Task Dependent Importance of Small Singular Values During Fine-Tuning

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Singular Values Review

$$\mathbf{W} = \mathbf{U}\mathbf{\Sigma}\mathbf{V}^\top$$

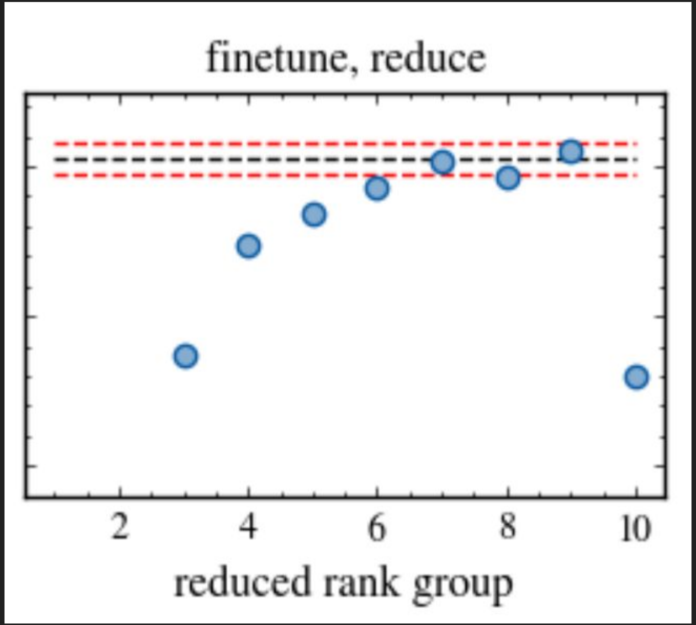
$$\begin{bmatrix} u_1 & u_2 & \cdots & u_n \end{bmatrix} \begin{bmatrix} \sigma_1 & & & \\ & \sigma_2 & & 0 \\ & & \ddots & \\ & 0 & & \sigma_m \\ & & & \end{bmatrix} \begin{bmatrix} v_1 & v_2 & \cdots & v_m \end{bmatrix}$$

Large singular values → strong signal directions

Small singular values → weak signal directions

Motivation

Staats et al. (2024) → "Small SVs store *alignment*"



<u>My contribution:</u>

Where in the model?

When during training?

Task dependent?

Goal:

Smarter SVD compression

Methodology

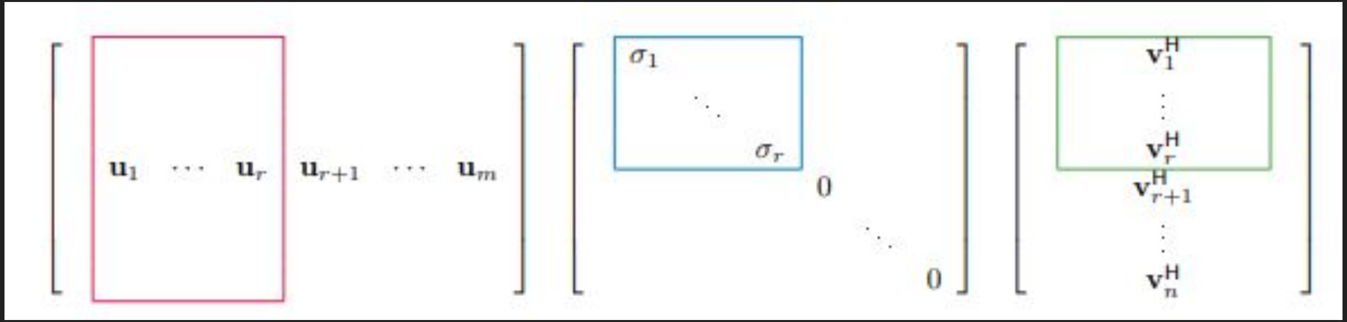
1. **Fine-tune DistilBERT**

   IMDb, RTE, QNLI, QQP, MNLI

2. **Remove SV decile**

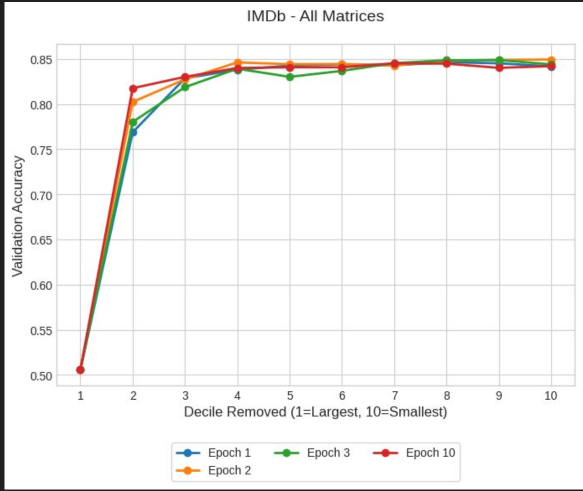
   Q, K, V, O, FFN

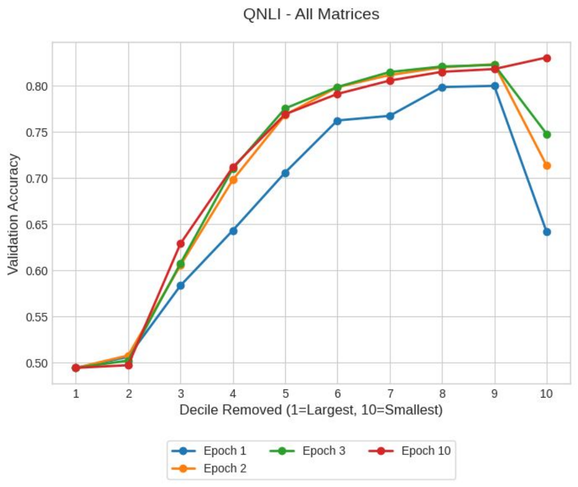
   Layer groups

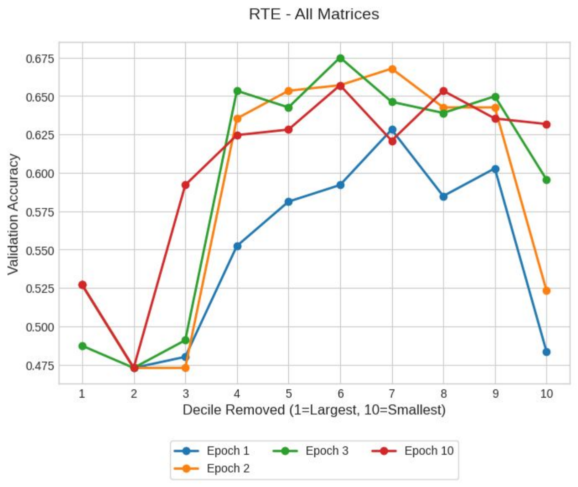


3. **Compute accuracy change**

Effect of Task Complexity





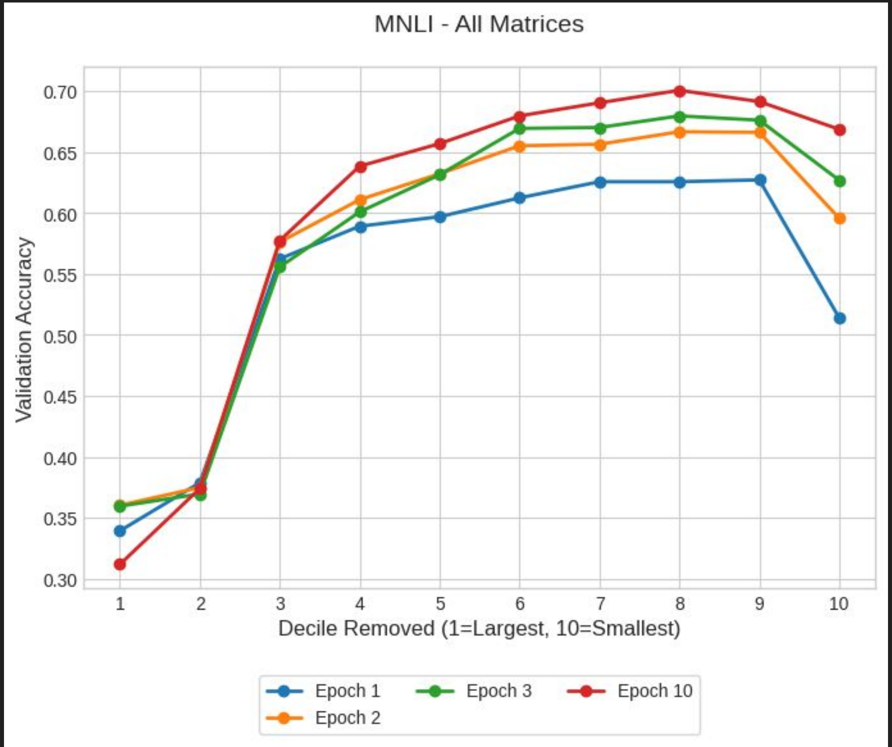


IMDb

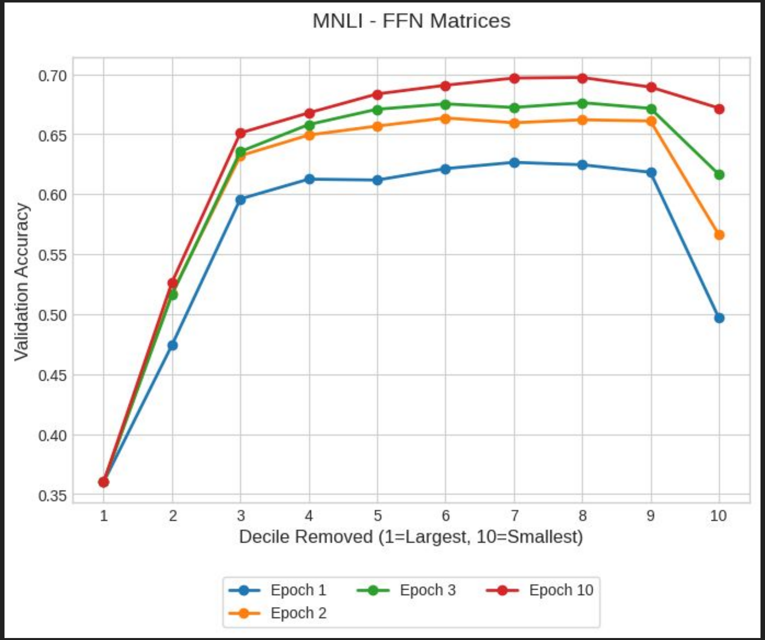
QNLI

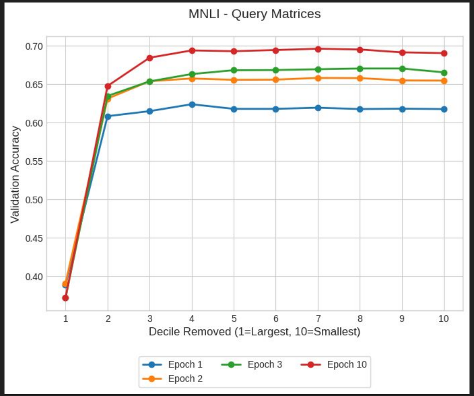
RTE

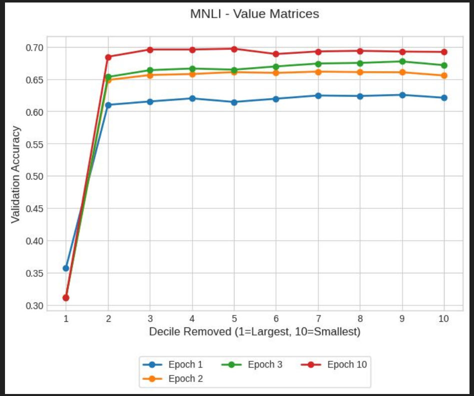
Effect of Training Duration

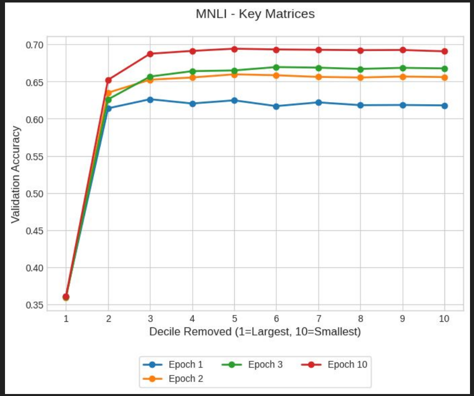


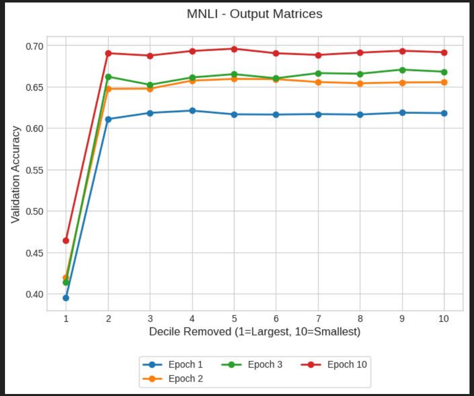
Matrix Specific SV Removal



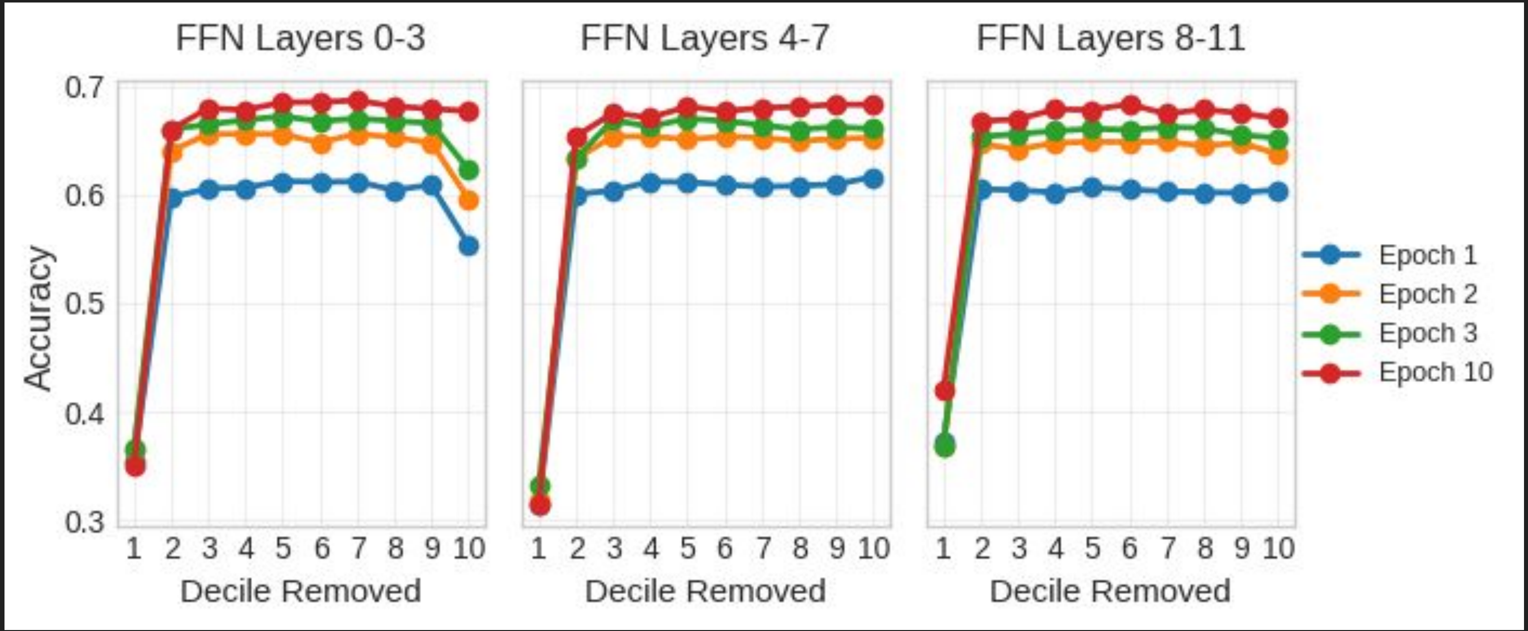








Early FFN Layers Matter



Conclusion

Where: Protect small SVs in FFN matrices

When: Early fine tuning

Why: Encode alignment for complex tasks

Future:

- Generalize to larger architectures
- Generative task performance

References

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Questions?