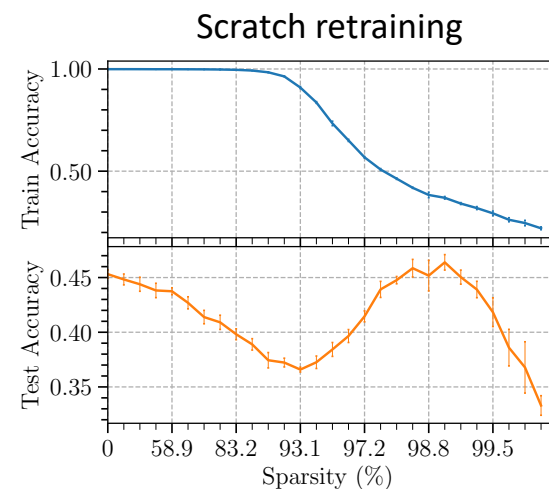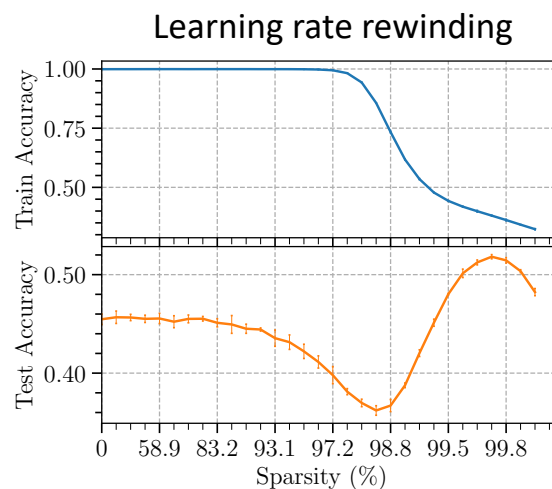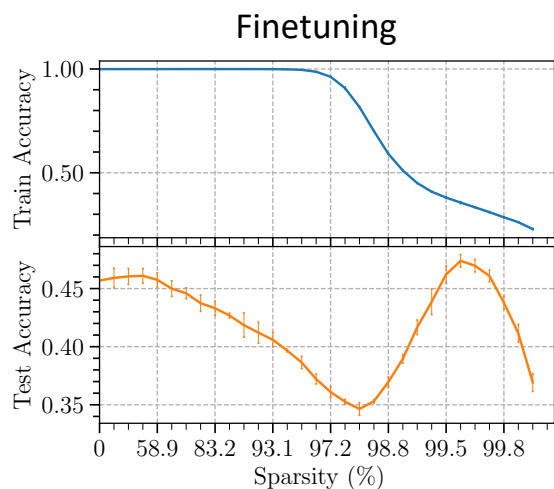
Sparse Double Descent

- Sparse double descent exists consistently across different experimental settings under label noise
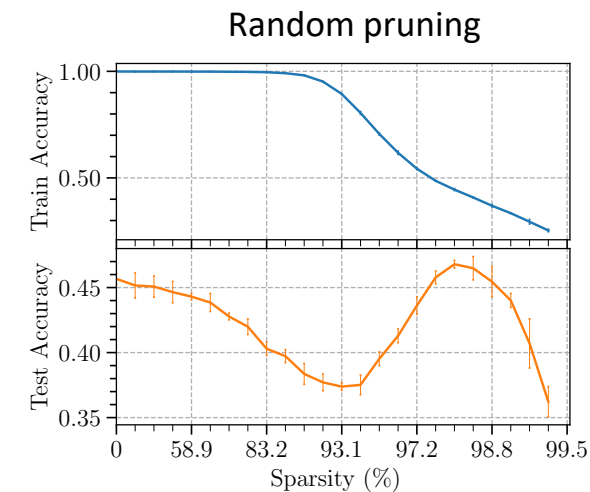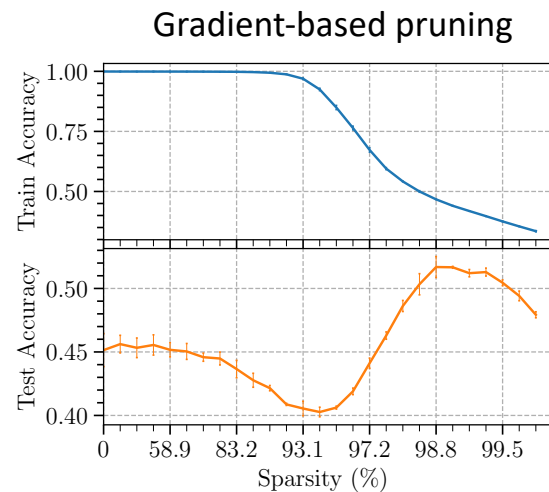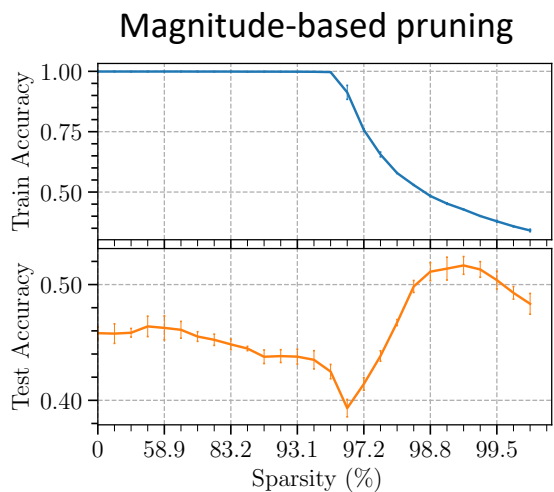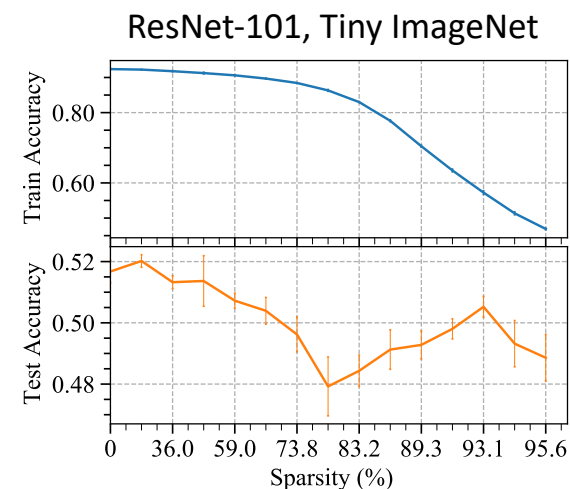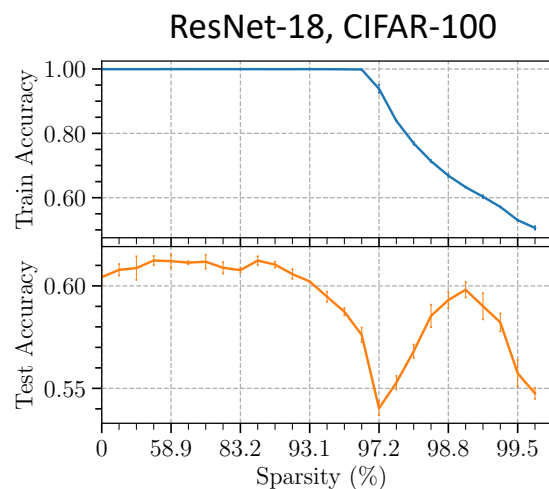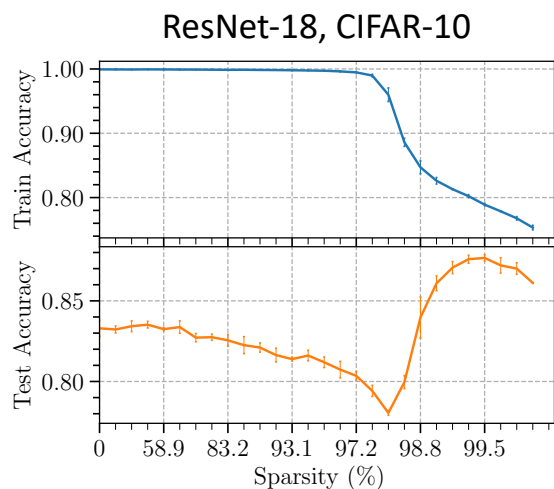
Sparse Double Descent
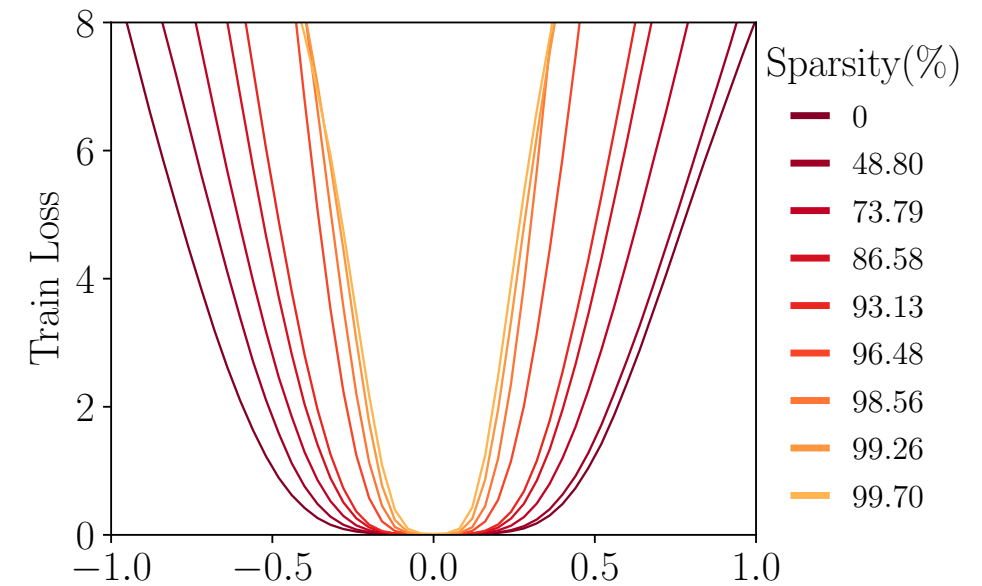
- Sparse double descent exits consistently across different experimental settings under label noise

Finetuning

Learning rate rewinding

Scratch retraining

20% symmetric label noise

40% symmetric label noise

80% symmetric label noise

Why Sparse Double Descent Occurs?

Minima flatness hypothesis

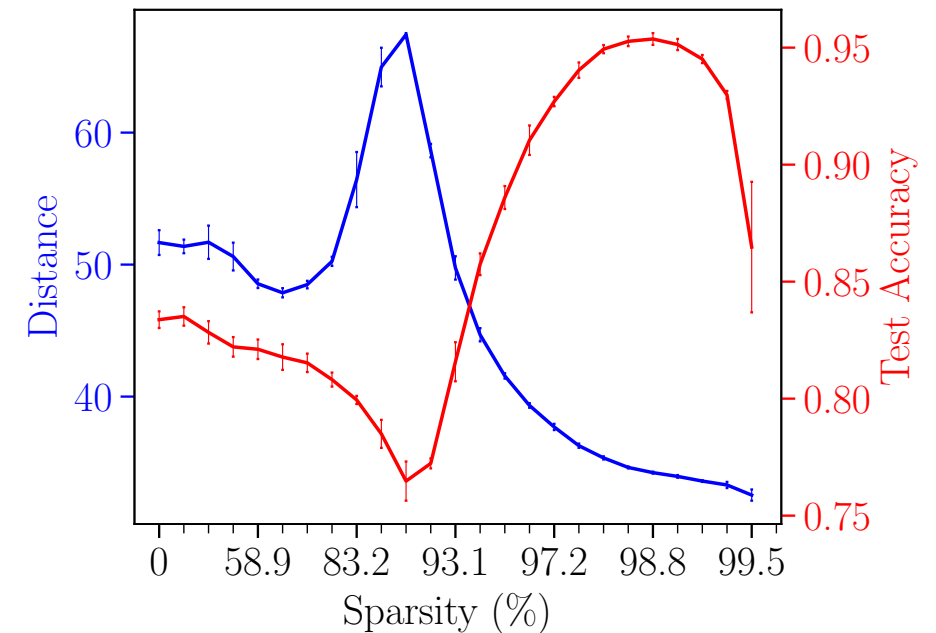- Previous works hypothesized that pruning encourages the optimizer to move towards flatter minima [Bartoldson et al., 2020]

- Minima flatness is usually correlated with good generalization

- We observed optimizer may not converge to flat regions as sparsity increases

Bartoldson, B., Morcos, A. S., Barbu, A., and Erlebacher, G. The generalization-stability tradeoff in neural network pruning. NIPS, 2020.
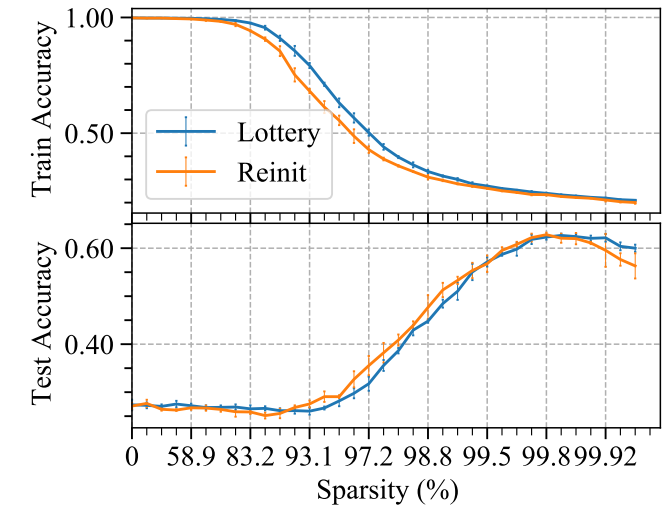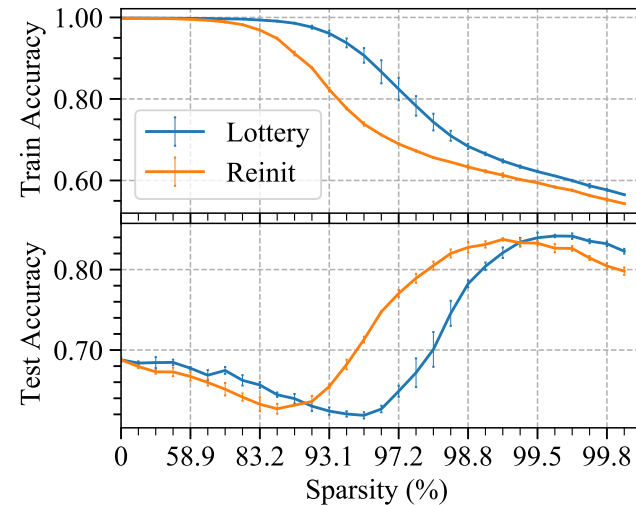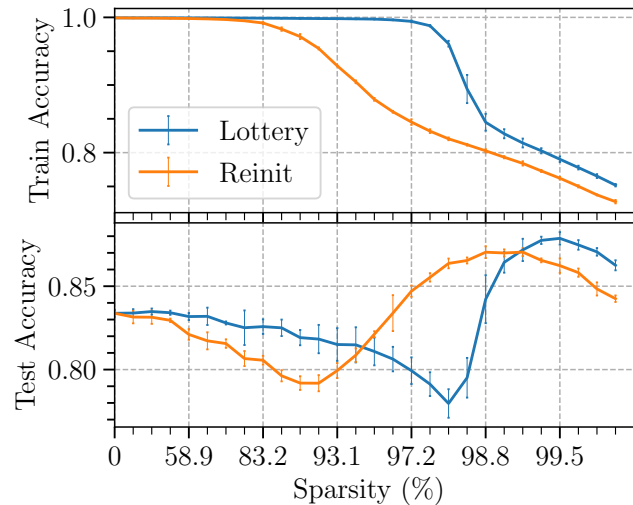
Why Sparse Double Descent Occurs?

Learning Distance hypothesis

- model capacity could be restricted by the l2 learning distance from initialization [Nagarajan & Kolter, 2019]

- Pruning may affect the learning distance

- We observed the curve of learning distance correlates with test accuracy

Nagarajan, V. and Kolter, J. Z. Generalization in deep networks: The role of distance from initialization. *arXiv preprint arXiv:1901.01672*, 2019.

Winning tickets may not always win

- Random reinitializations sometimes surpass the wining ticket initializations in the Lottery Ticket Hypothesis [Frankle & Carbin, 2019]

Frankle, J. and Carbin, M. The lottery ticket hypothesis: Finding sparse, trainable neural networks. ICLR, 2019.