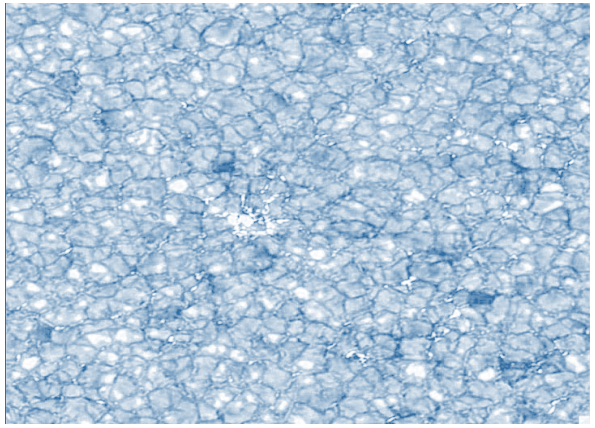
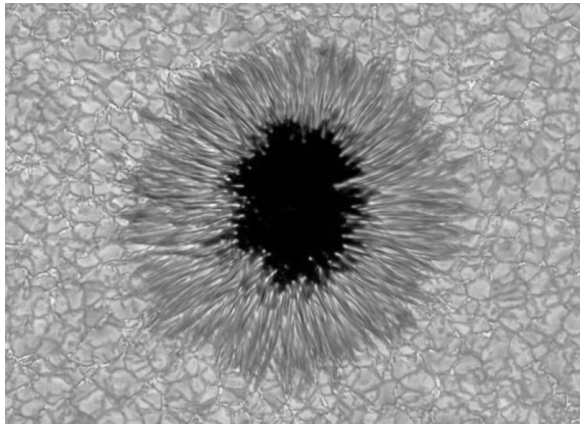
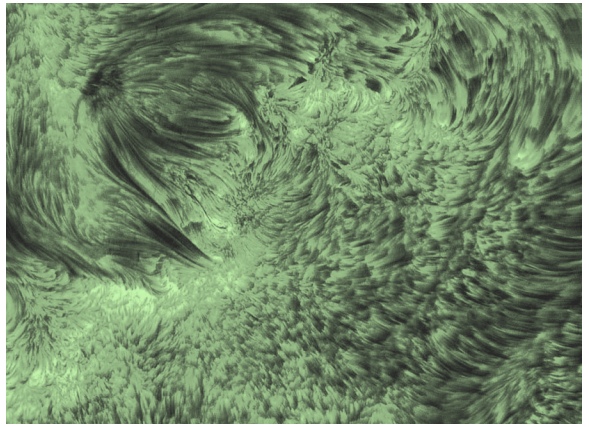
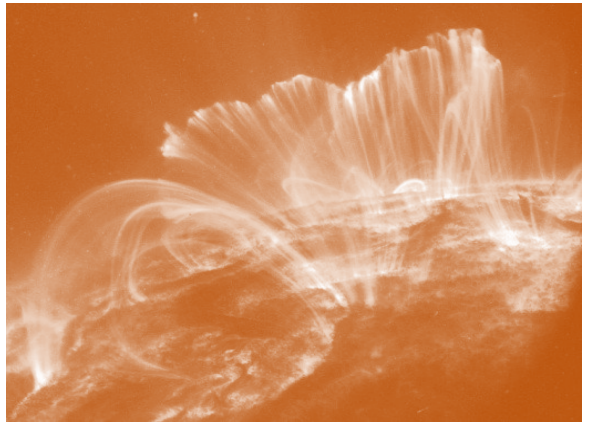
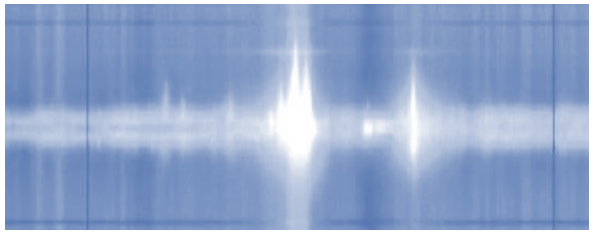
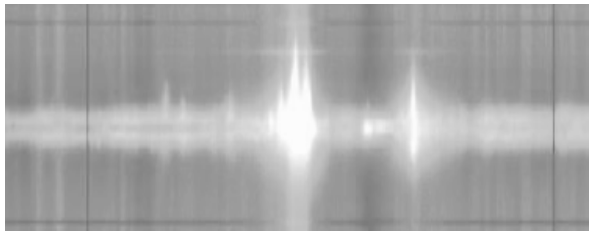
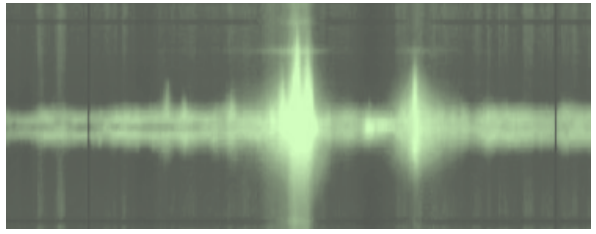
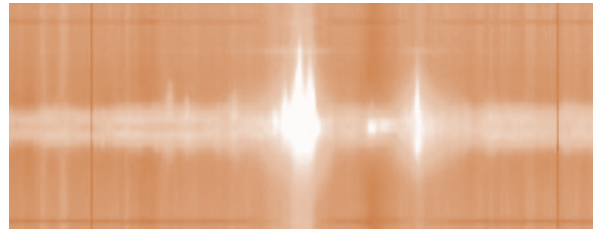
Predicting solar flares with IRIS spectra and machine learning

Brandon Panos, brandon.panos@fhnw.ch, IRIS-10 Bangalore 2019

New data source (IRIS Mg II Spectra)

Quiet Sun | Sunspot | Active region | Pre-Flare

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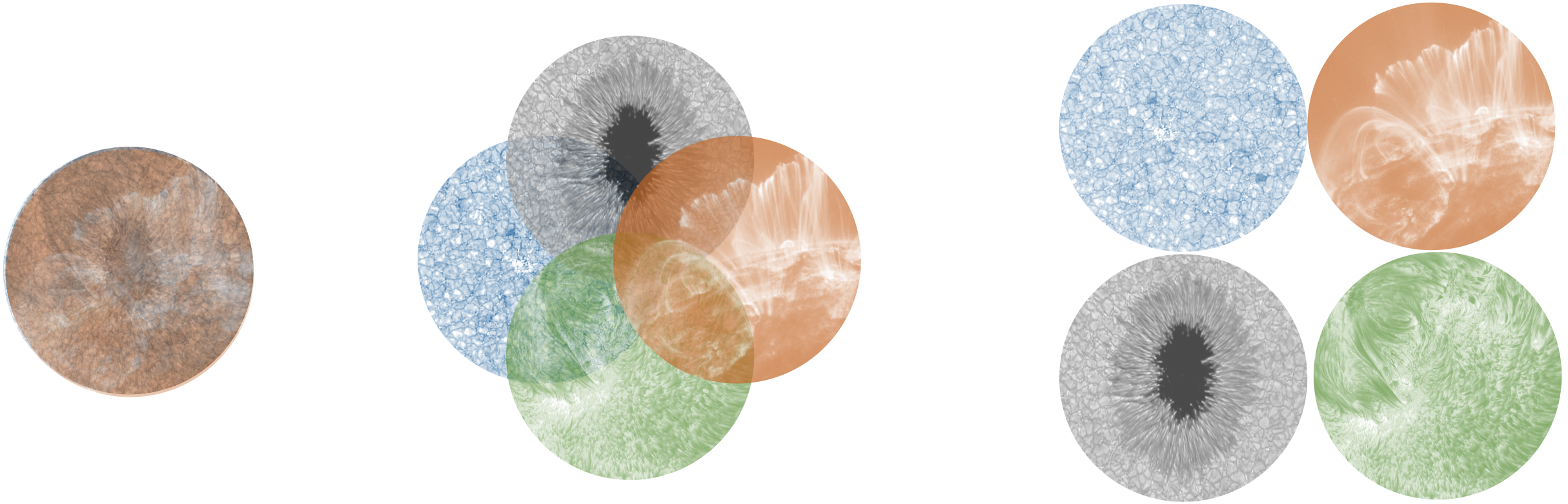
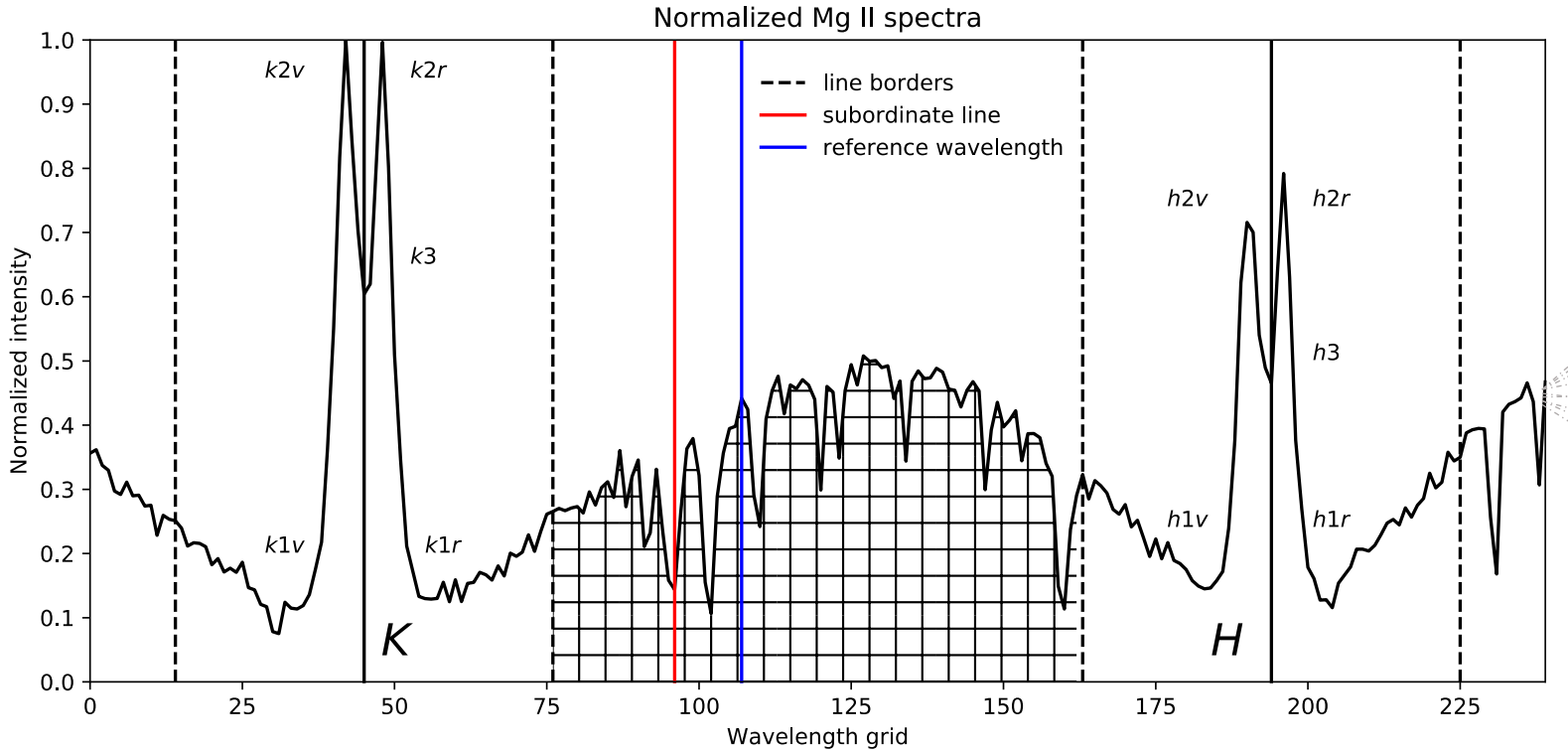
What do we plan on doing with these four data sets?



Separability

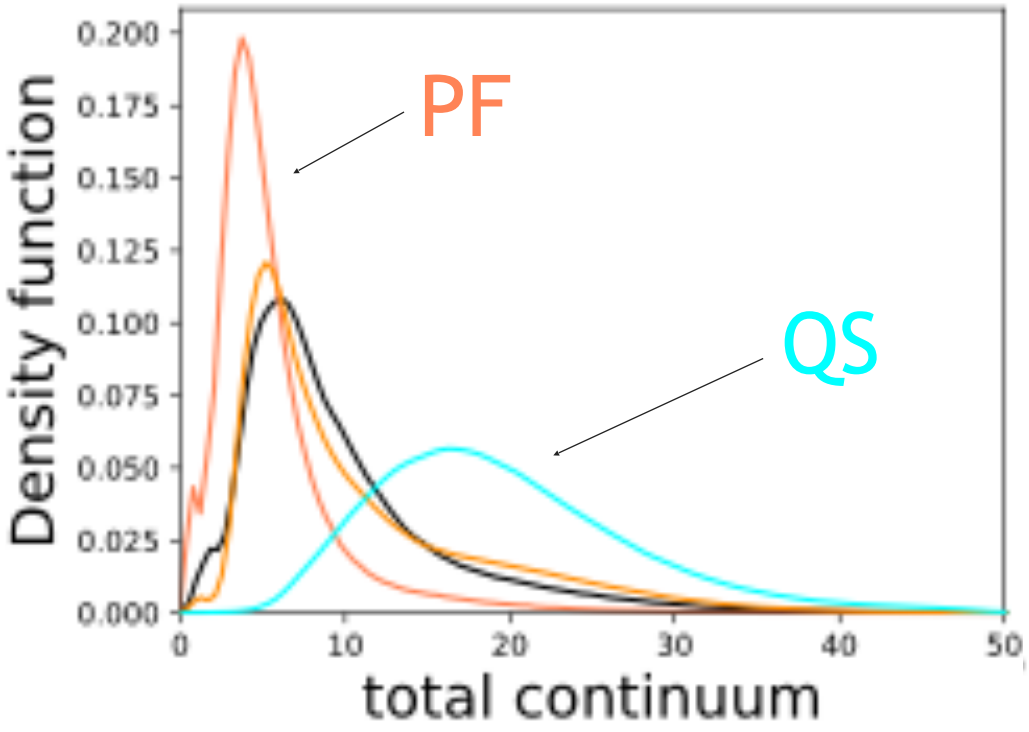
Informative basis

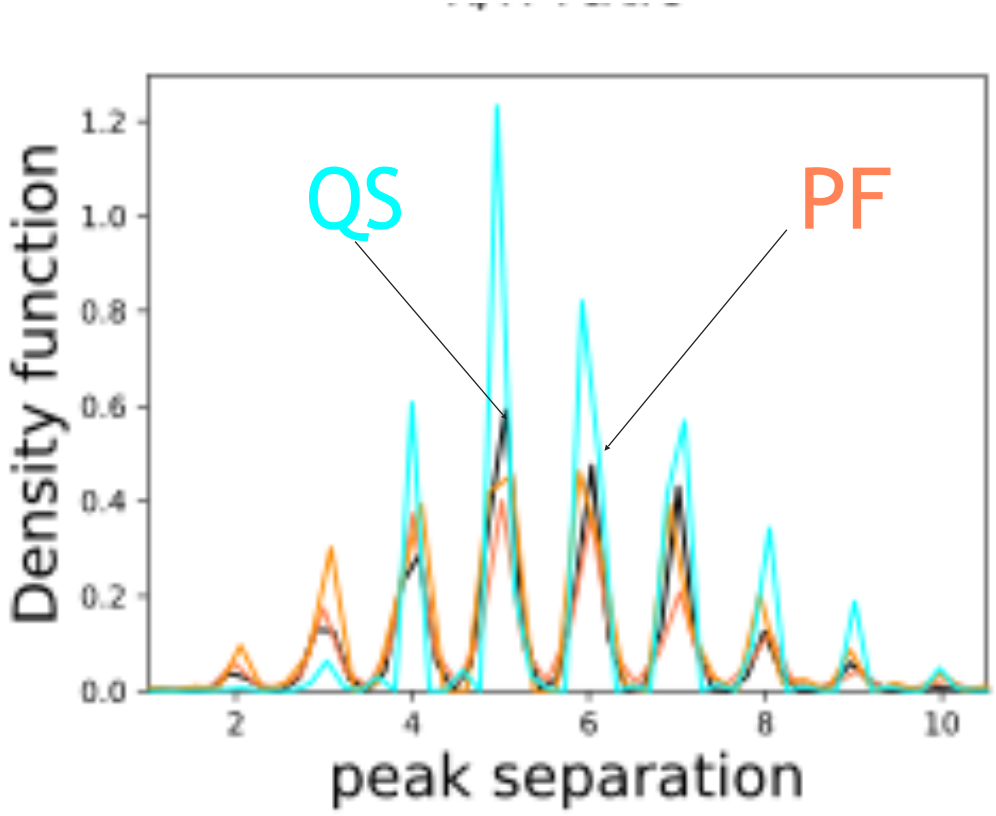


1. k/h ratio
2. Intensity
3. K3-height
4. Peak ratio
5. Line width
6. Line center
7. Triplet emission
8. Peak separation
9. Line asymmetry
10. Continuum emission

Feature distributions of the 4 data sets

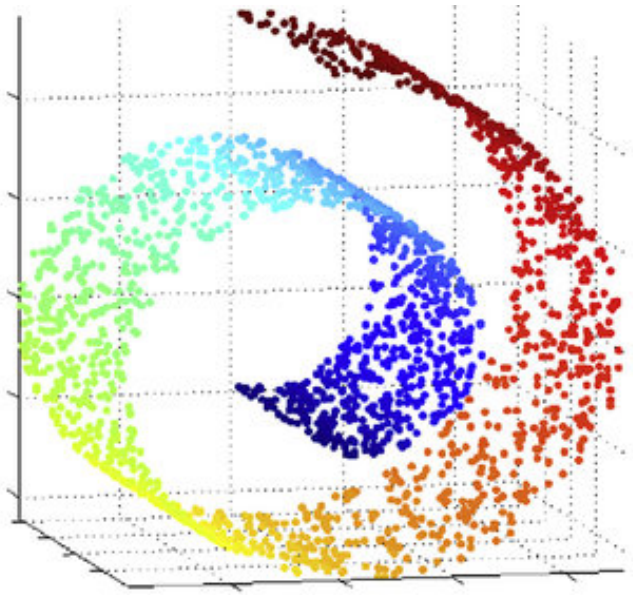
C0



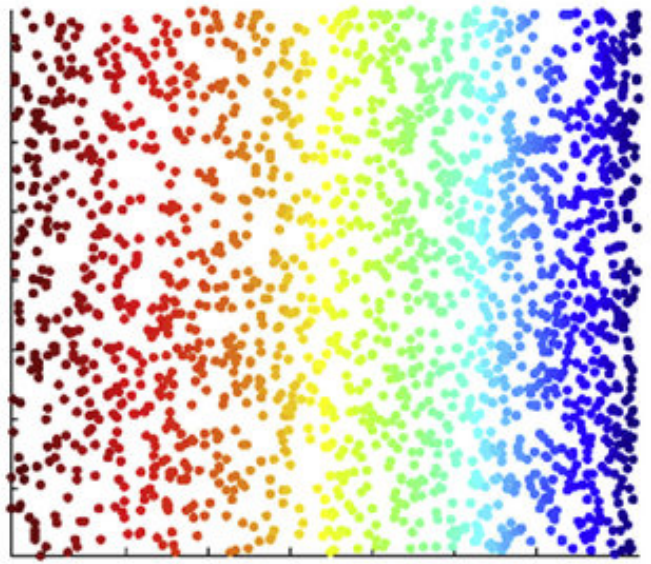


- C0 (distributions)
- C1 (PCA)
- C2 (t-SNE)
- C3 (neural networks)

Dimensionality reduction



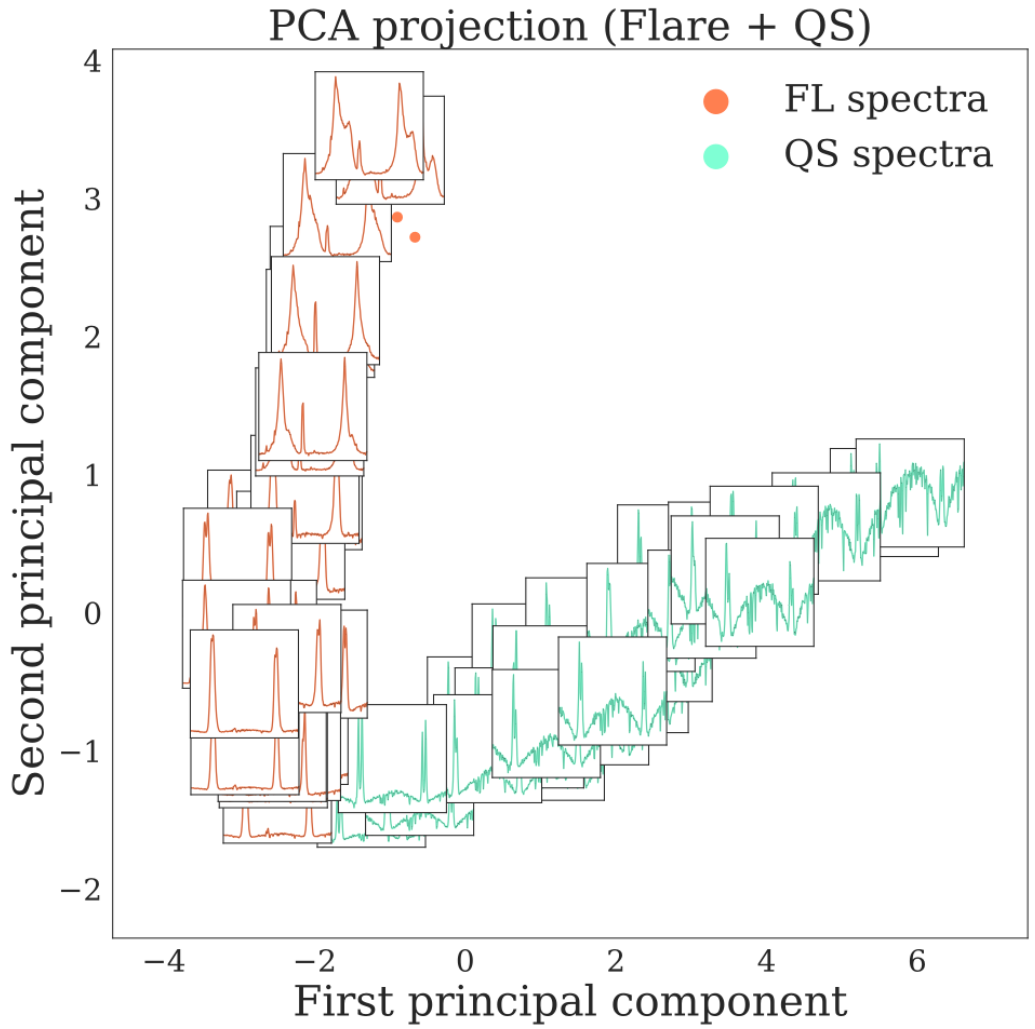
High (3d)



Low (2d)

PCA

C1



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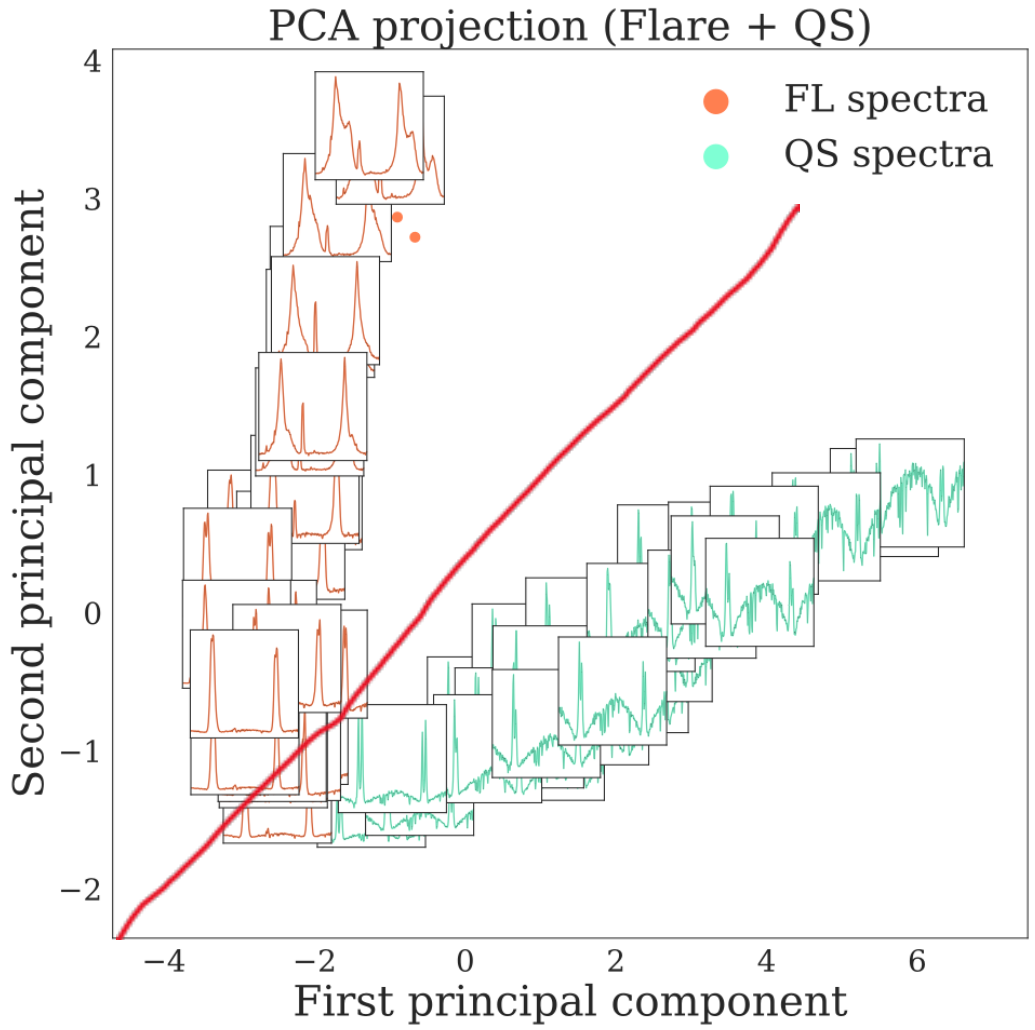
PCA

C1



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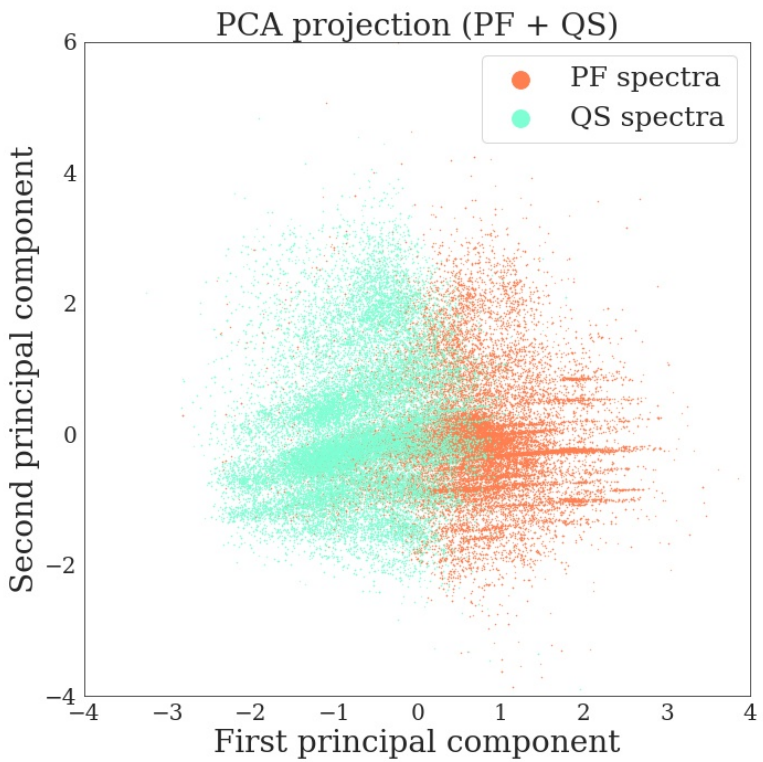
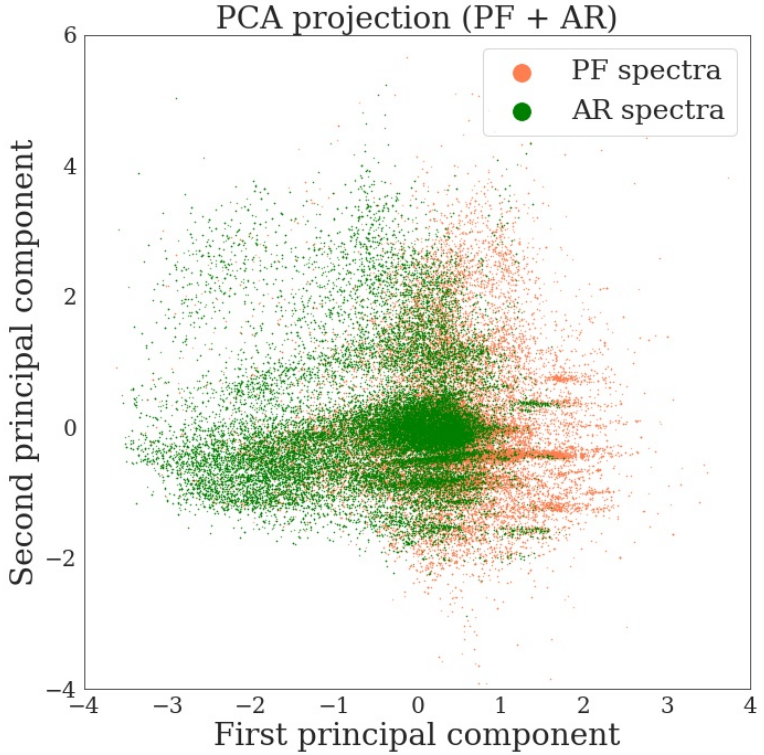
PCA

C1





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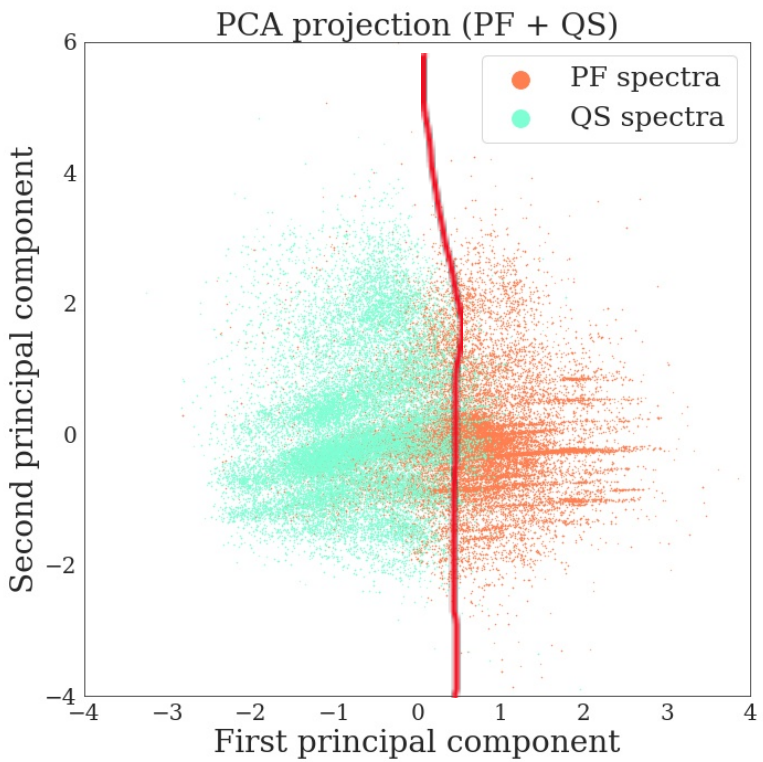
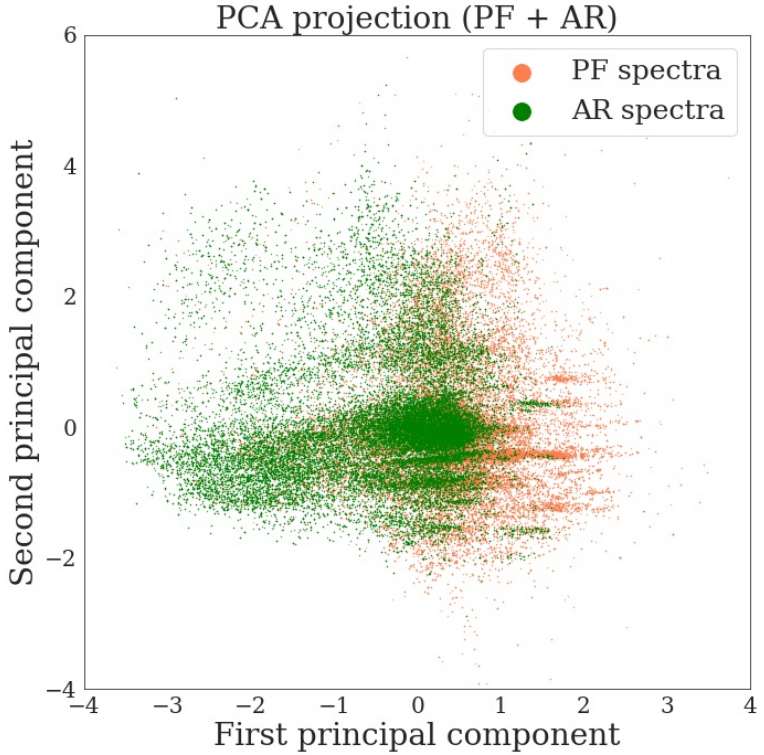
PCA

C1





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PCA

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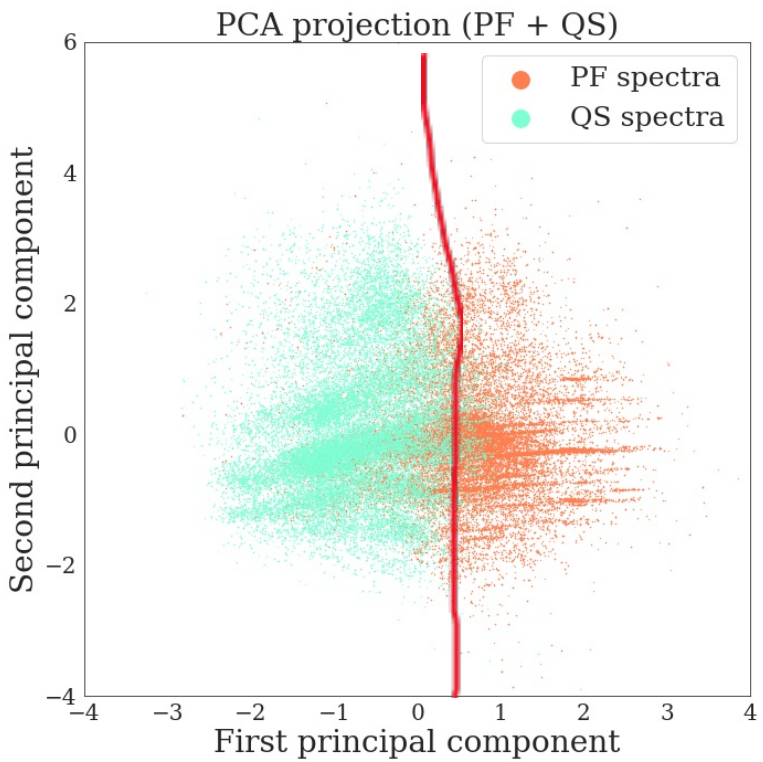

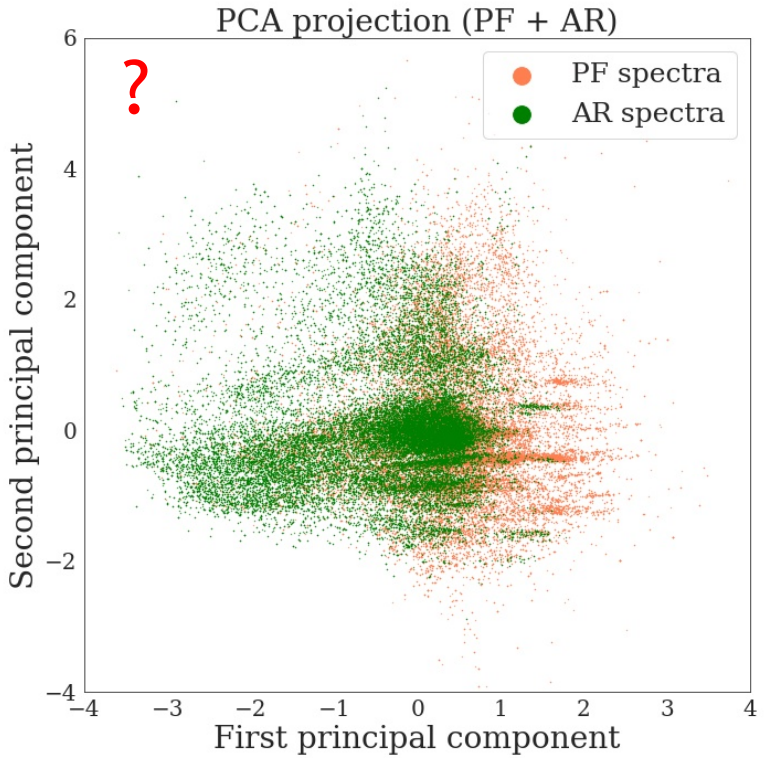

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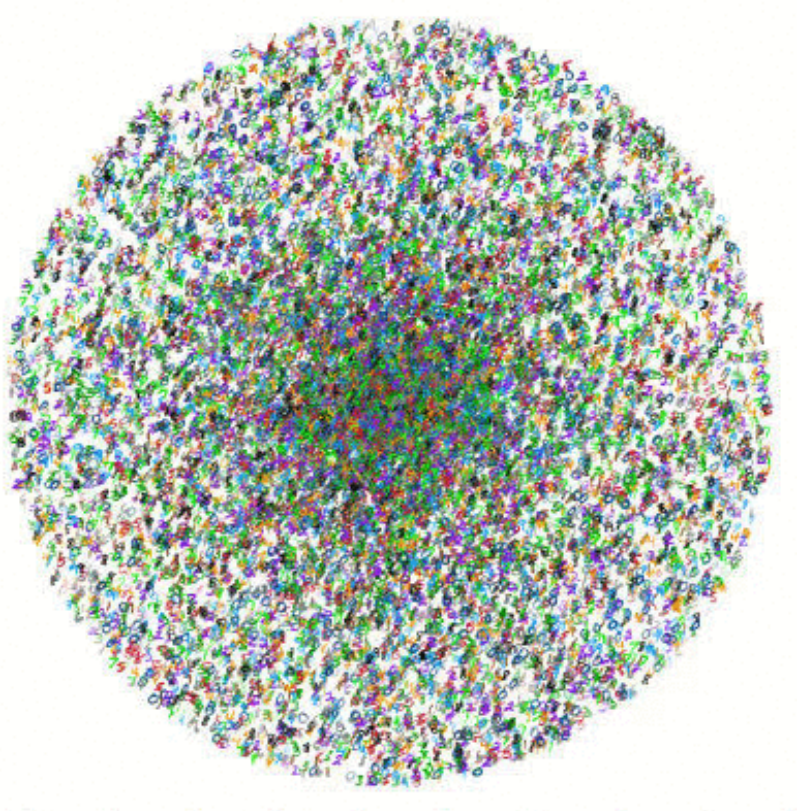
t-SNE

C2



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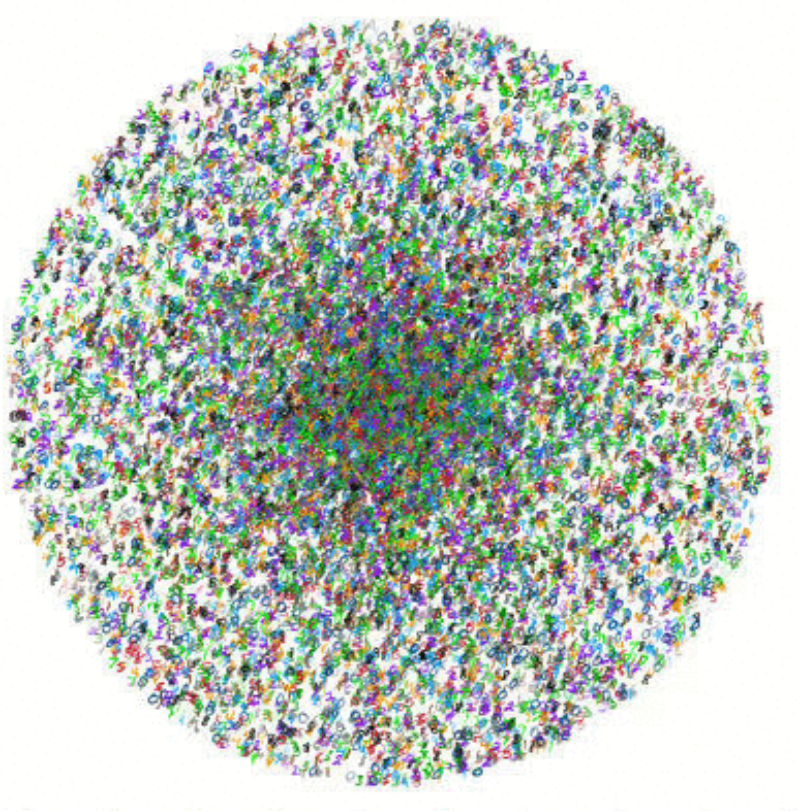
t-SNE

C2



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t-SNE

C2

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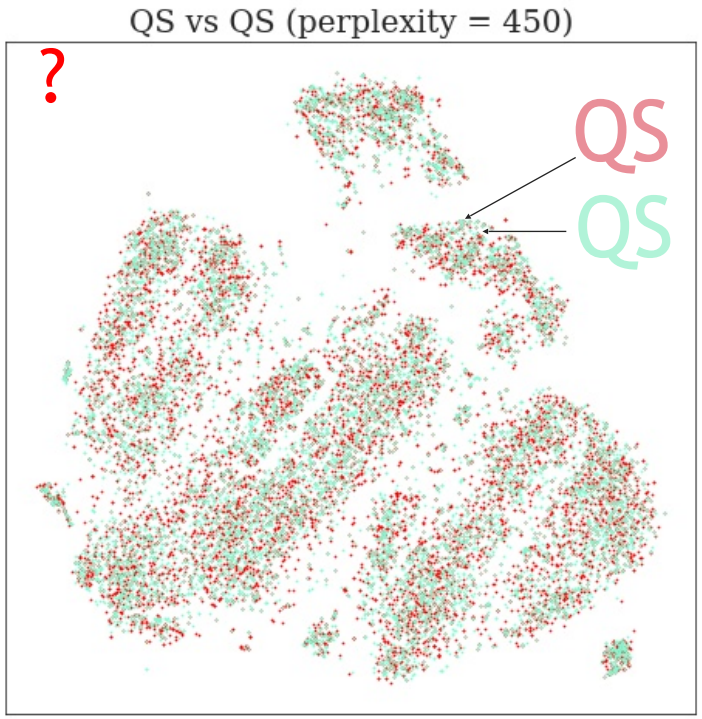
t-SNE

C2



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t-SNE

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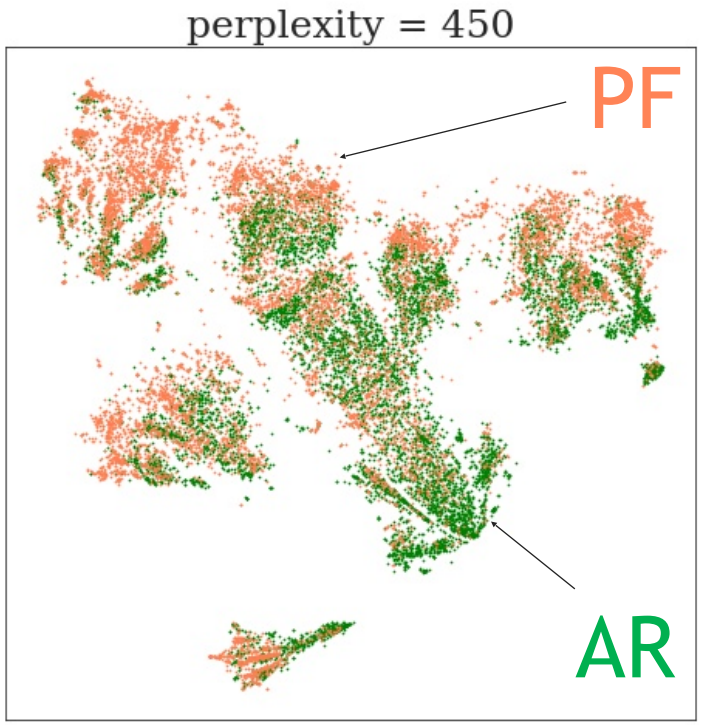

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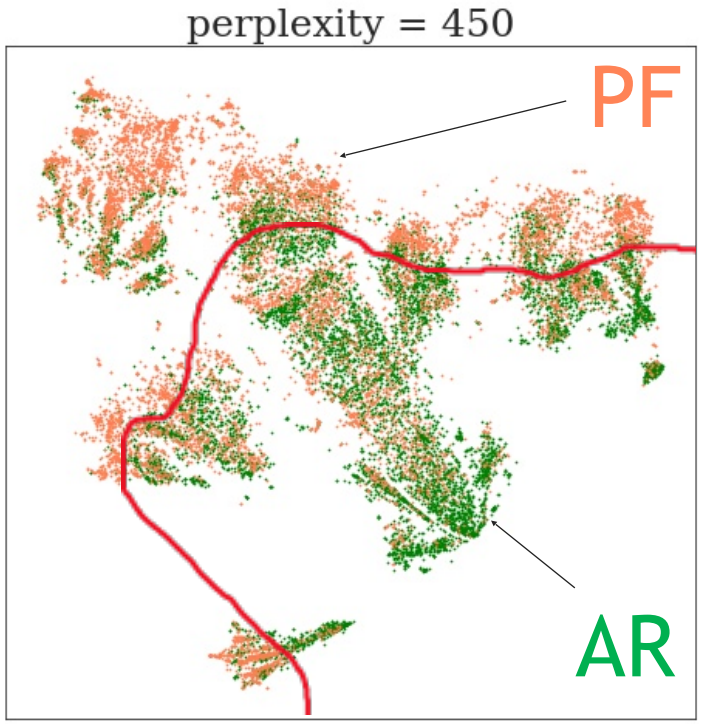

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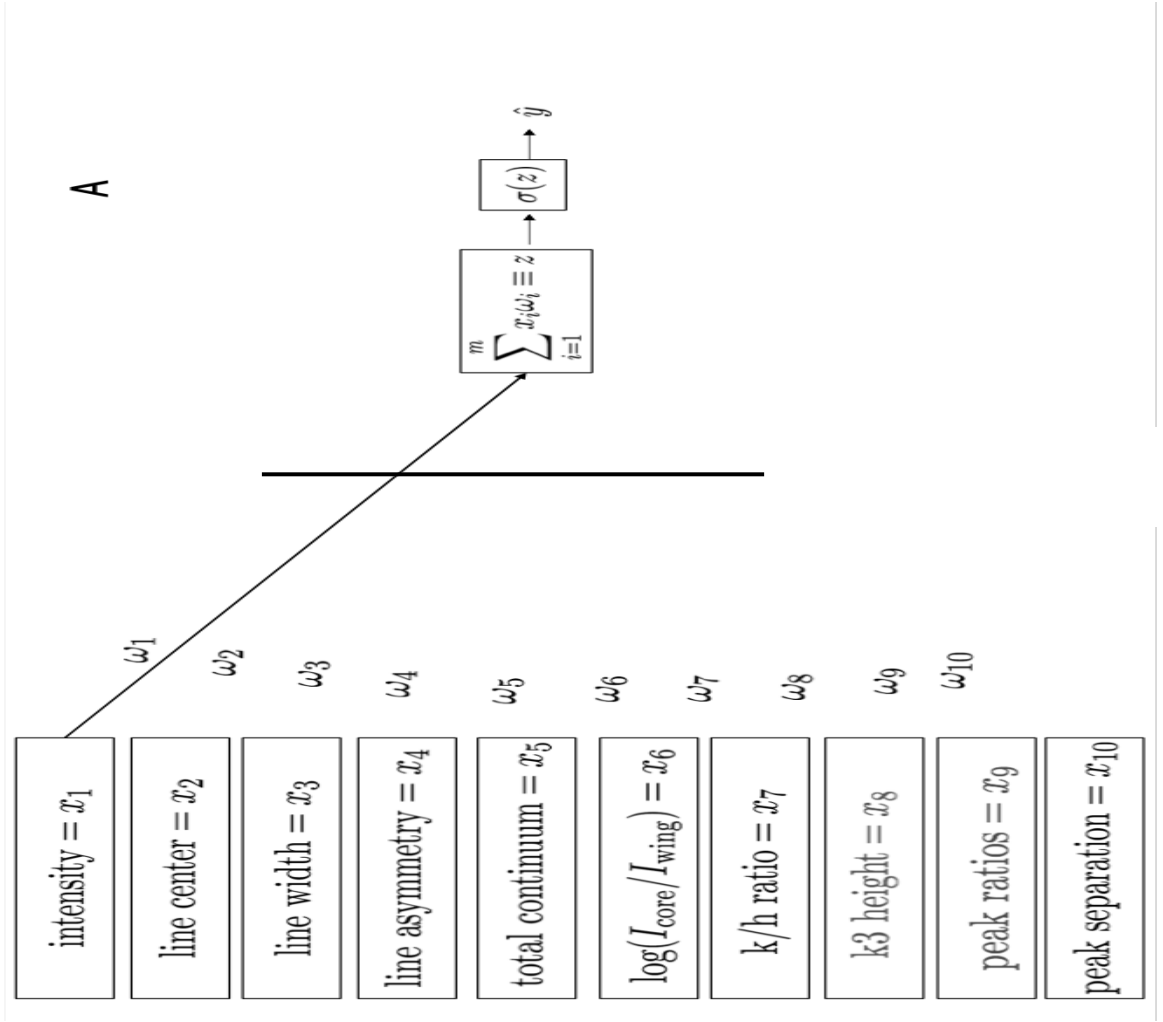
NN

C3



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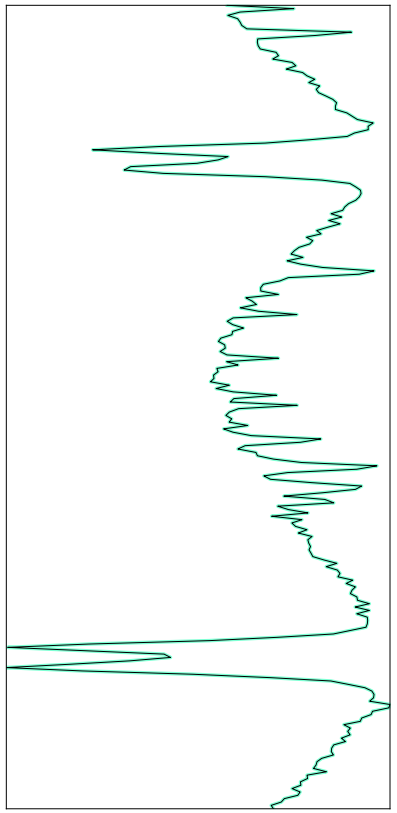
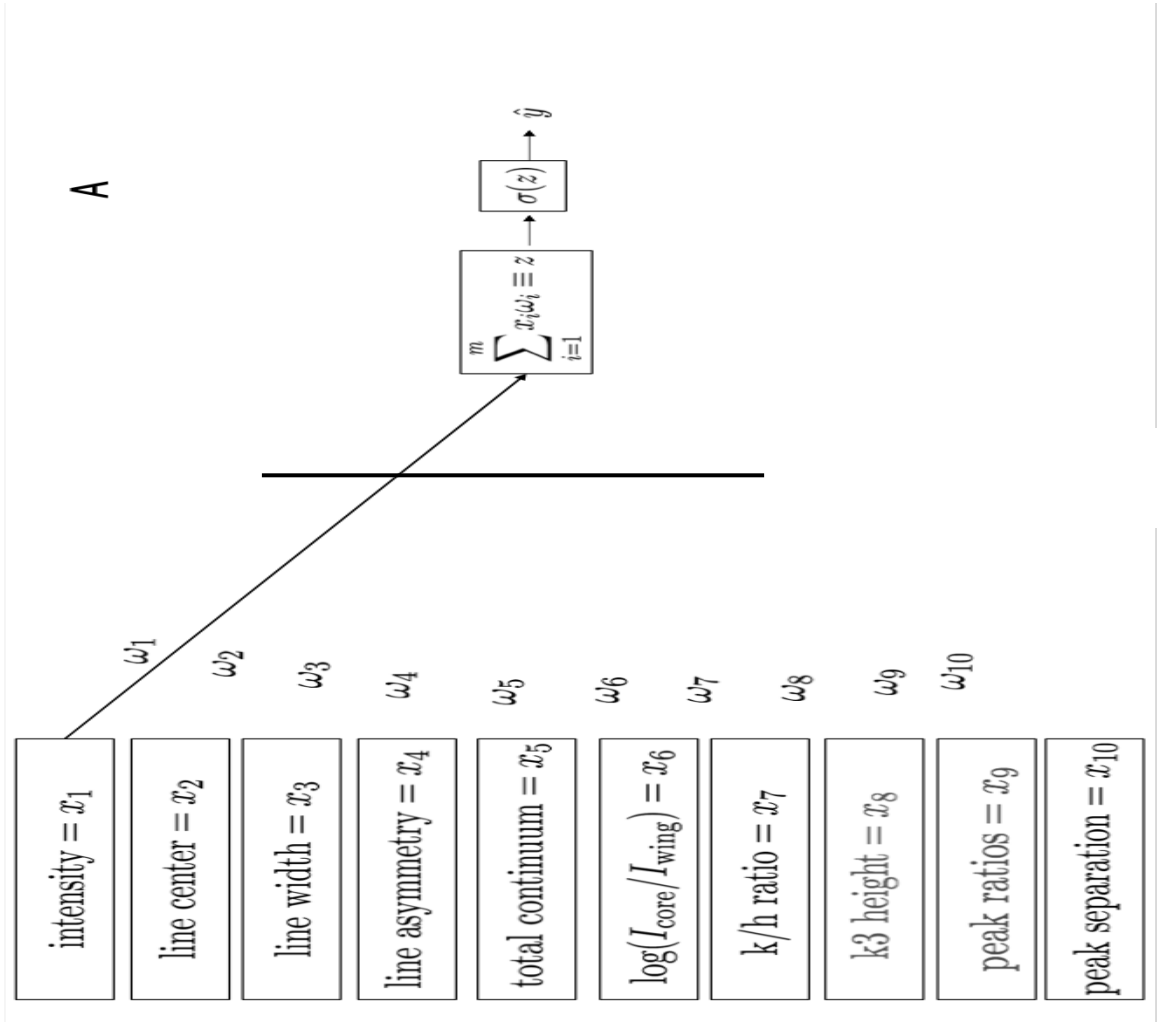
NN

C3





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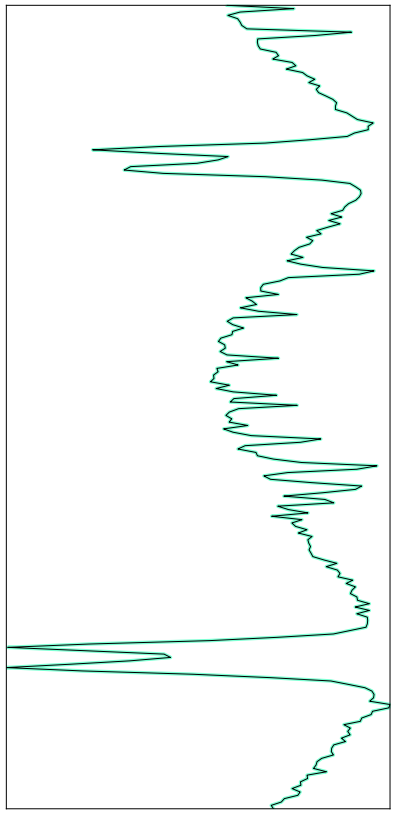
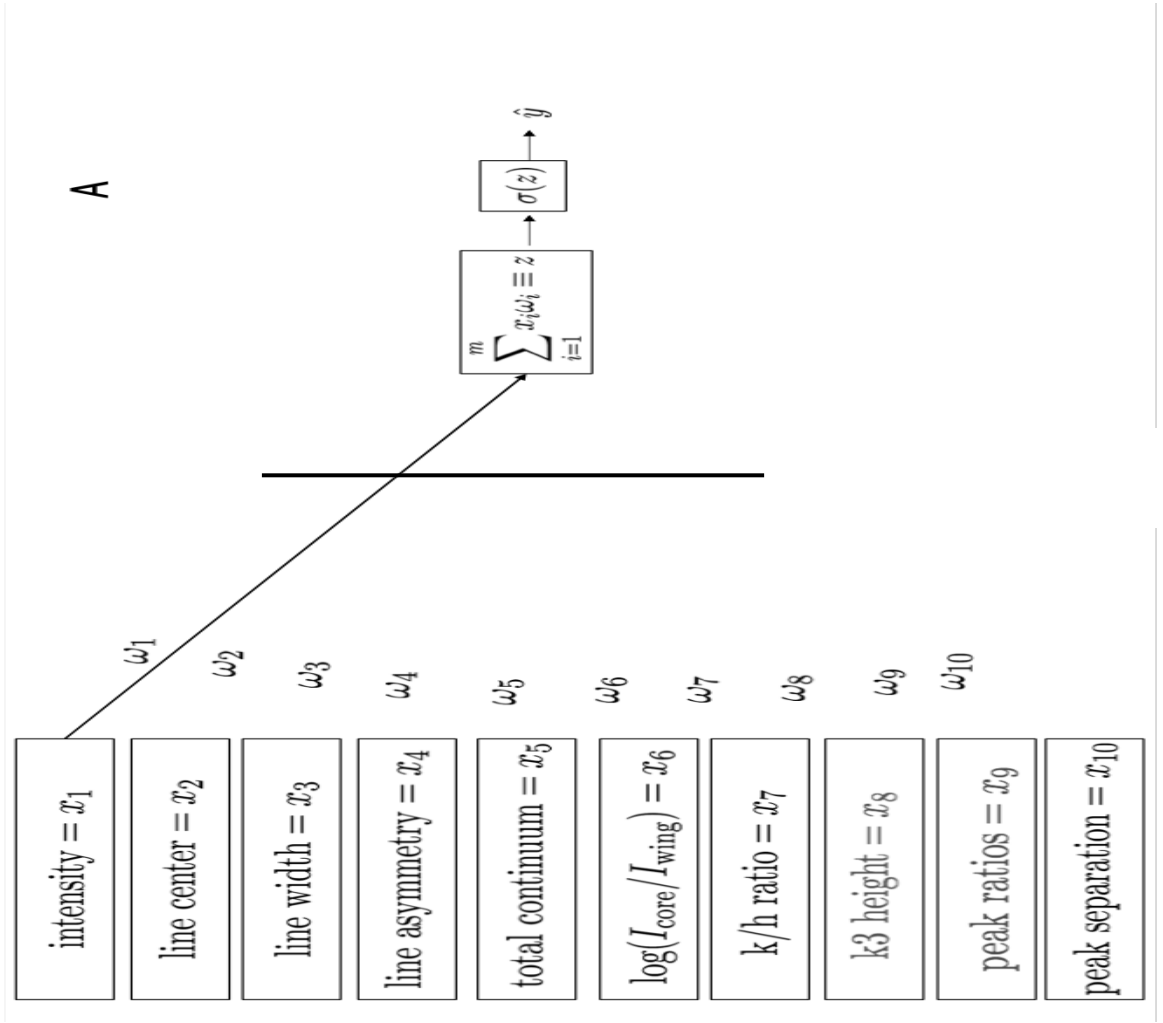
NN

C3





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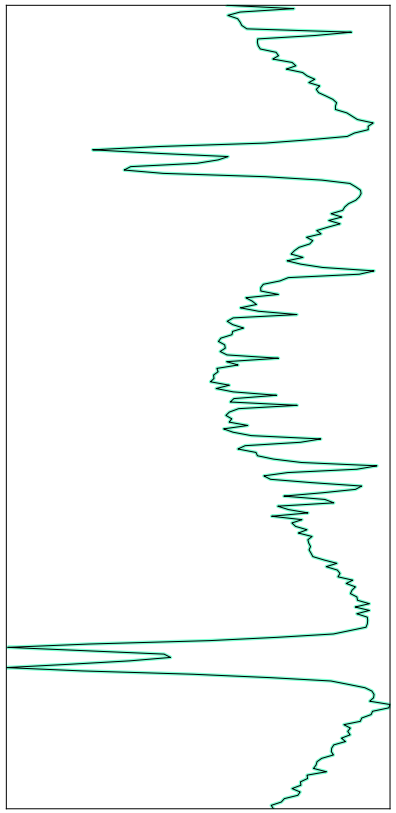

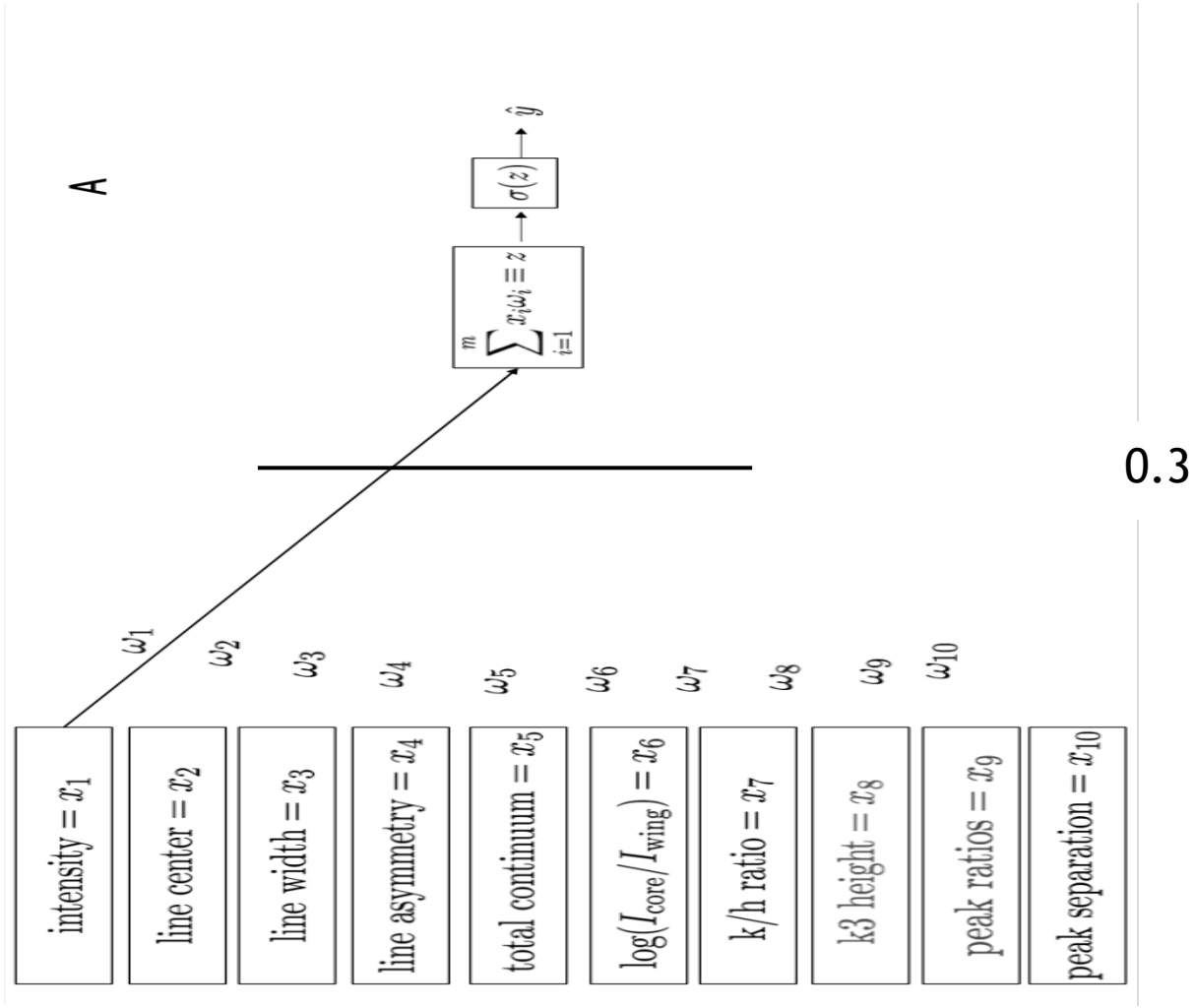

0.3

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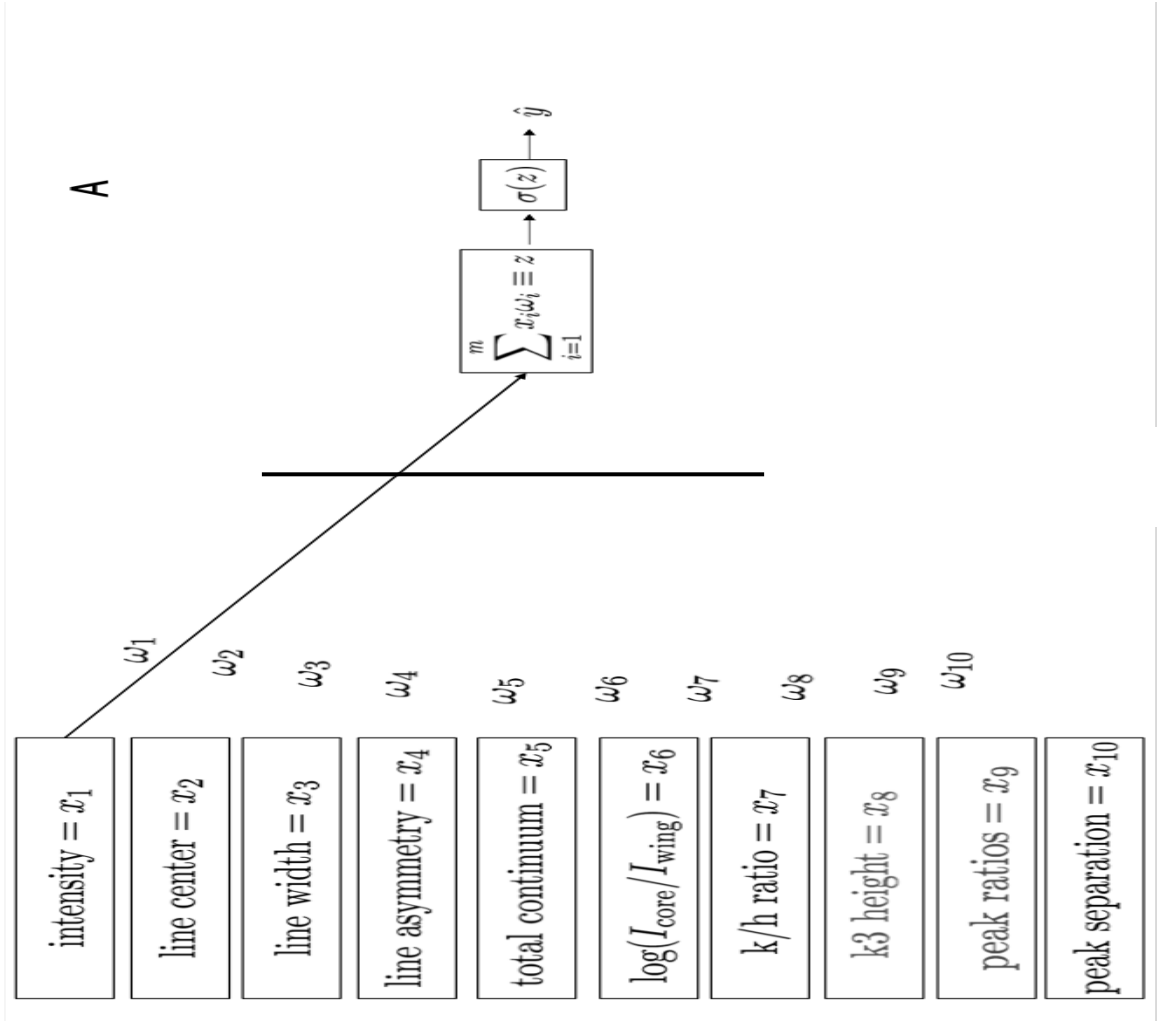
NN

C3



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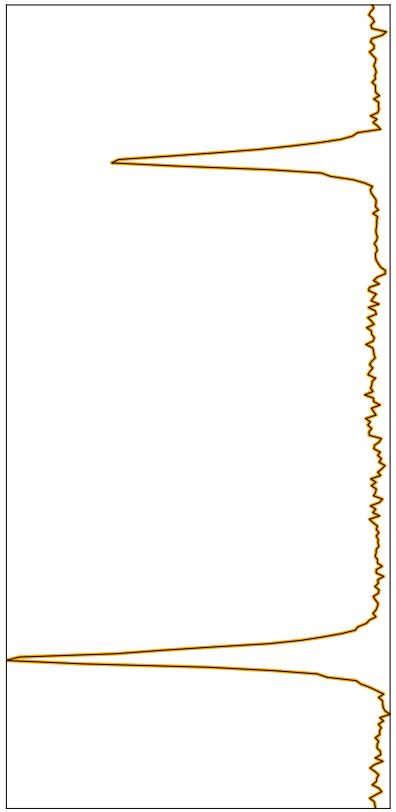
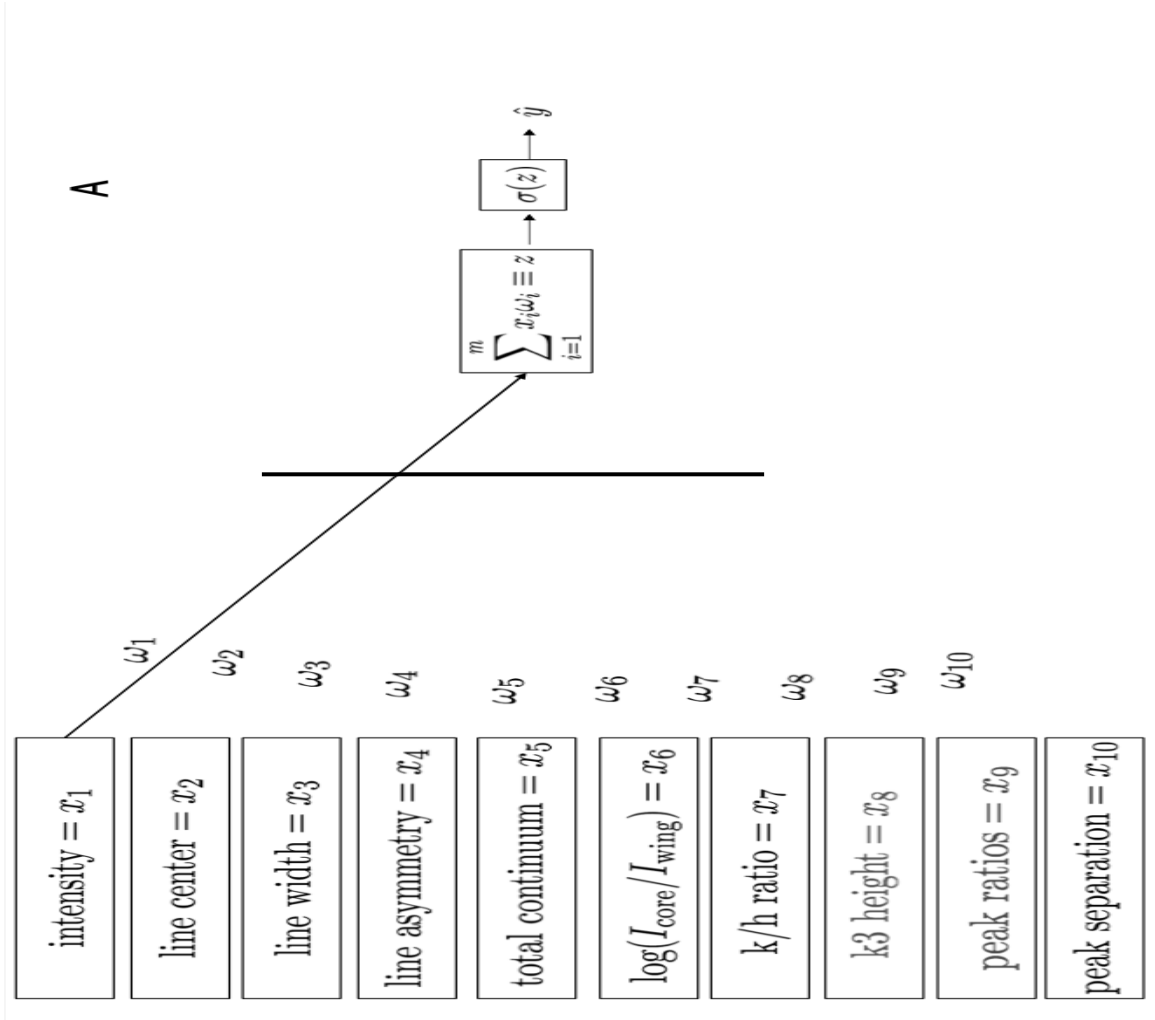
NN

C3





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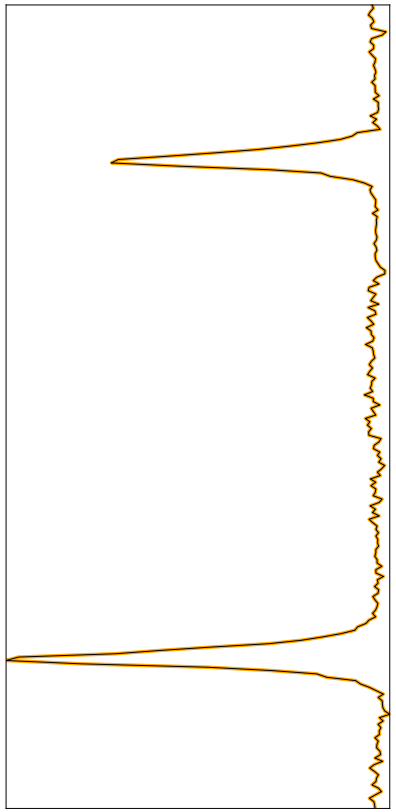
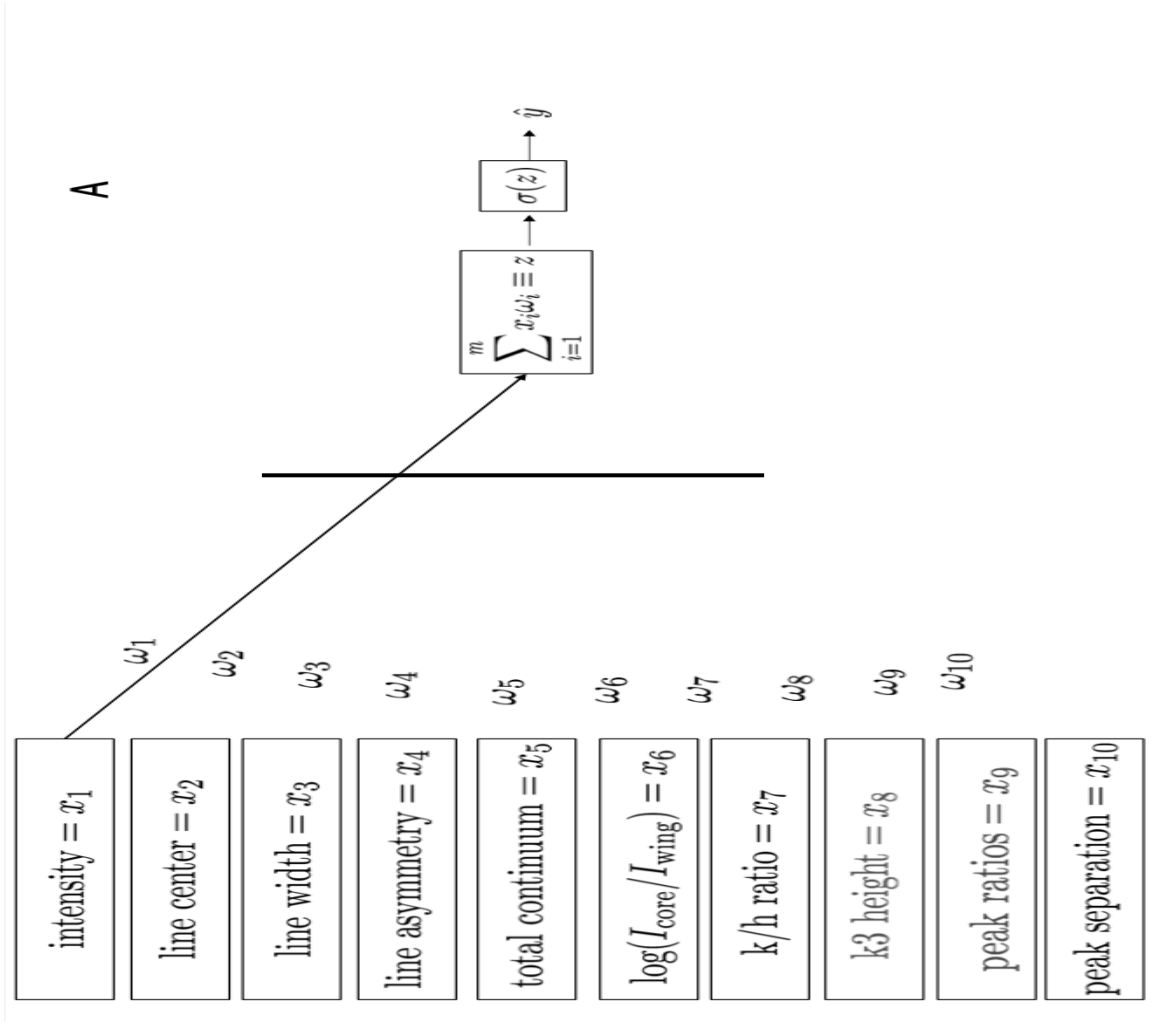
NN

C3





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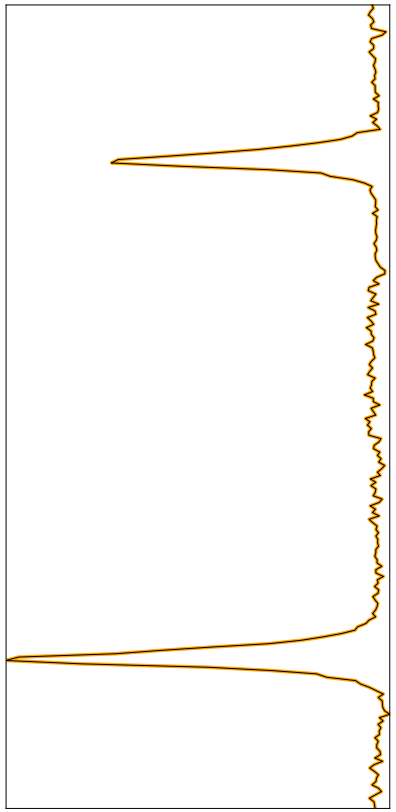
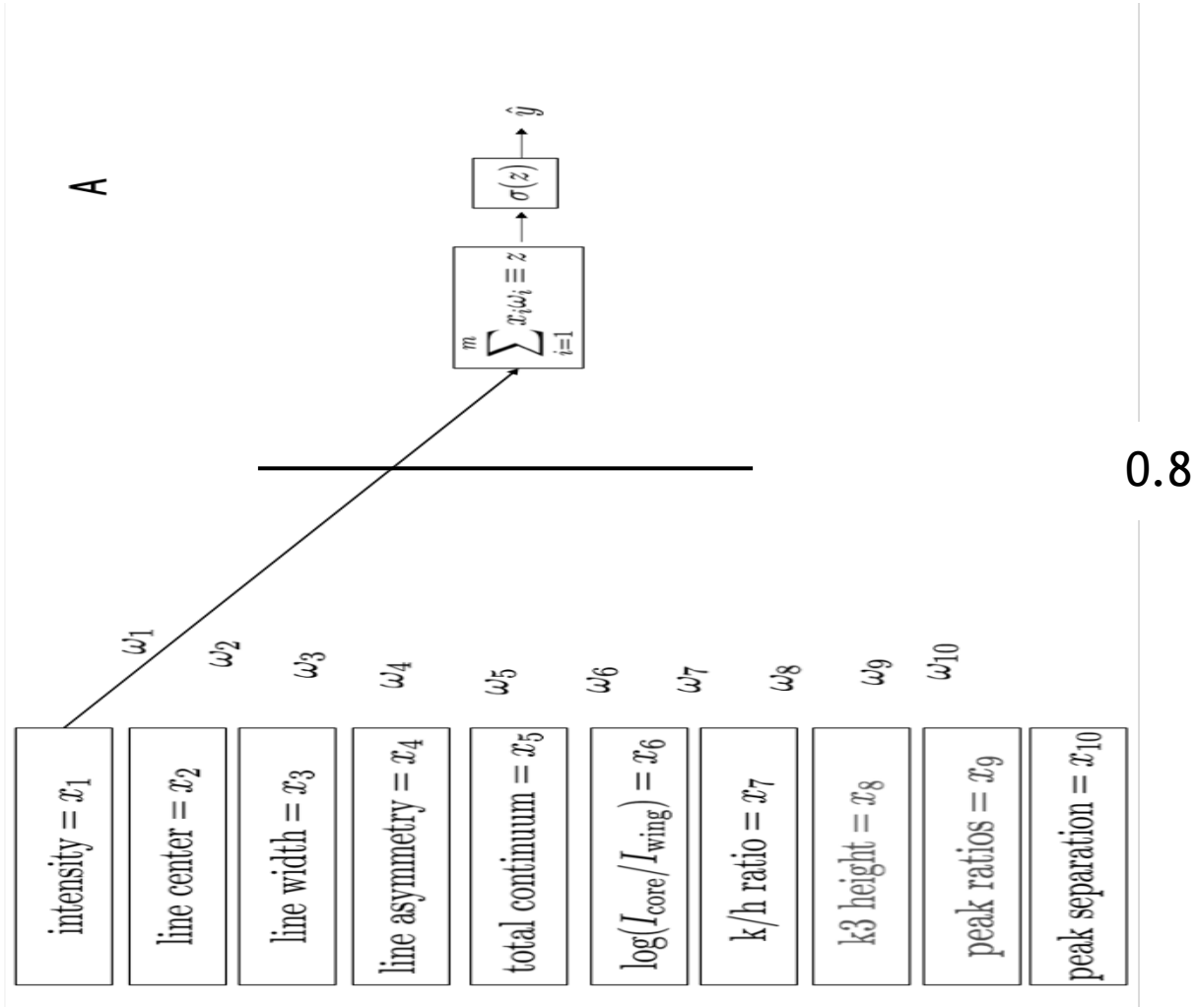
NN

C3





0.8

- C0 (distributions)
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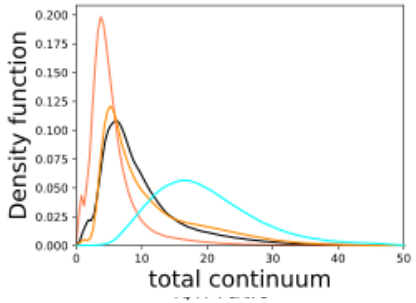
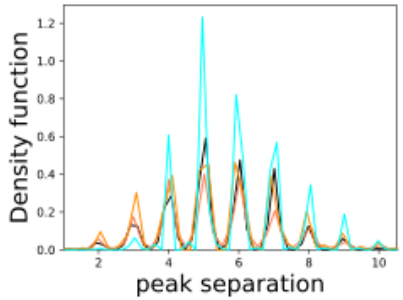
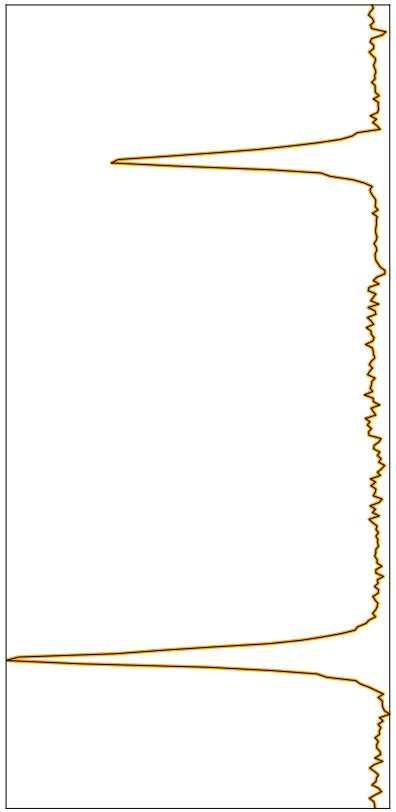
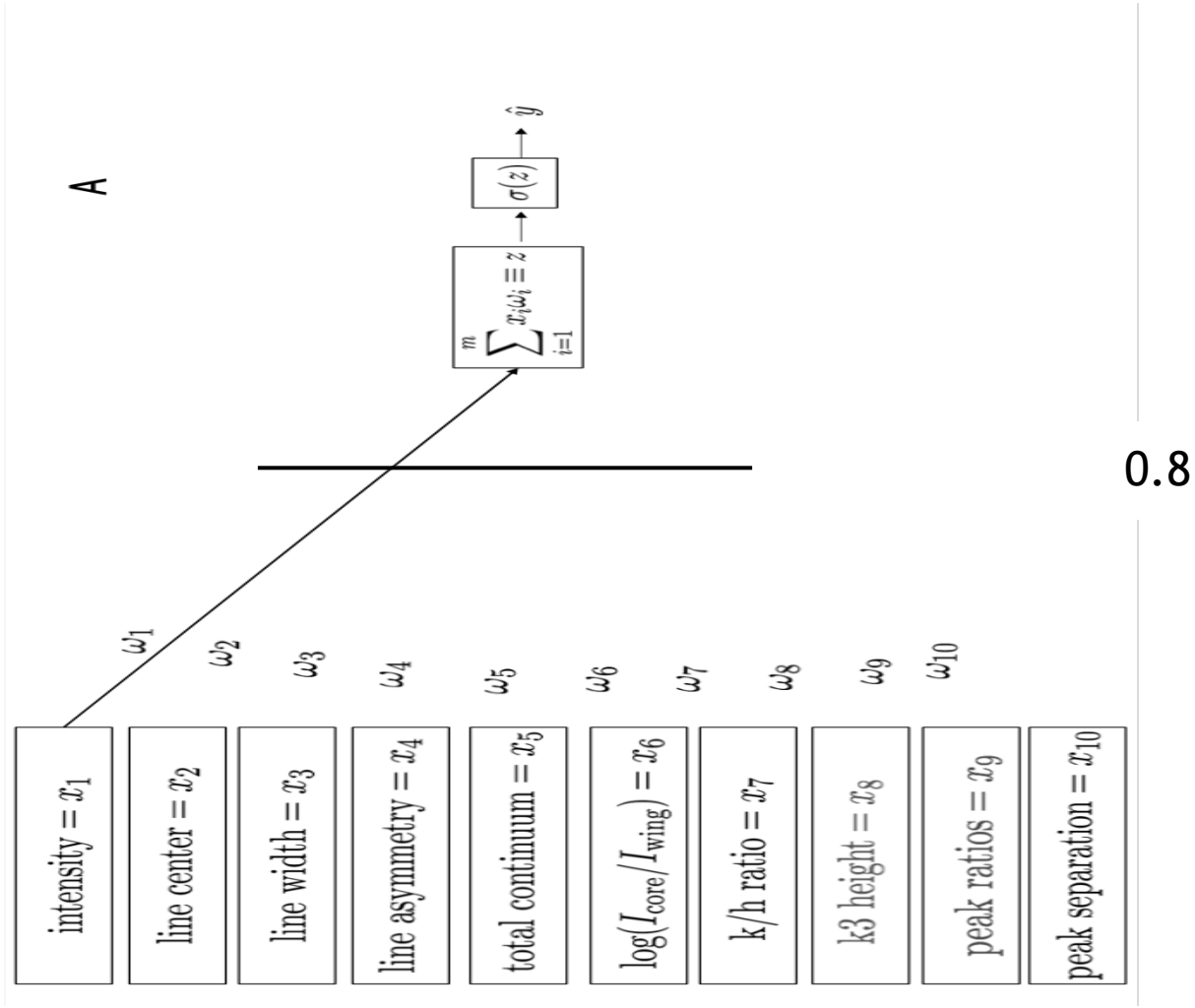
NN

C3









0.8

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NN

C3

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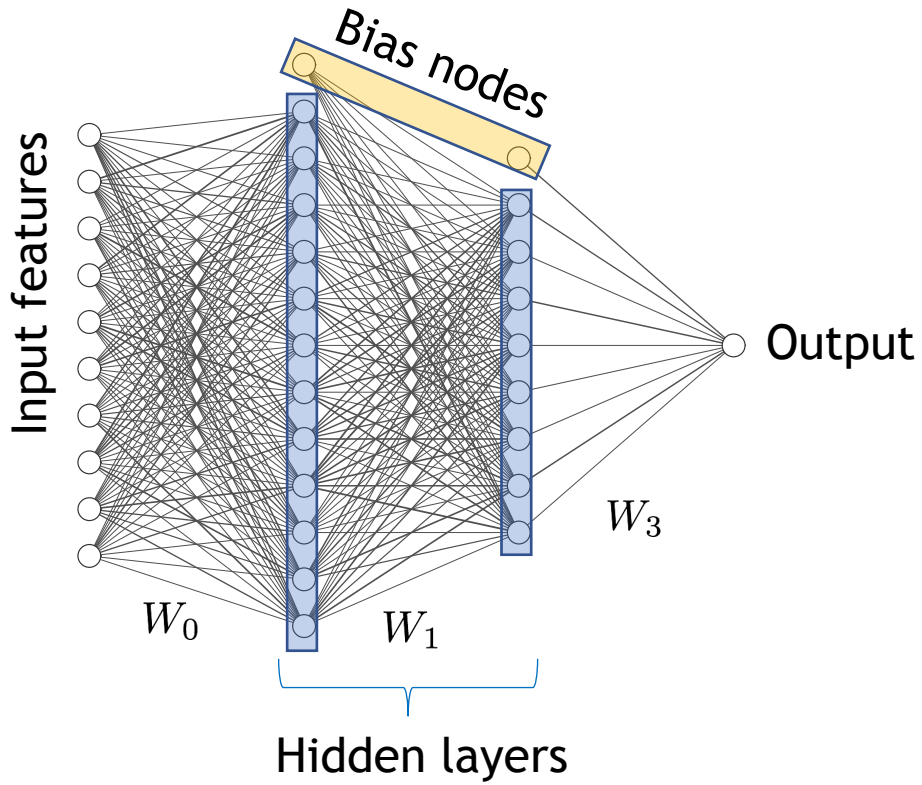

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NN

C3

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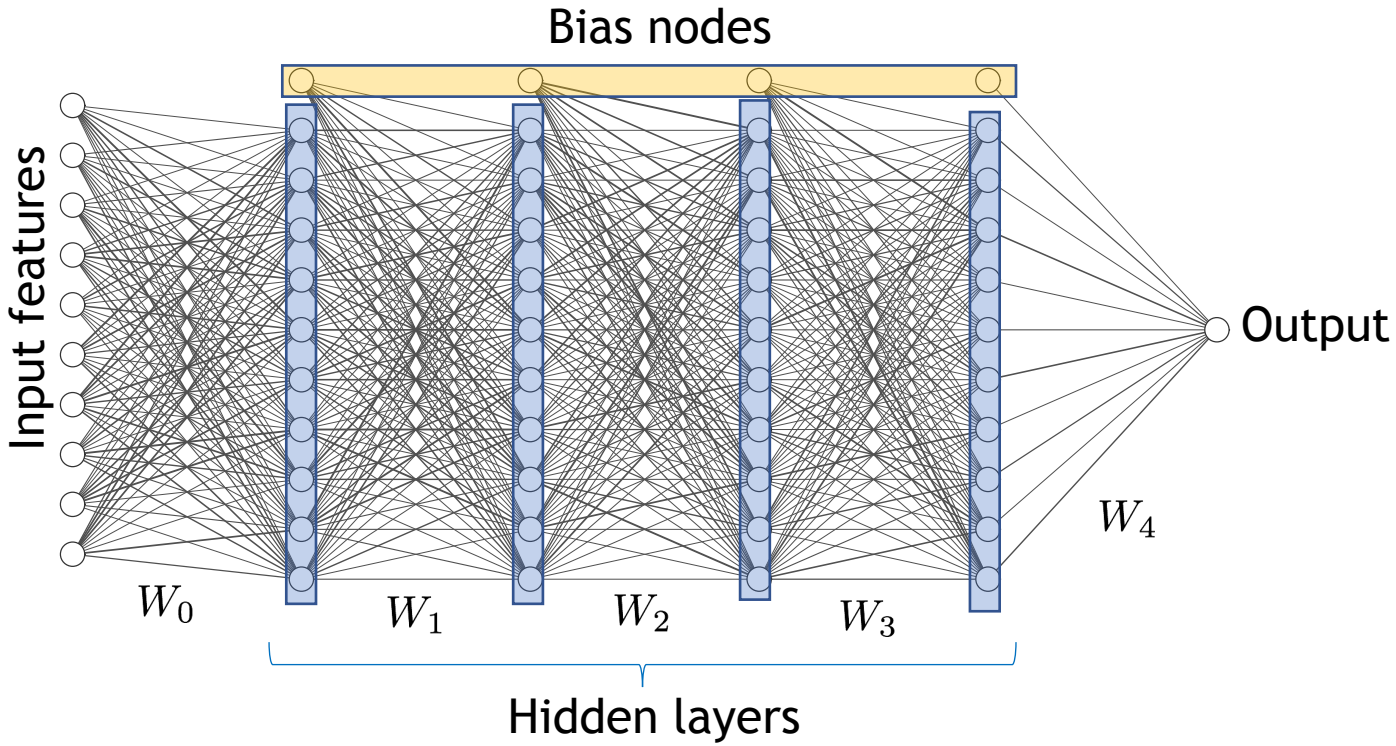
NN

C3



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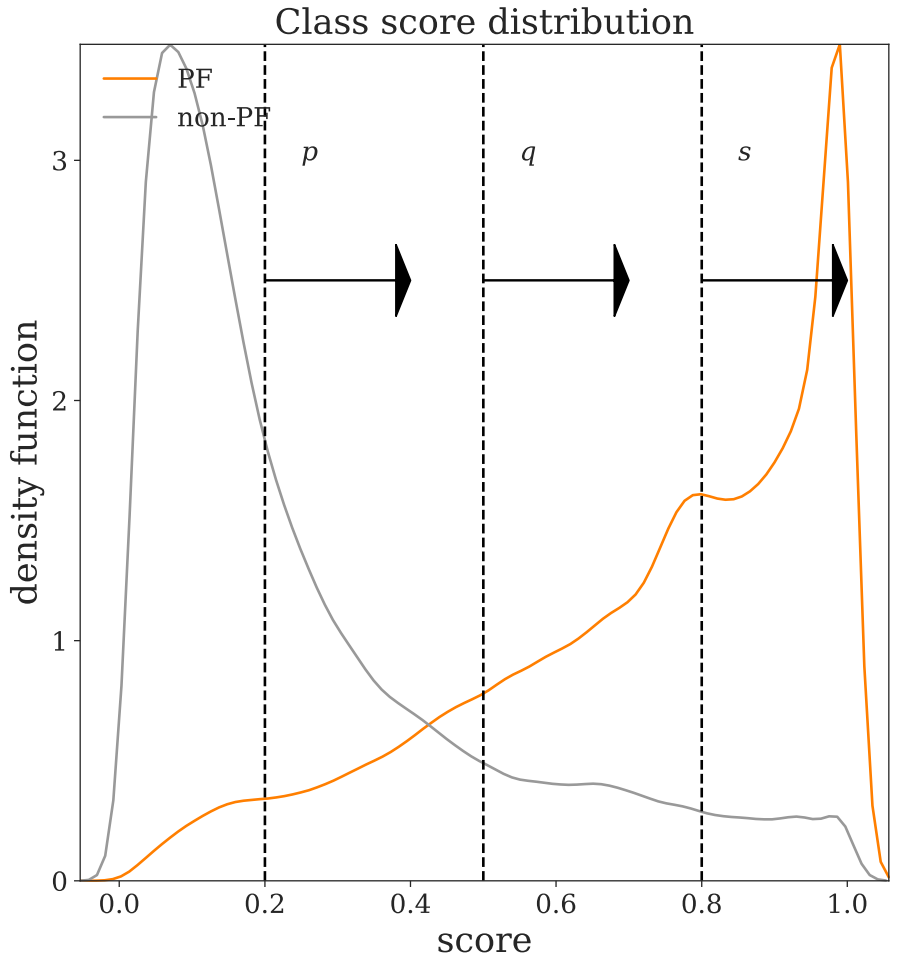
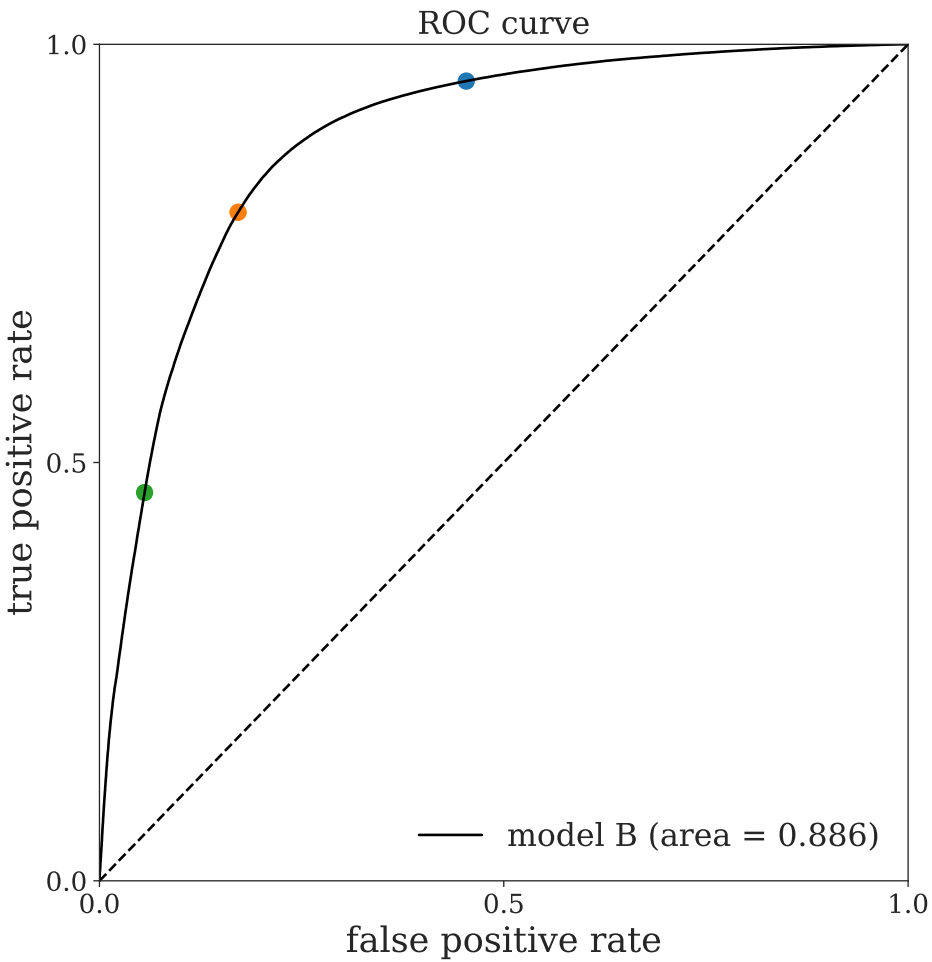
Results

C3

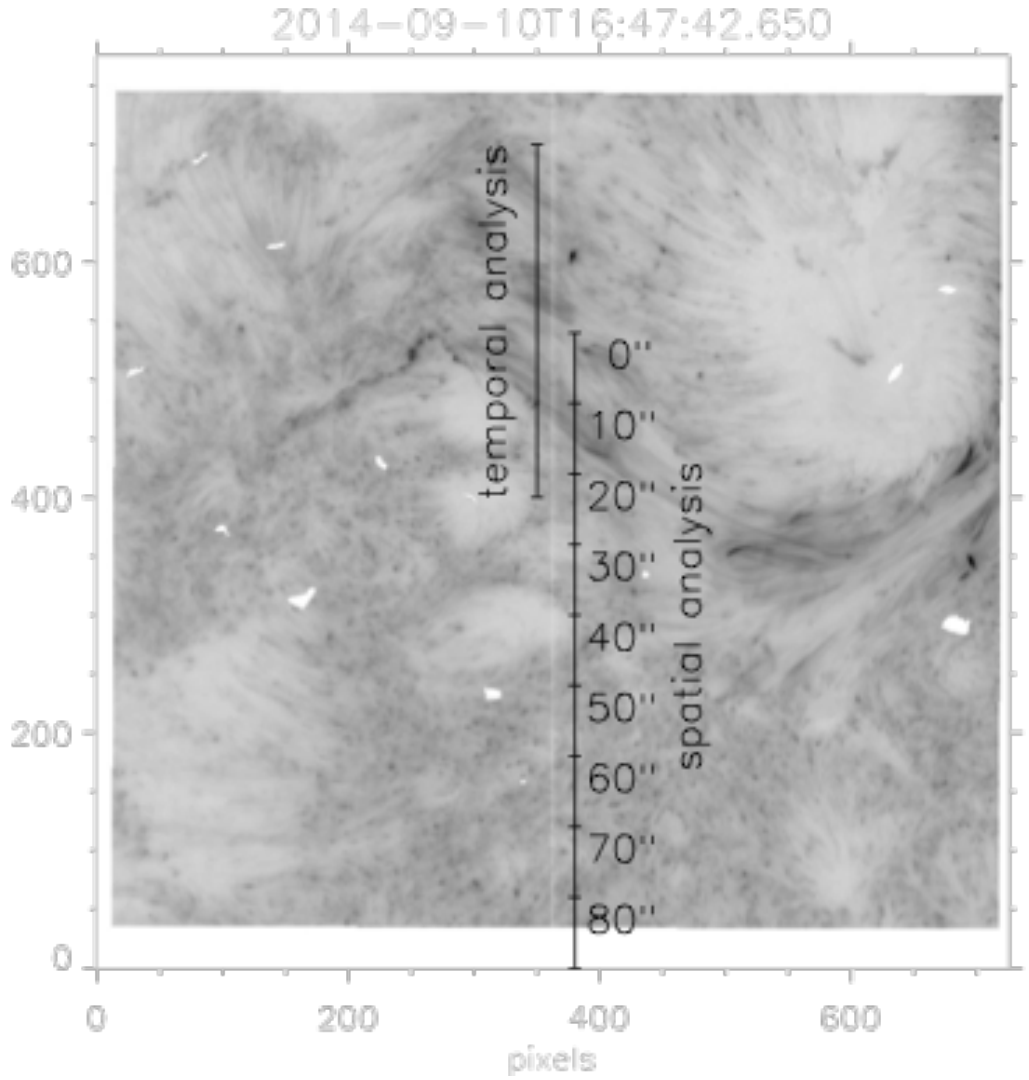


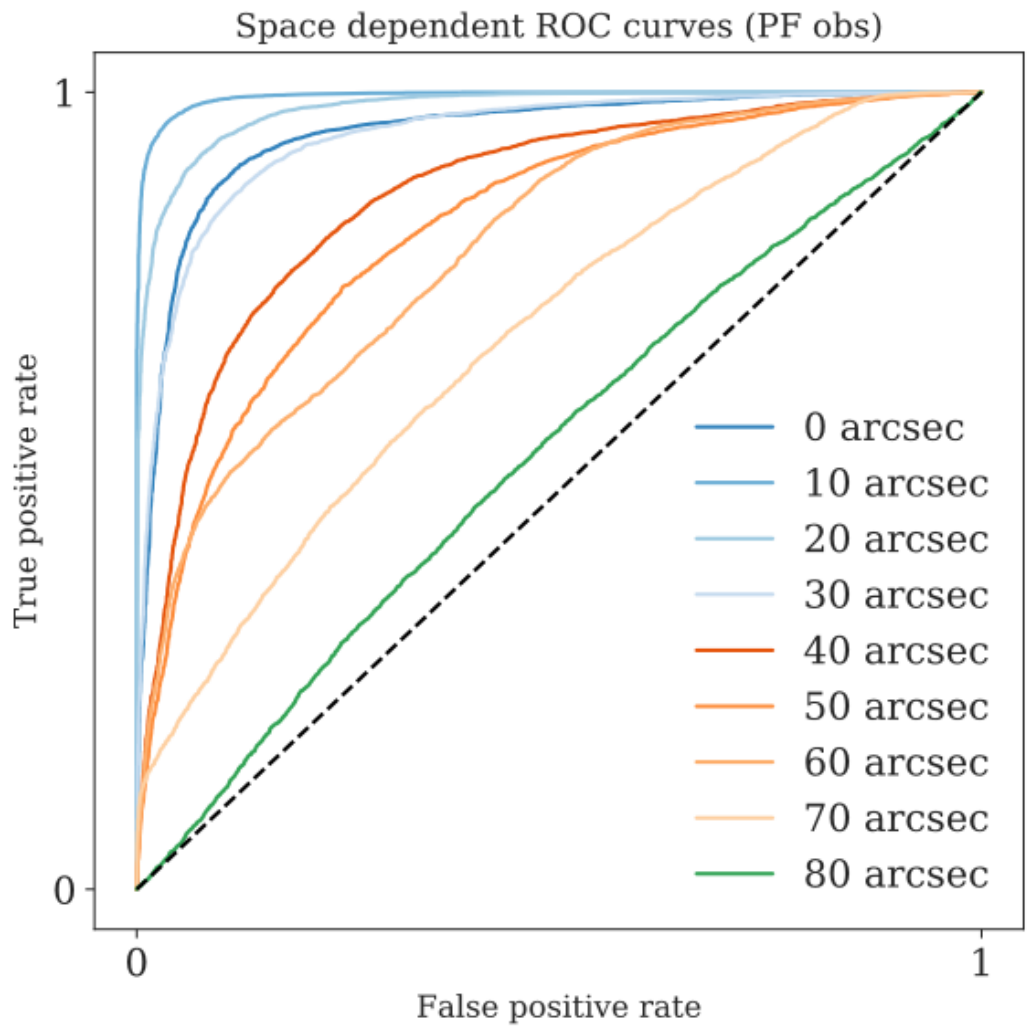


- C0 (distributions)
- C1 (PCA)
- C2 (t-SNE)
- C3 (neural networks)

Results

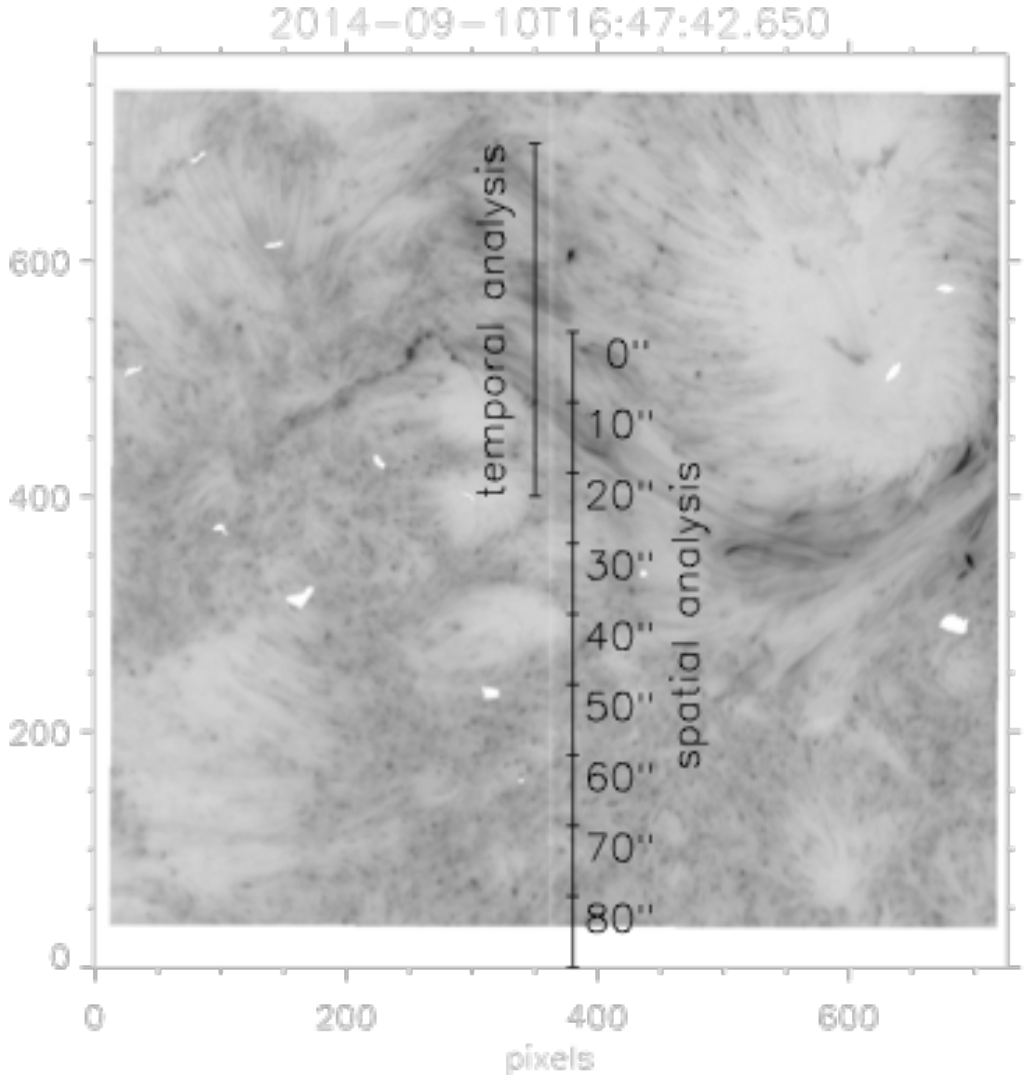
C3

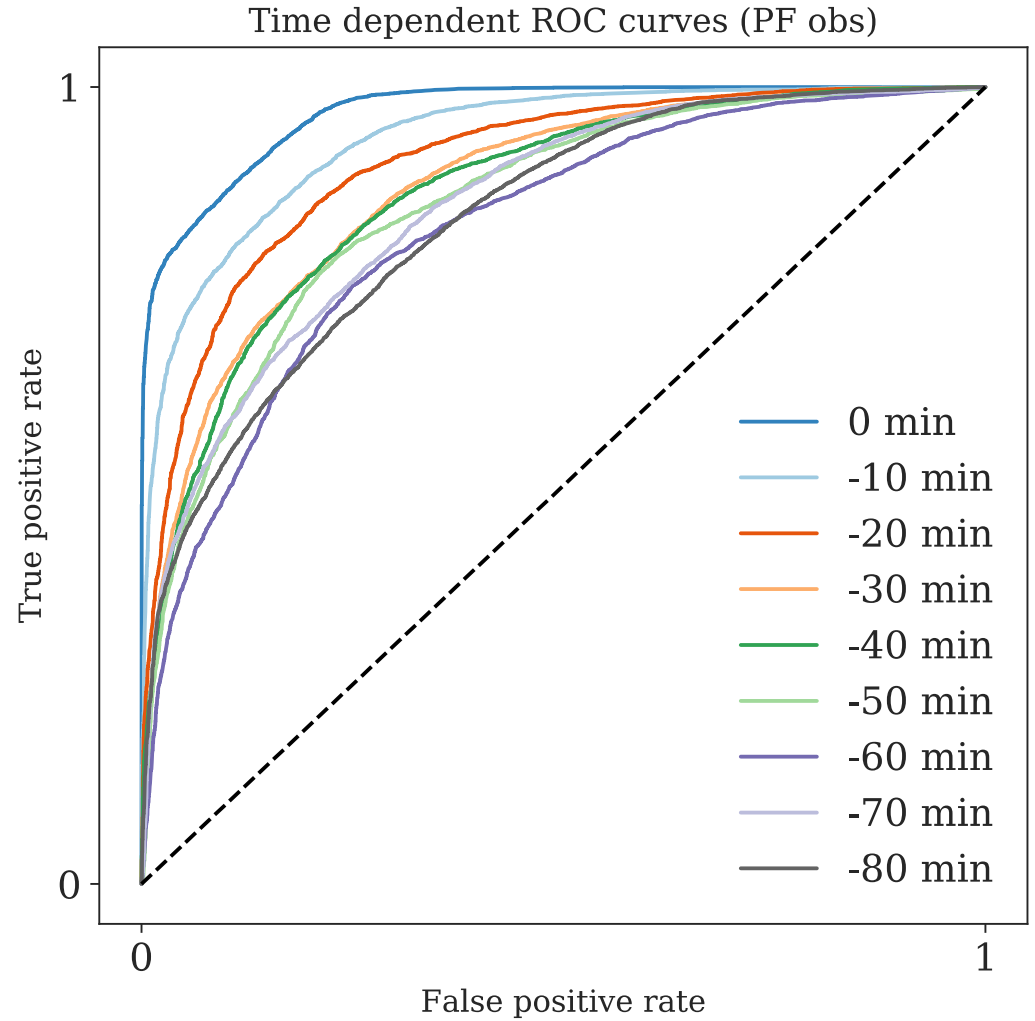

2014-09-10T16:47:42.650
temporal analysis
spatial analysis
0''
10''
20''
30''
40''
50''
60''
70''
80''
0
200
400
600
pixels


Space dependent ROC curves (PF obs)
True positive rate
False positive rate
0
1
0 arcsec
10 arcsec
20 arcsec
30 arcsec
40 arcsec
50 arcsec
60 arcsec
70 arcsec
80 arcsec

Results

C3


2014-09-10T16:47:42.650
temporal analysis
spatial analysis
0''
10''
20''
30''
40''
50''
60''
70''
80''
600
400
200
0
0
200
400
600
pixels


Time dependent ROC curves (PF obs)
True positive rate
False positive rate
1
0
0
1
0 min
-10 min
-20 min
-30 min
-40 min
-50 min
-60 min
-70 min
-80 min

Conclusions

- Specific solar regions produce distinct spectra
- This distinction can be leveraged by NNs to develop models that can be used as rudimentary tools for flare prediction
- Therefore, spectral data should be considered as an additional source of information alongside HMI magnetograms

Resources for solar physics and Machine learning

1. Monica Bobra and James Mason, interactive book, http://helioml
2. Cèdric Huwyer , IRISreader, https://github.com/i4Ds/IRISreader