SNIascore

Deep learning binary classification
of low-resolution SEDM spectra

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Table 1
Data Summary

Class	All	Training	Validation	Testing
SNIa	2619	1526	607	486
NotSNIa	2931	1997	409	525
H-rich CC SN	1285	751	312	222
H-poor CC SN	585	393	94	98
TDE	37	35	0	2
CV	325	284	0	41
Other	699	534	3	162

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Deep learning binary classification
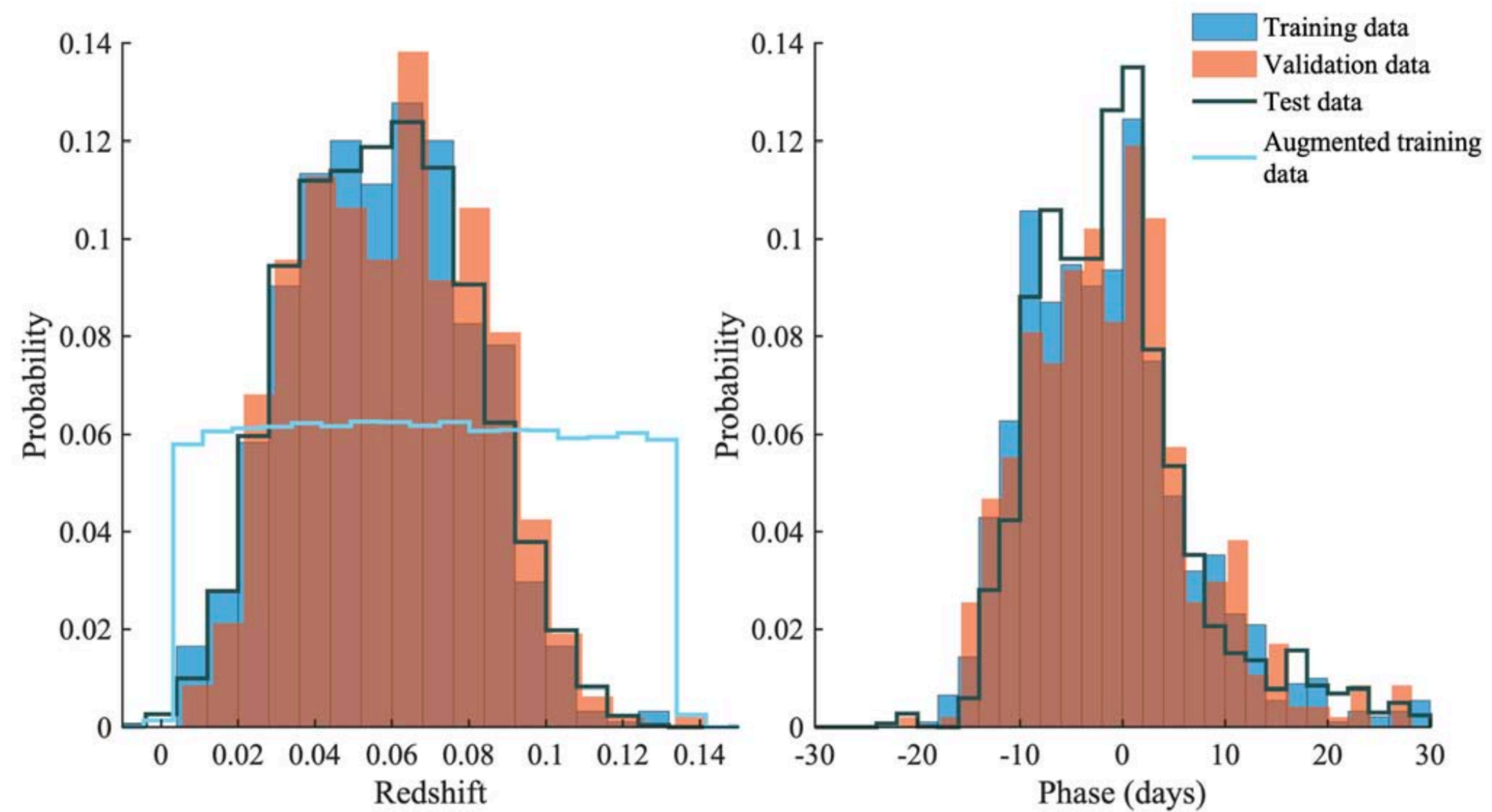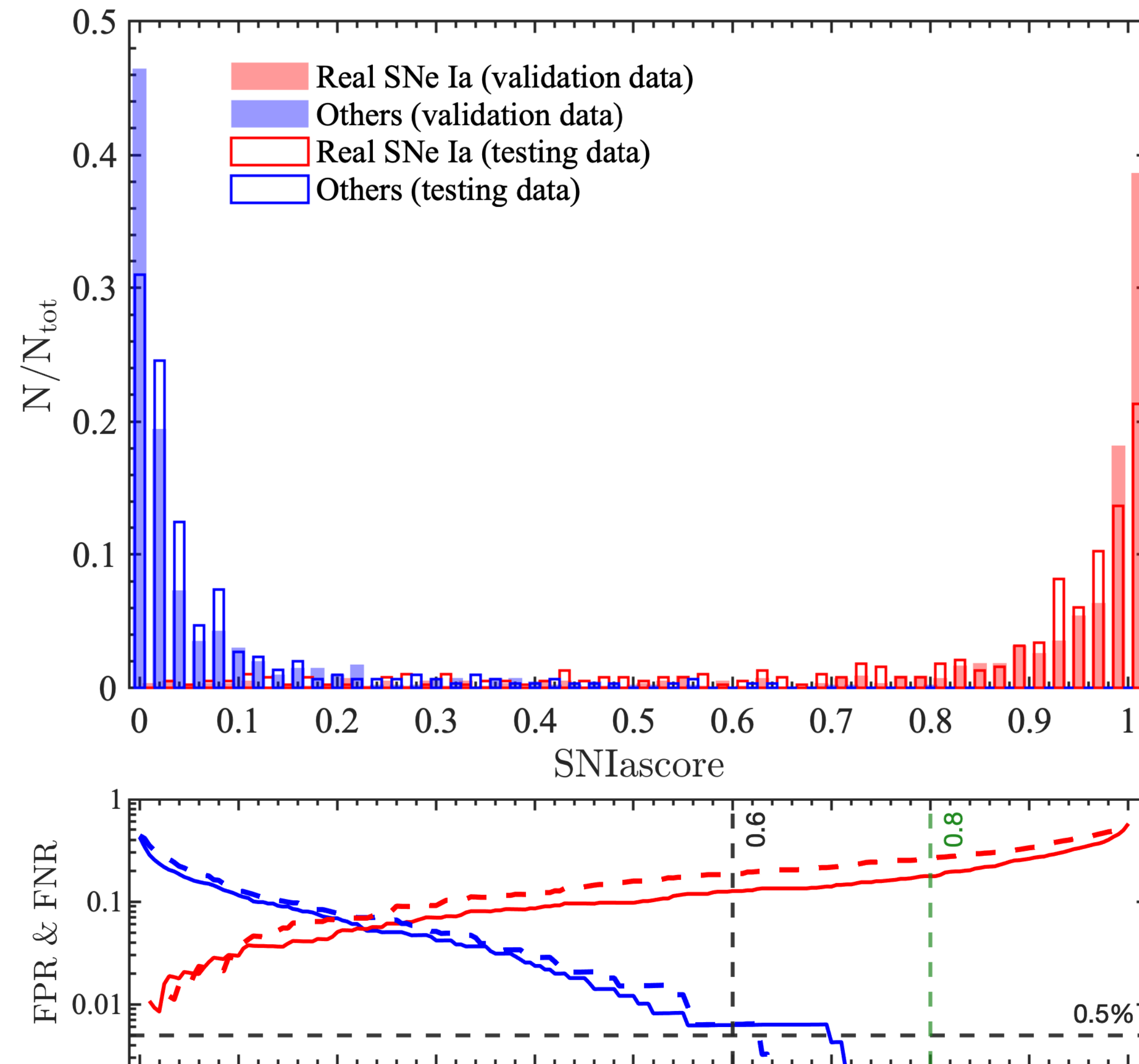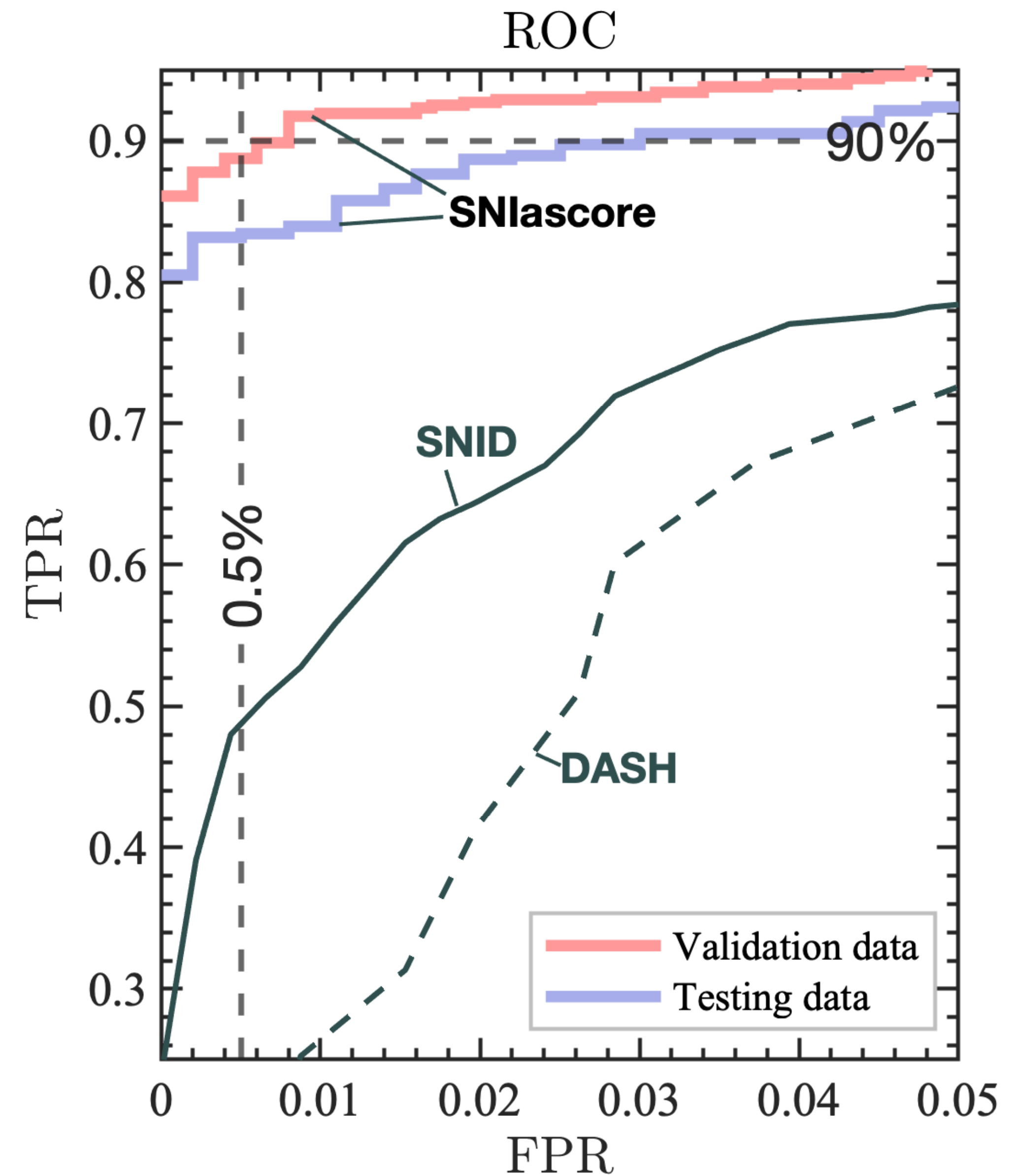of low-resolution SEDM spectra

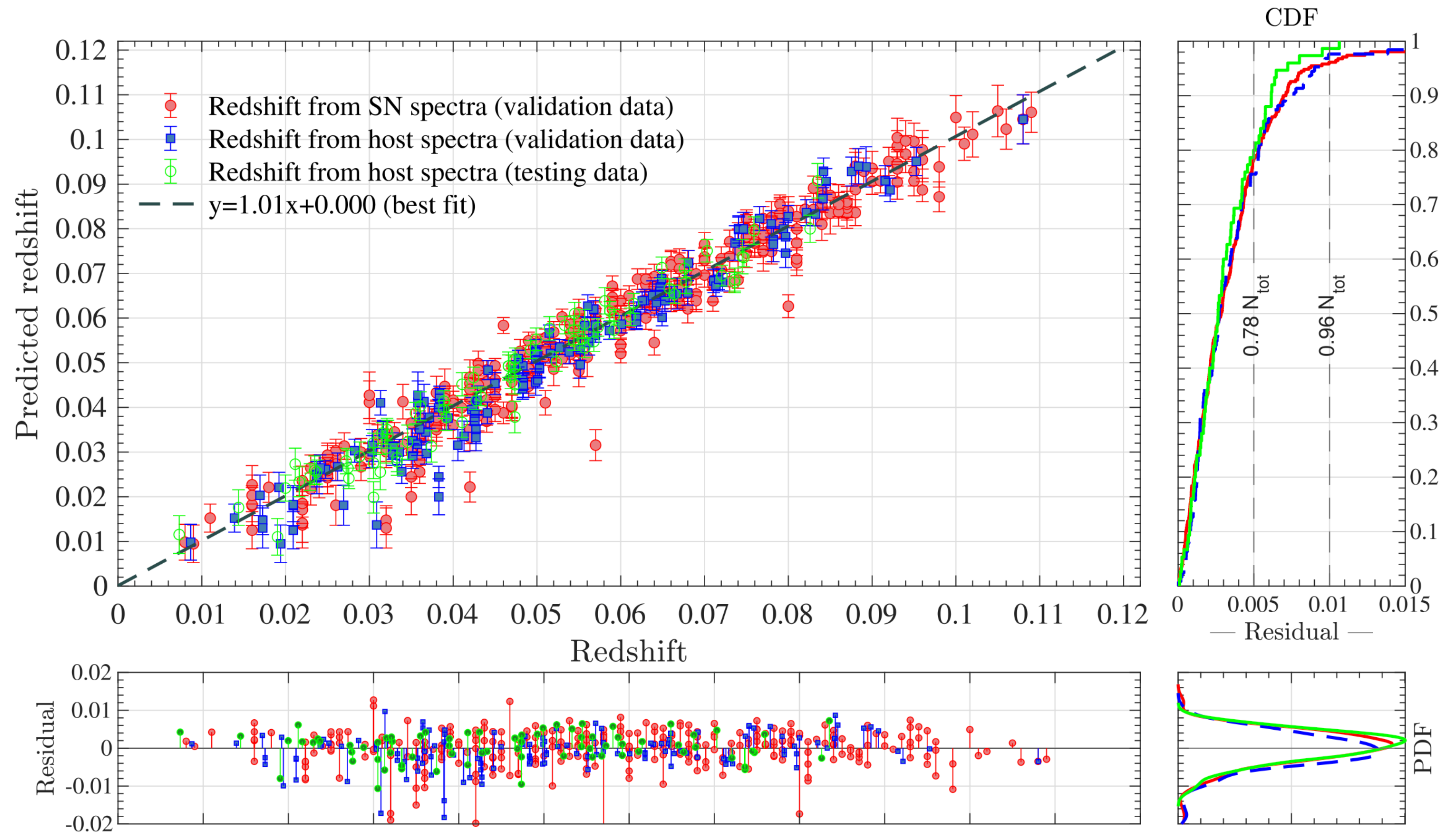**RNN** architecture with
high dropout

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RNN architecture with
high dropout

< 1 % False positives while
classifying >80% of all SEDM
SN Ia spectra automatically

ROC curve figure showing TPR vs FPR with SNIascore, SNID, and DASH curves; dashed lines at 0.5% and 90%; legend: Validation data, Testing data.

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Redshift regression at least as good as SNID in the range z=0.01 to 0.11

Legend:
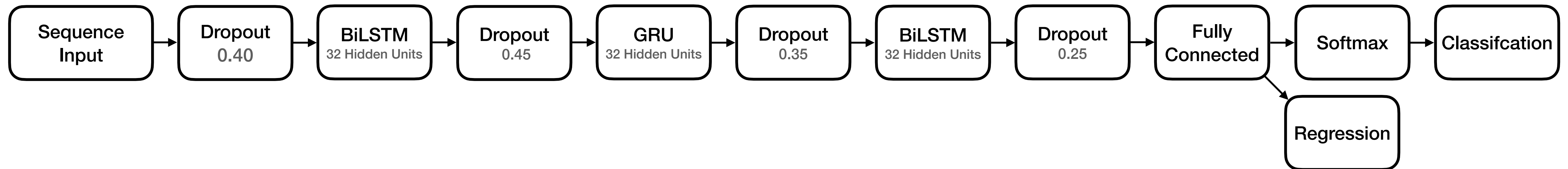- Redshift from SN spectra (validation data)
- Redshift from host spectra (validation data)
- Redshift from host spectra (testing data)
- $y=1.01x+0.000$ (best fit)

Axes: Predicted redshift vs Redshift. CDF panel with $0.78\,N_{tot}$ and $0.96\,N_{tot}$. Residual and PDF panels.
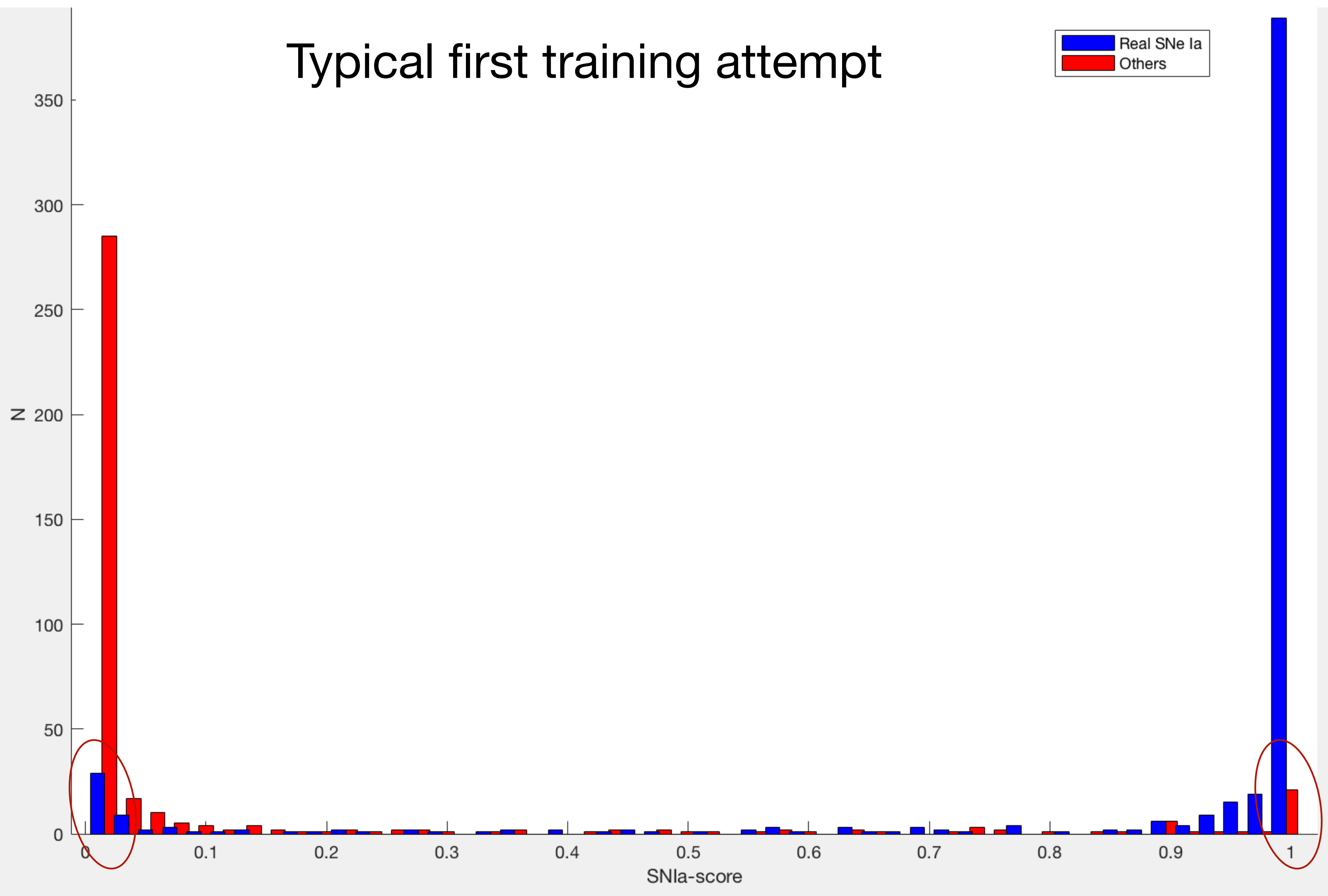
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Typical first training attempt

Optimized network

Real SNe Ia (validation data)
Others (validation data)
Real SNe Ia (testing data)
Others (testing data)
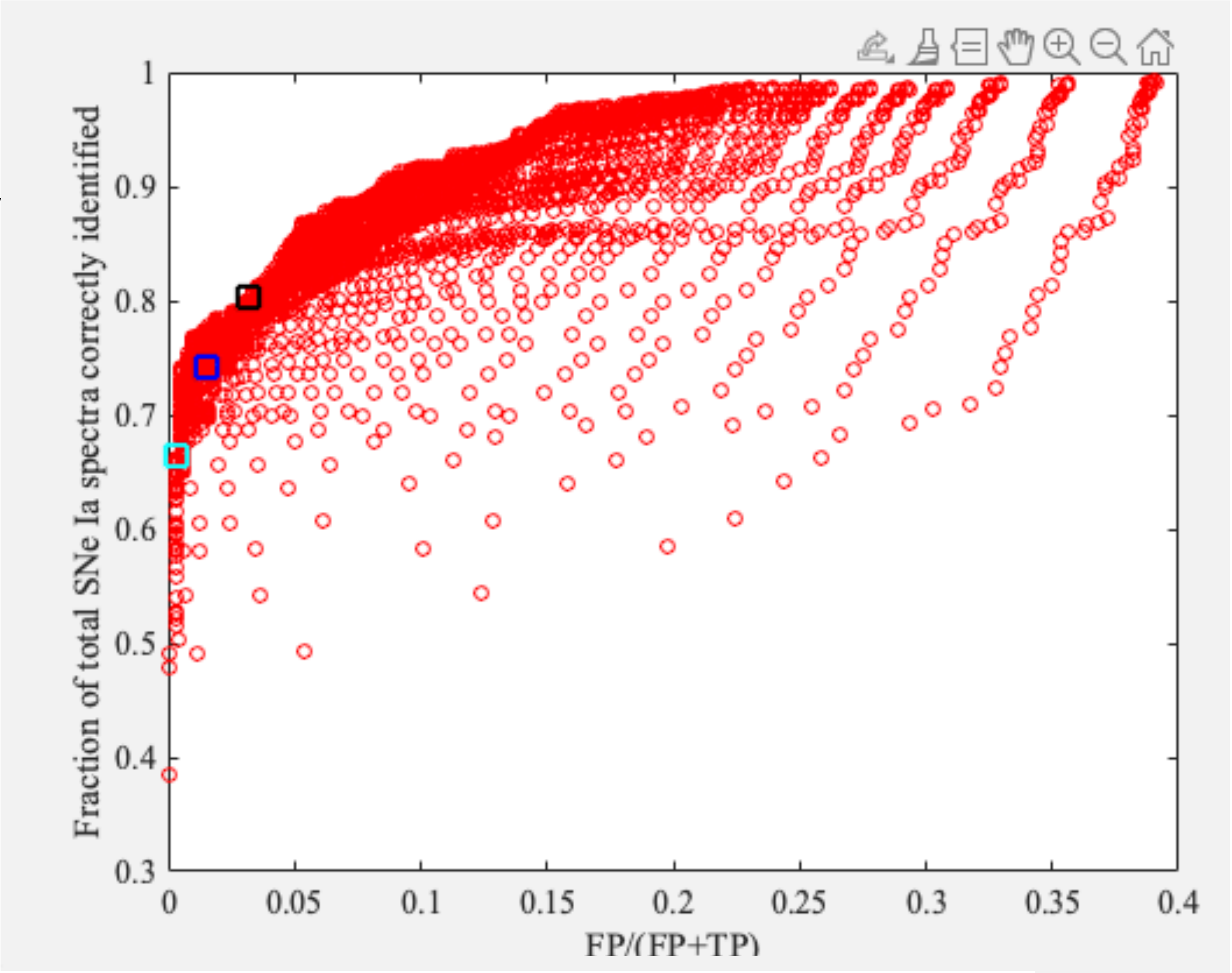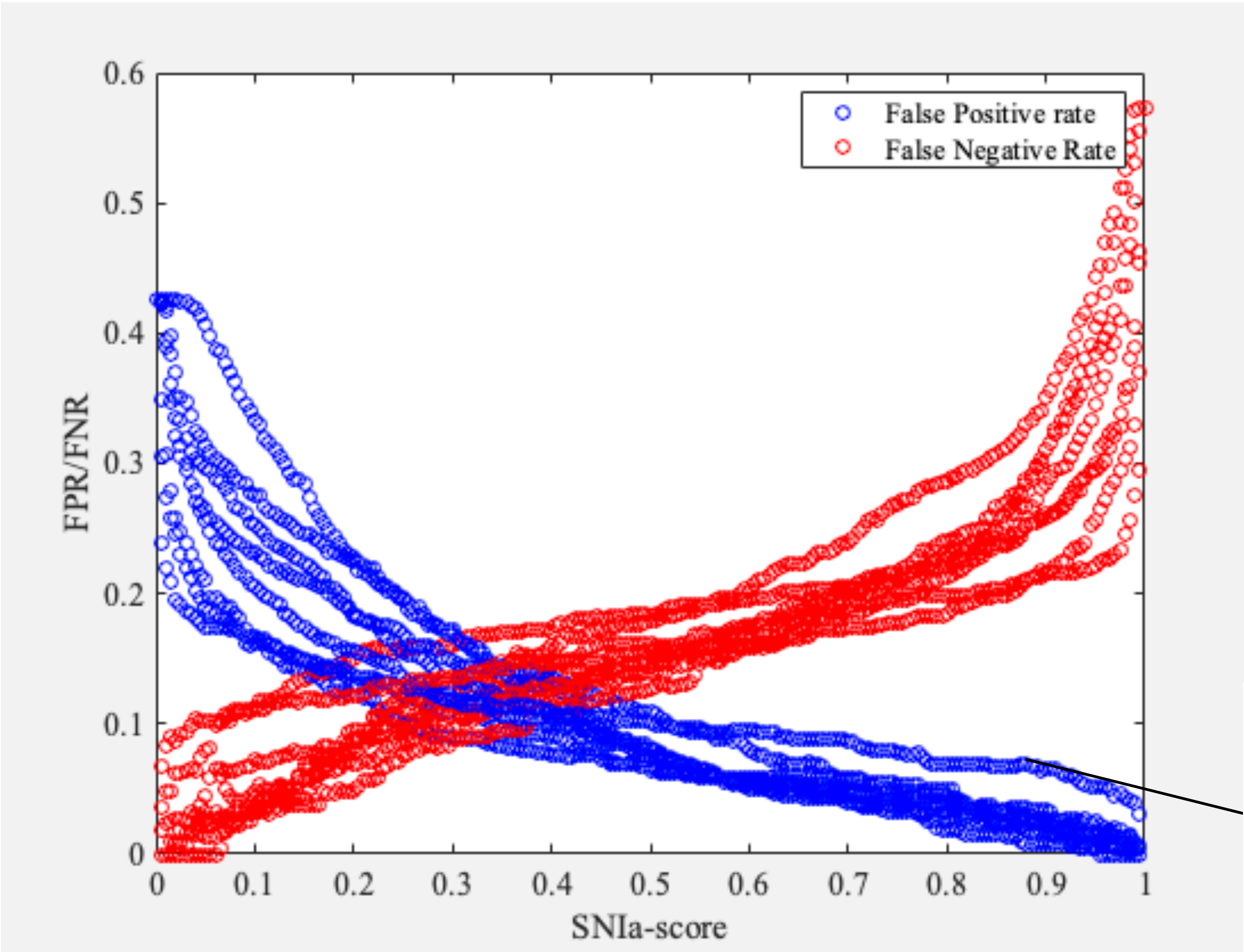
Metrics:

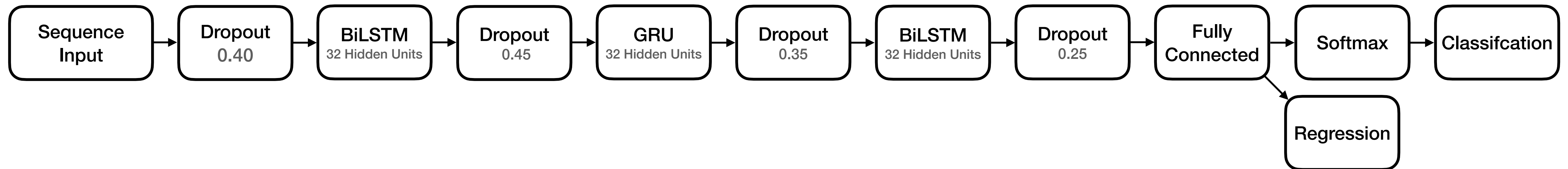Recovery at 1.5 % FPR, Minimum FPR at > 50% recovery, FPR at 80% recovery

Use statistics on many training epochs not just the final epoch for a fixed training length, or stop training when goals are reached
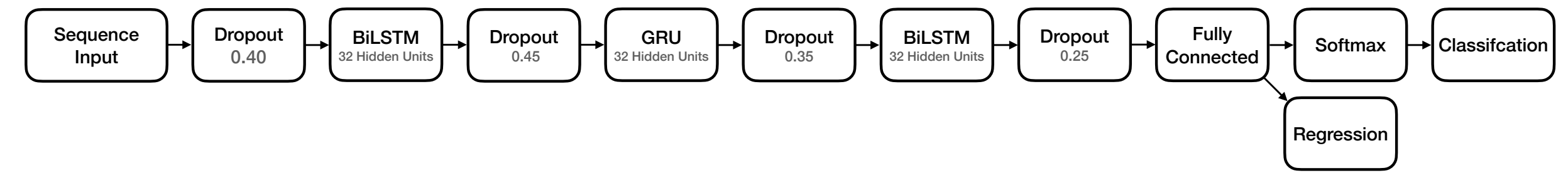
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| Sequence Input | → | Dropout 0.40 | BiLSTM 32 Hidden Units | → | Dropout 0.45 | GRU 32 Hidden Units | → | Dropout 0.35 | BiLSTM 32 Hidden Units | → | Dropout 0.25 | Fully Connected | → | Softmax | → | Classifcation |

Regression

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Sequence Input → Dropout 0.40 → BiLSTM 32 Hidden Units → Dropout 0.45 → GRU 32 Hidden Units → Dropout 0.35 → BiLSTM 32 Hidden Units → Dropout 0.25 → Fully Connected → Softmax → Classifcation / Regression

Matlab RNN and Python CNN (thanks to M. Coughlin) example SNIascore code:

https://sites.astro.caltech.edu/~cfremling/SNIascore/

Regression for phase of SN Ia spectra up for grabs! (but somewhat more challenging)