Mapping the chemical structure of the Milky Way with neural nets and SDSS-V

Peter Shi

UNIVERSITY OF TORONTO | DATA SCIENCES INSTITUTE

Abstract

- Traditional methods of determining elemental abundances are slow, computationally expensive, and sensitive to noise
- We adapt neural networks trained on data from the fourth Sloan Digital Sky Survey (SDSS-IV) to predict elemental abundances using spectra from SDSS-V
- Despite differences in spectra between the two surveys we find that the model generates similar stellar parameter (Teff, log(g)) estimations between the surveys

Research Questions

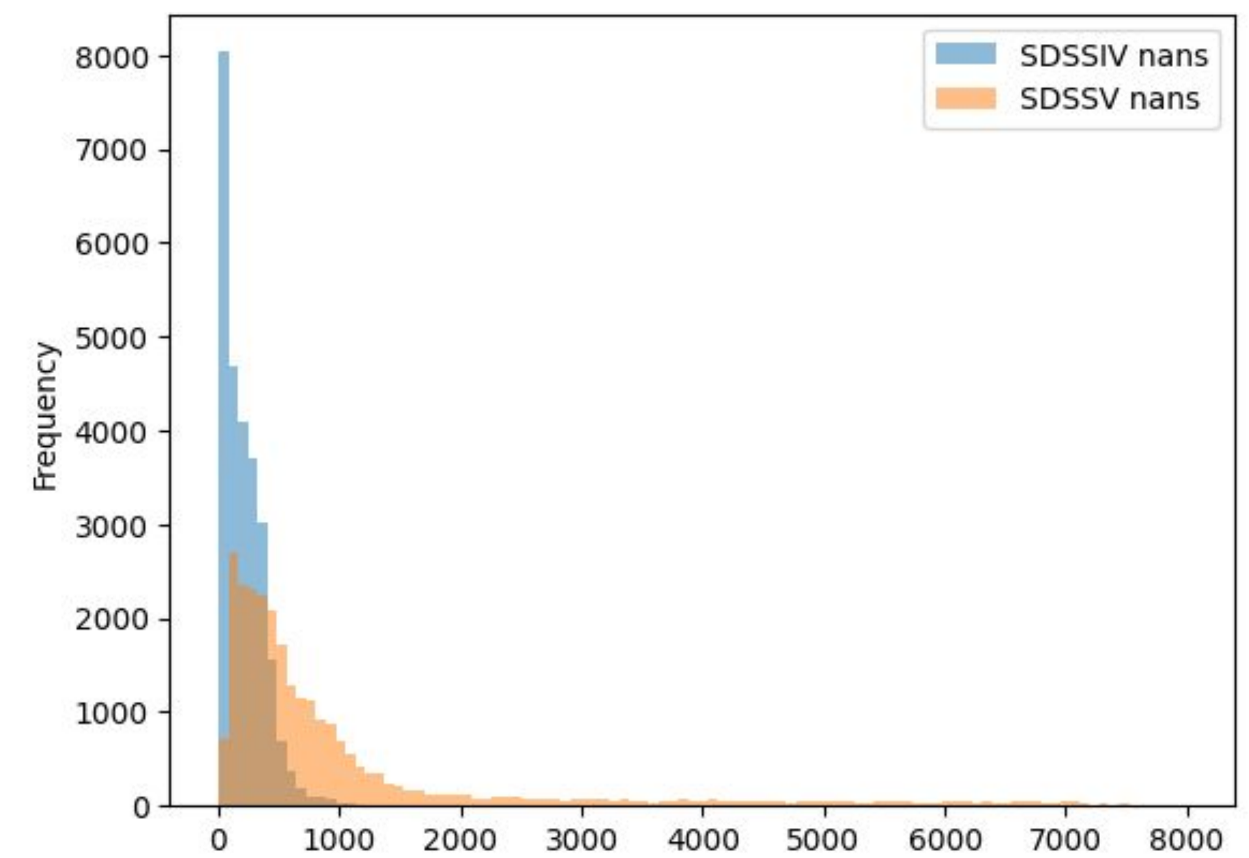
- Does a model trained on SDSS-IV data generalize to SDSS-V data?
- How can model performance be improved for certain subsets of the parameter space? (Main Sequence Stars)
- What extraneous factors (Signal-to-Noise, Bad Pixels) negatively affect model performance?

Methods

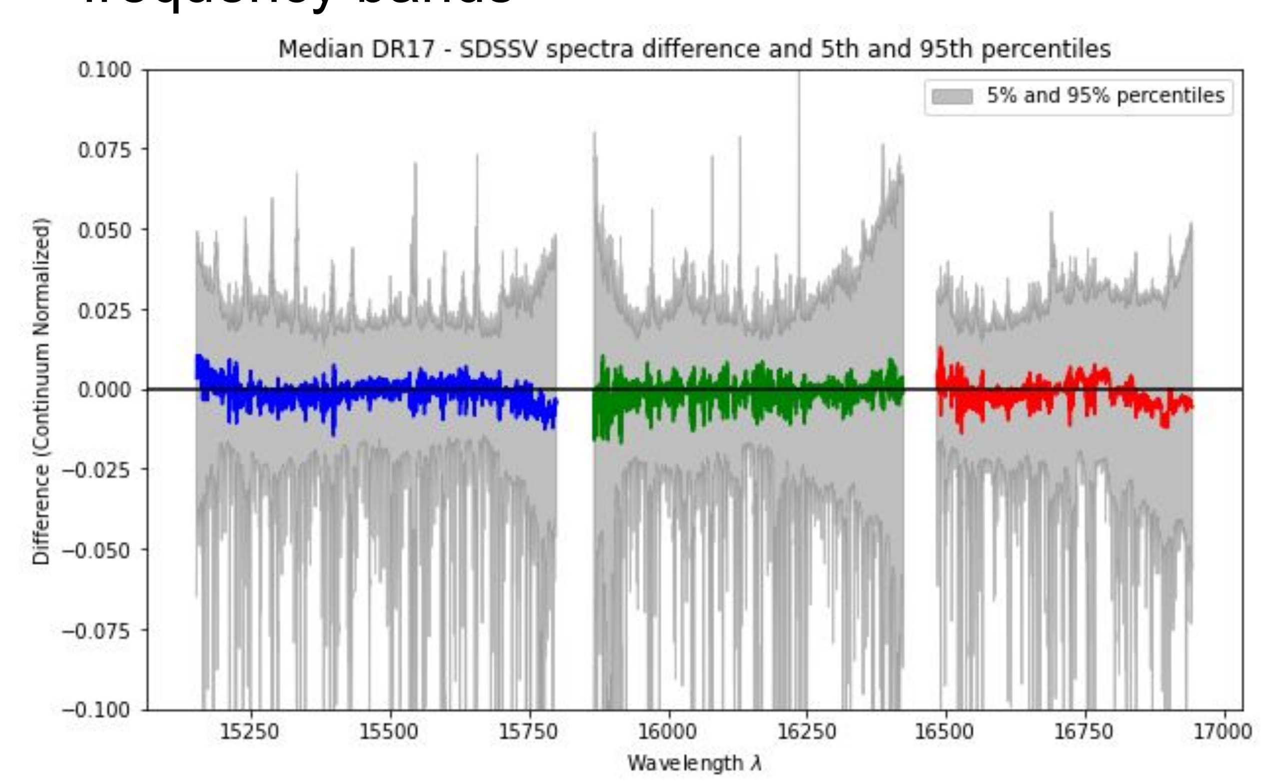
- Inspect spectra for differences that could affect inference
- Compare model performance on a subset of stars present in both SDSS-IV and SDSS-V
- Produce error plots against several variables of interest
- Retrain model on a less conservative SDSS-IV dataset
- Evaluate model on entirety of SDSS-V data

Results

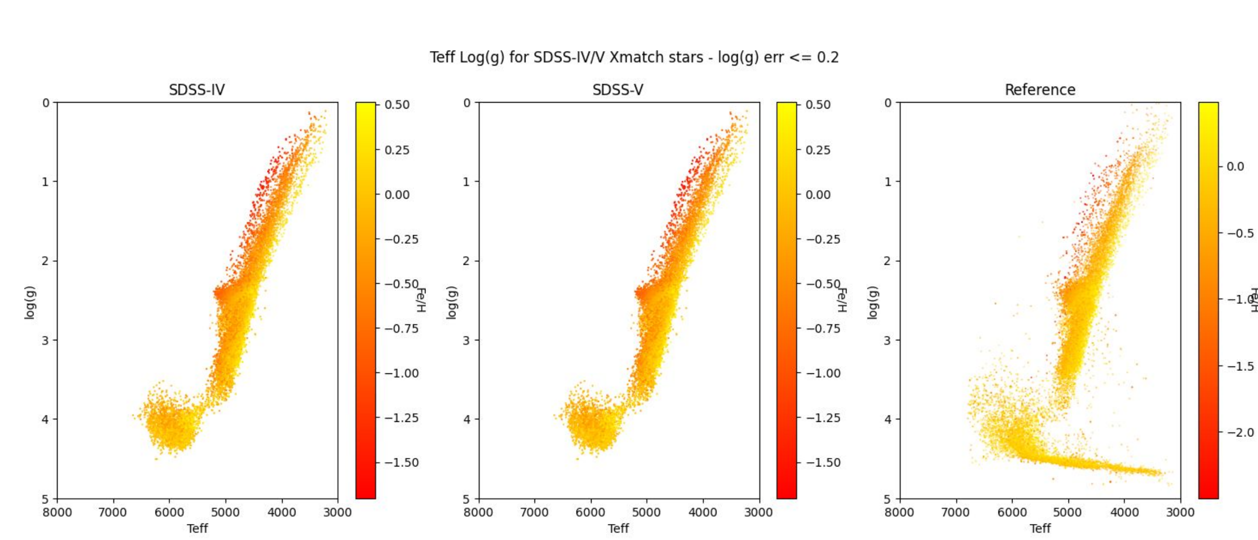
- SDSS-V spectra have more bad pixels compared to SDSS-IV



- This leads to significant differences in all frequency bands

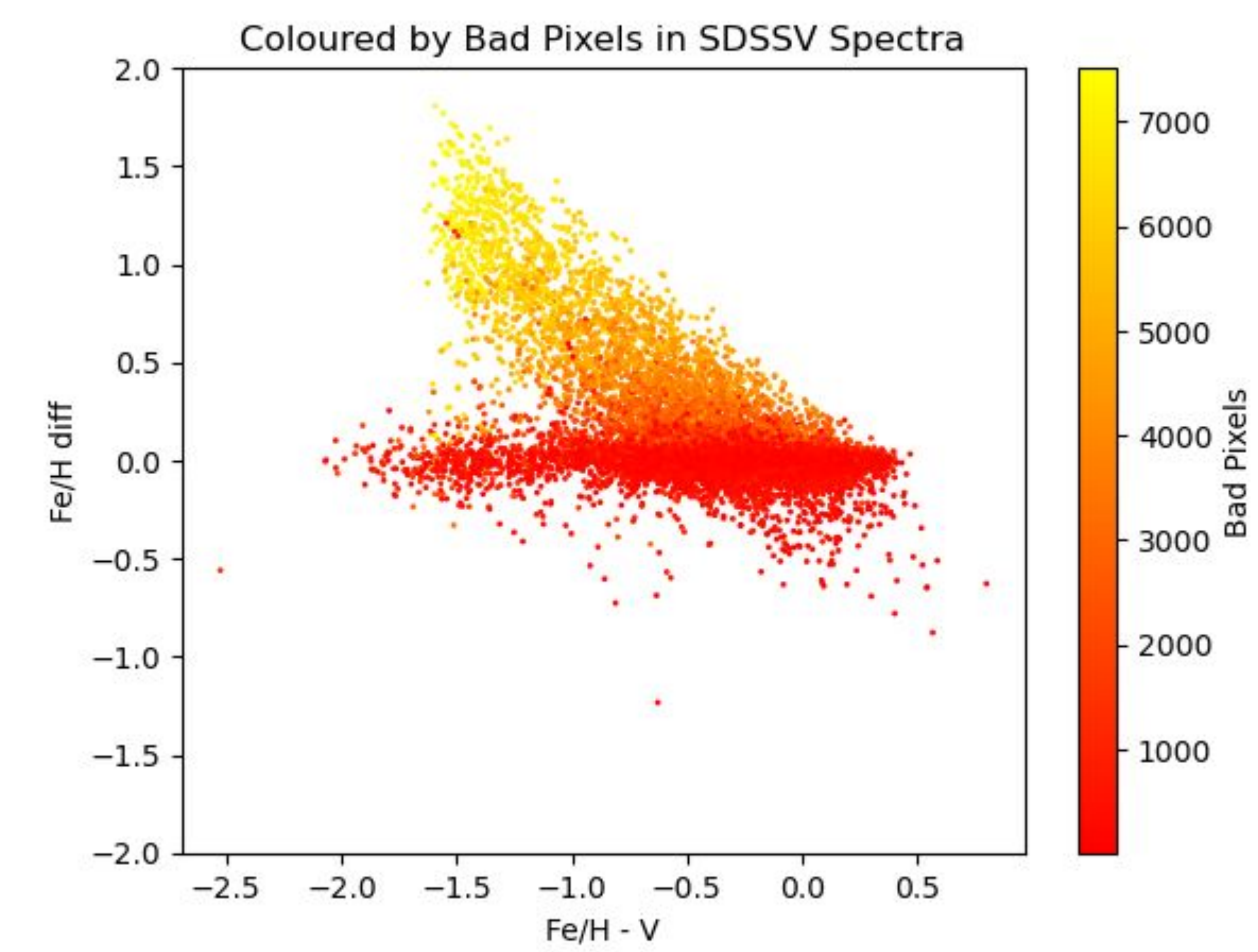


- But initial prediction results are still quite similar between the two surveys (See Appendix 1 - 4)

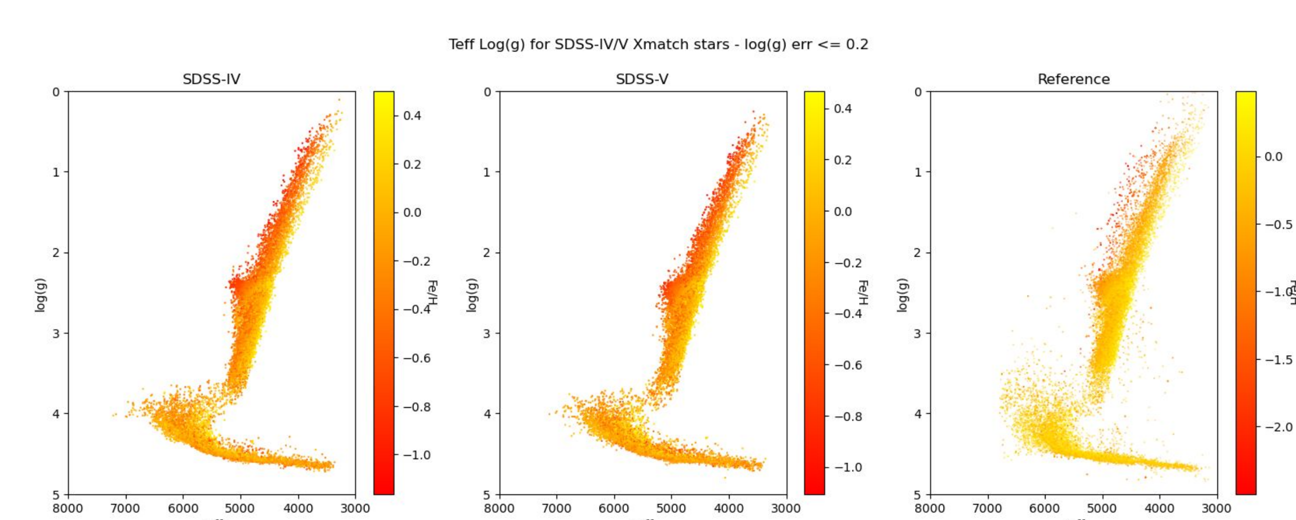


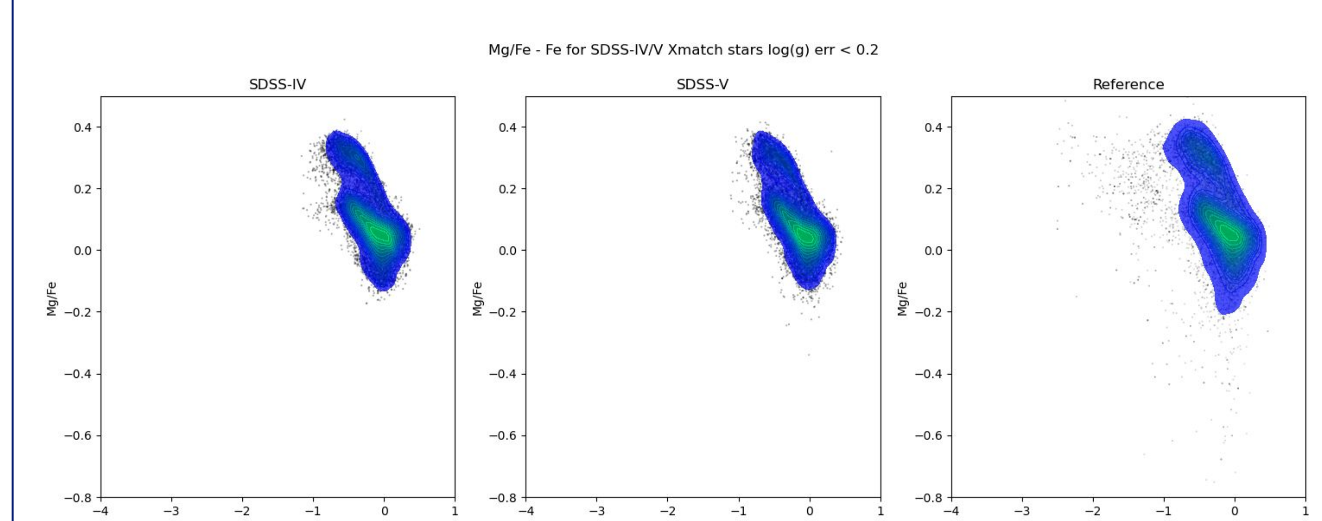
Results

- The heteroskedasticity in prediction differences are primarily caused by bad pixels in SDSS-V (See Appendix 5)



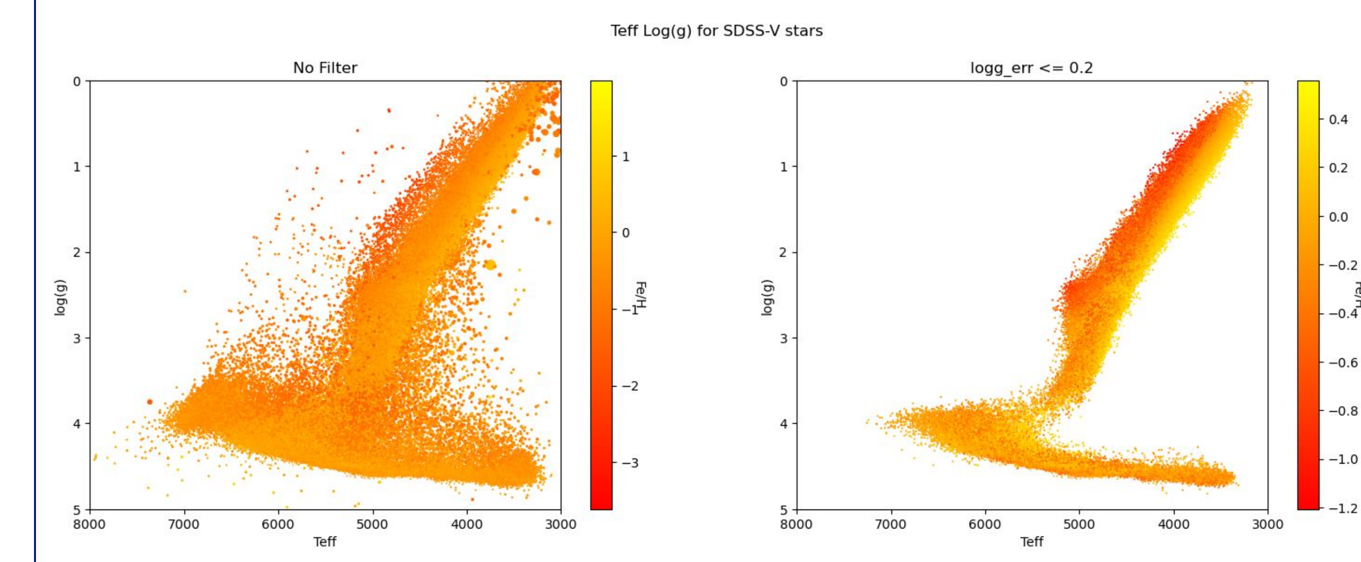
- Retraining on a less conservative set of training data yields better performance on main sequence stars (See Appendix 6 - 9)

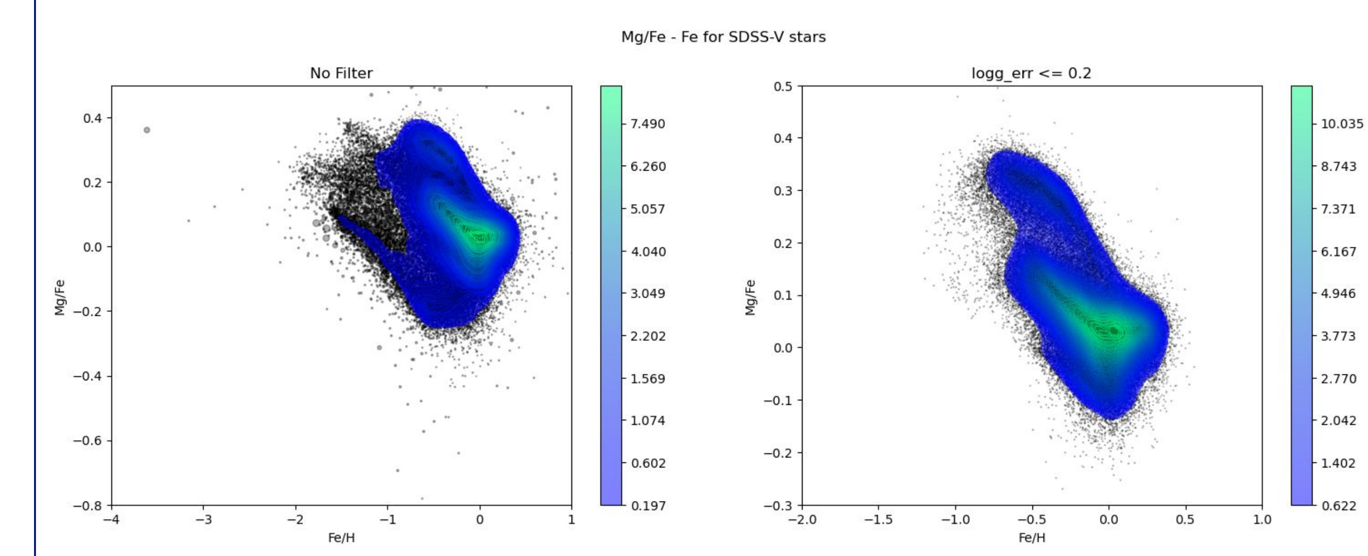




Conclusion

- Application of the retrained model to the entirety of SDSS-V spectra yields expected results (See Appendix 10 - 11)





References

Leung, Henry W, and Jo Bovy. "Deep Learning of Multi-Element Abundances from High-Resolution Spectroscopic Data." *Monthly Notices of the Royal Astronomical Society*, 2018. https://doi.org/10.1093/mnras/sty3217.

Paper, Poster, and Contact Info

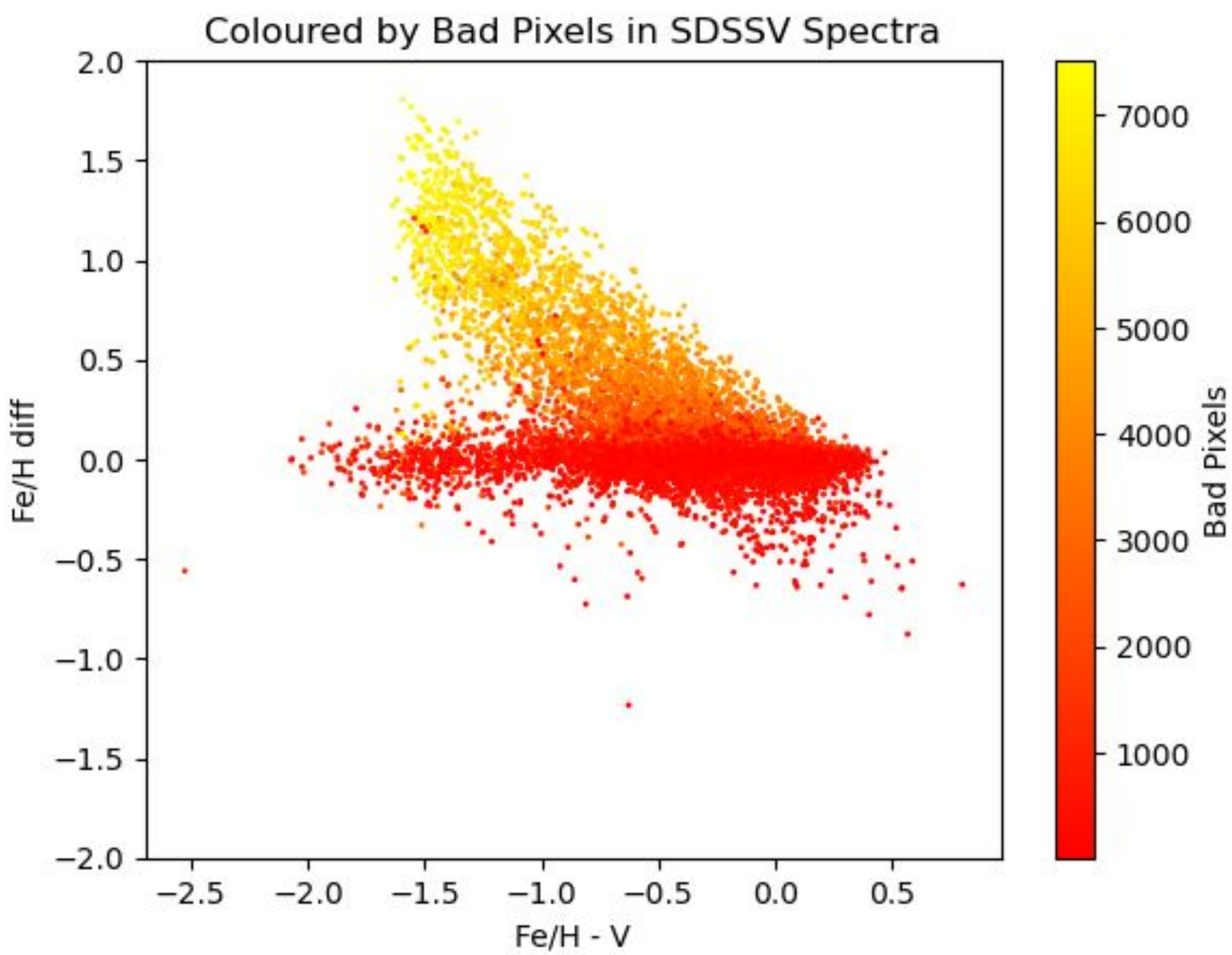
Appendix 1: Initial Model Predictions (Teff - Log(g)) for XMatch Stars (No Error Filter)

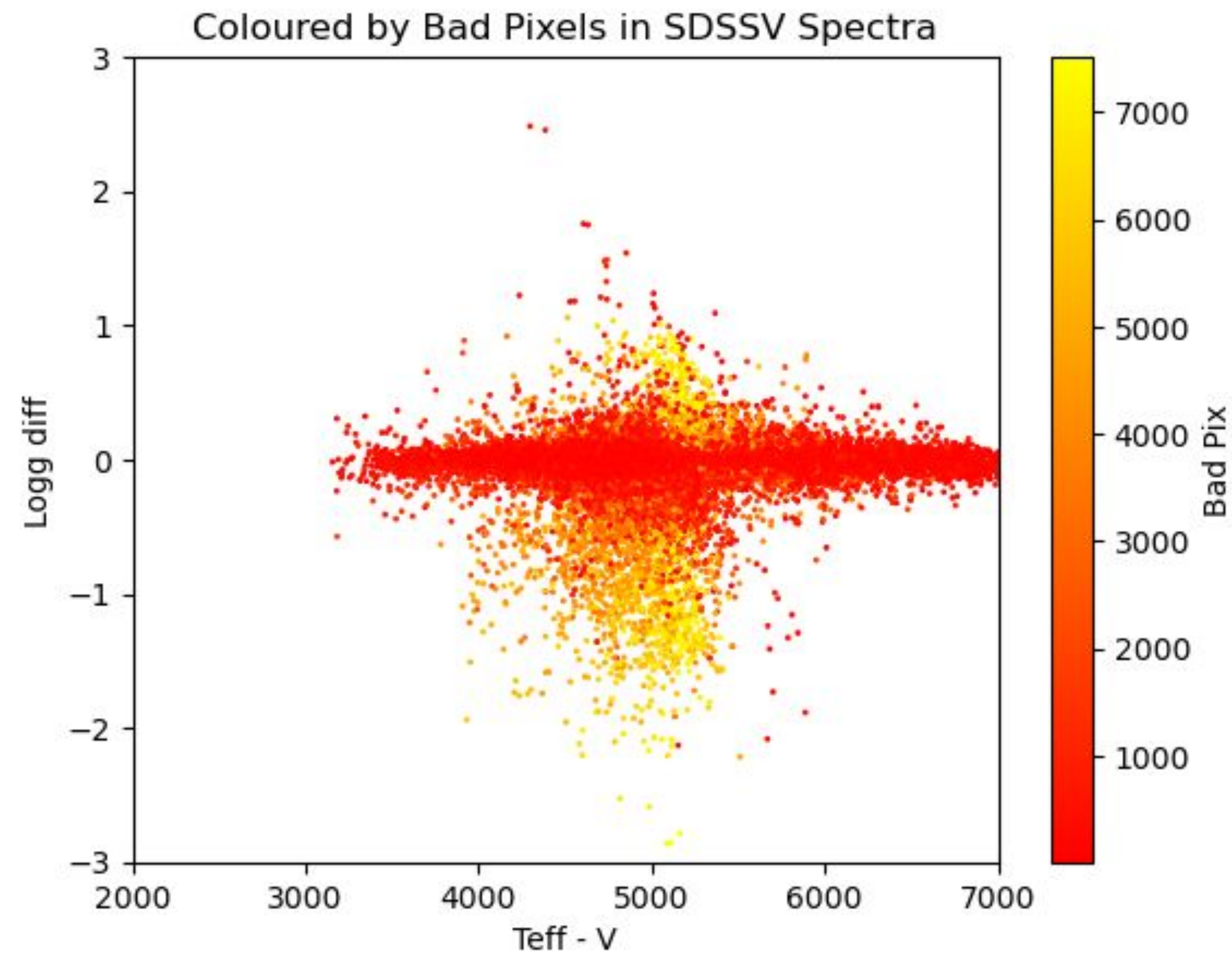
Appendix 2: Initial Model Predictions (Teff - Log(g)) for XMatch Stars (Log(g) error <= 0.2)

Appendix 3: Initial Model Predictions (Mg/Fe - Fe/H) for XMatch Stars (No Error Filter)

Appendix 4: Initial Model Predictions (Mg/Fe - Fe/H) for XMatch Stars (Log(g) error <= 0.2)

Appendix 5: Heteroskedasticity Exhibits





Appendix 6: Retrained Model Predictions (Teff - Log(g)) for XMatch Stars (No Error Filter)

Appendix 7: Retrained Model Predictions (Teff - Log(g)) for XMatch Stars (Log(g) error <= 0.2)

Appendix 8: Retrained Model Predictions (Mg/Fe - Fe/H) for XMatch Stars (No Error Filter)

Appendix 9: Retrained Model Predictions (Mg/Fe - Fe/H) for XMatch Stars (Log(g) <= 0.2)

Appendix 10: Retrained Model Predictions (Teff - Log(g)) for SDSS-V Stars

Appendix 11: Retrained Model Predictions (Mg/Fe - Fe/H) for SDSS-V Stars