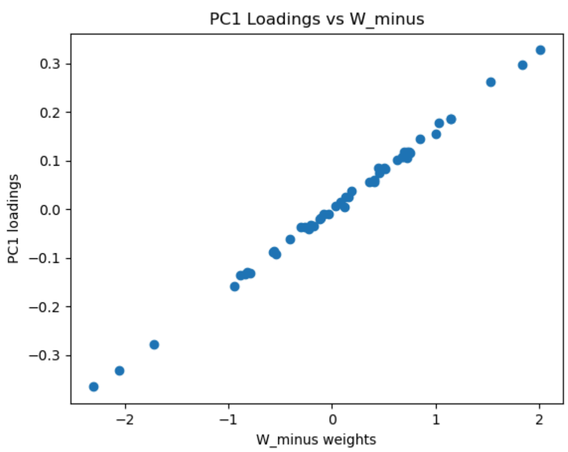
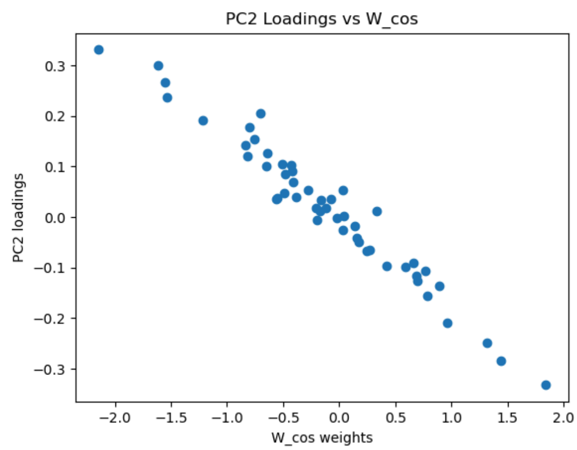
Tutorial 9.1

Part 1

Step d:

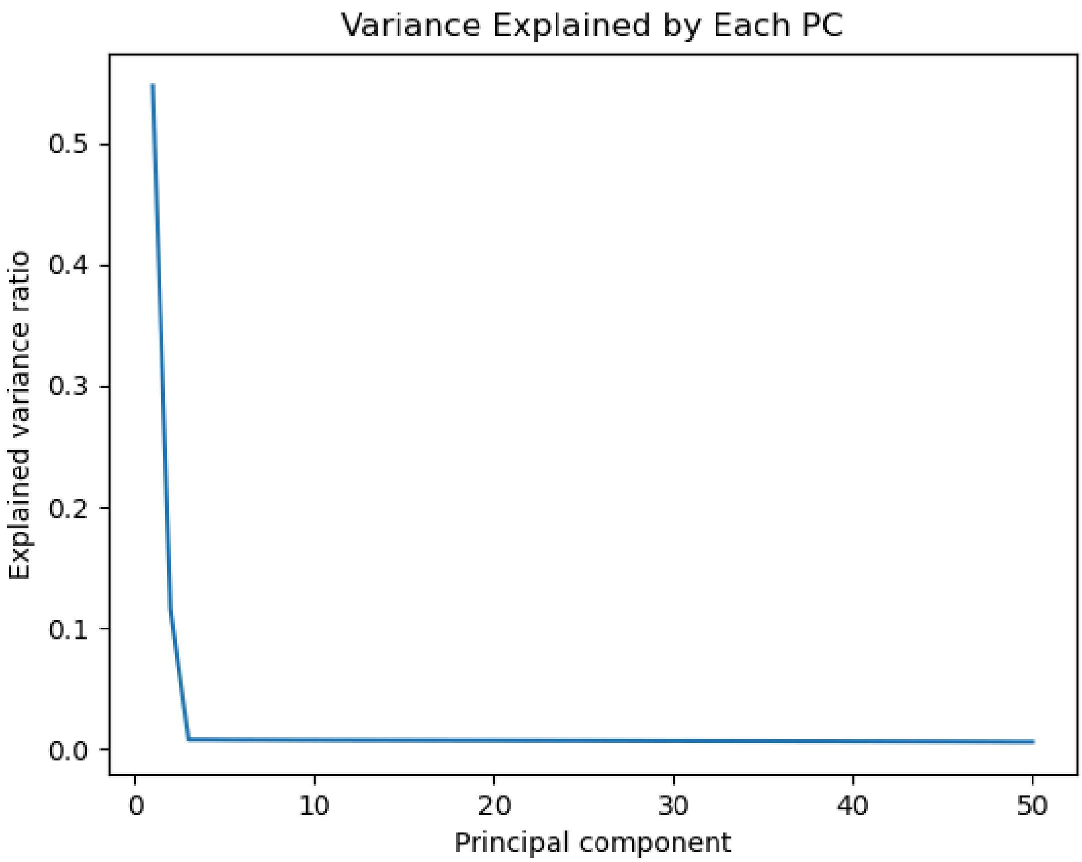
Columns of COEFF against input weights, have roughly linear relationship
The first column of COEFF has a denser distribution than the second column.w
two plots always have opposite slope signs.





Step e

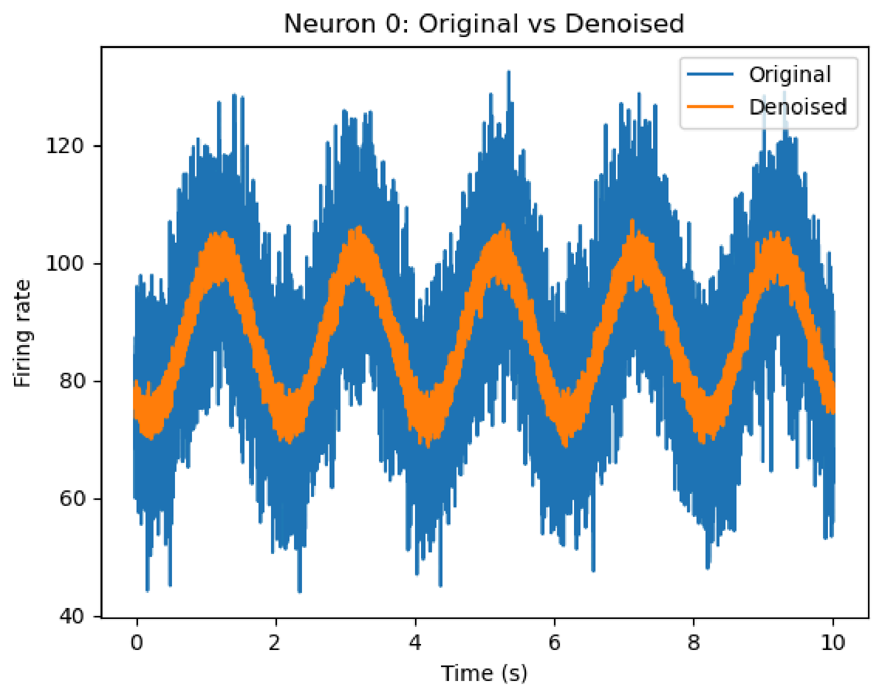
PC 1 accounts for almost all of the variance (→ ~95 %+),
because the ramp runs continuously and dominates the firing rates.
PC 2 explains only (< 5 %), just enough to capture the one-second transient
higher PCs account for negligible, mostly noise variance.

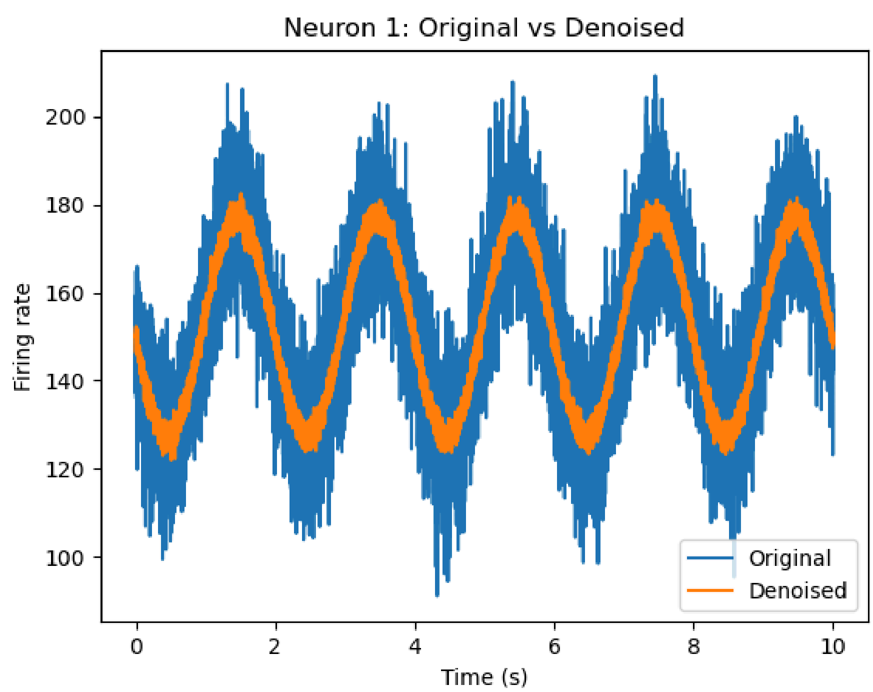


Step G

Compare the behavior of the denoised data with the original data

For two example neurons, the denoised traces (reconstructing only PCs 1–2) retain the smooth ramp plus the transient bump while discarding the high-frequency noise. This shows that those two components suffice to reconstruct the core dynamics.

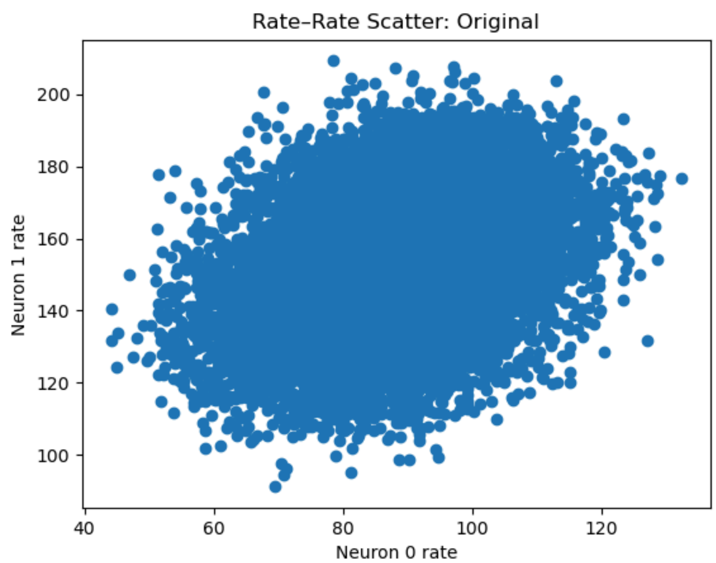


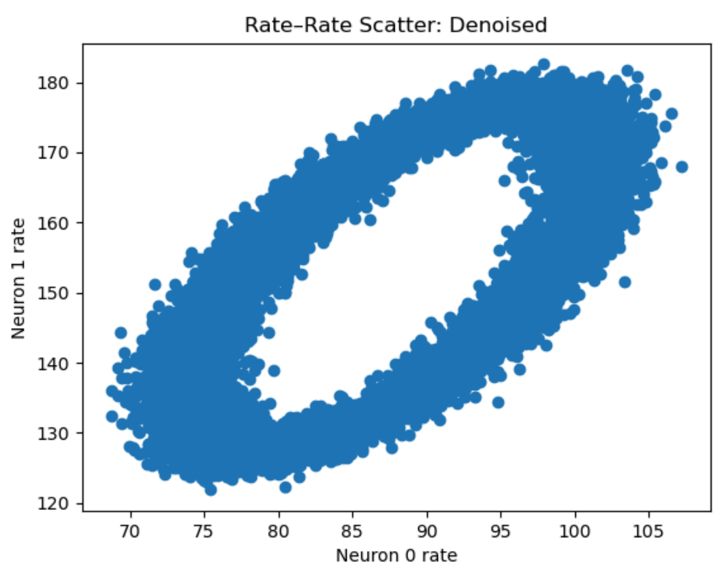


Step h

Plots of Rate of a Neuron to another: Original and Denoised

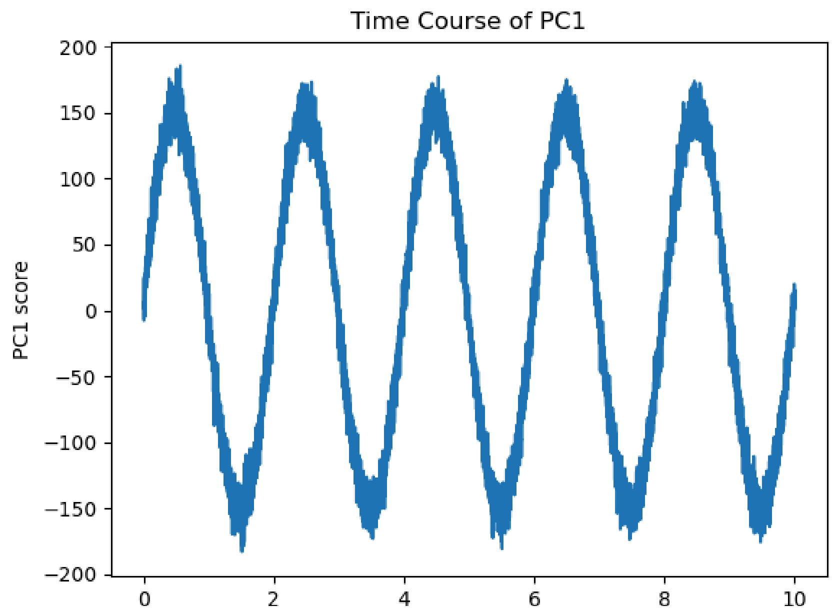
Before denoising, the scatter of neuron 0 vs. neuron 1 rates is a broad, fuzzy cloud,
After denoising, the points collapse onto a much tighter ellipse

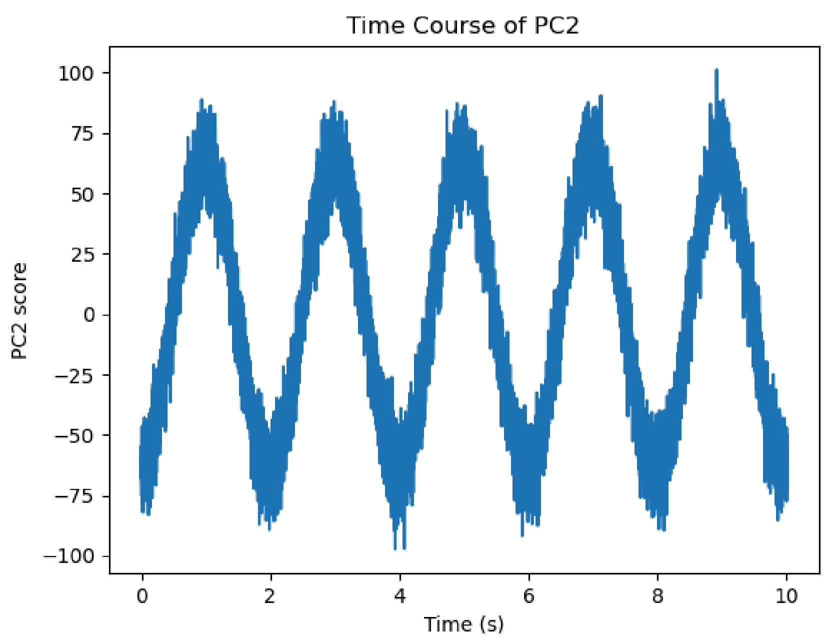




Step i

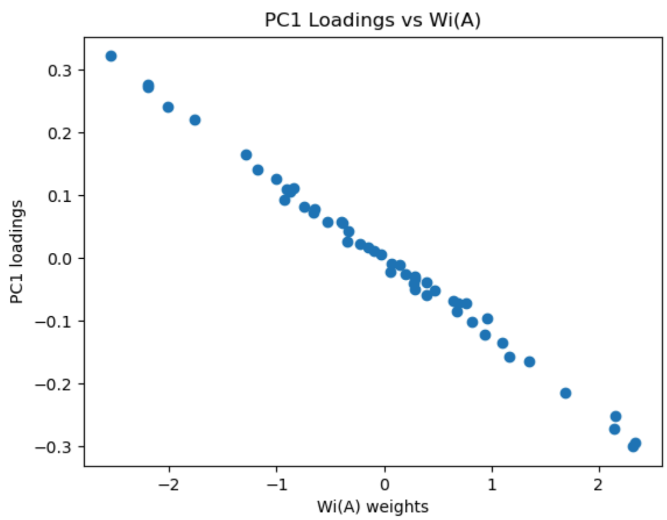
Plots of matrix SCORE
Both traces oscillate at around 0.5 Hz, PC 1 has a larger amplitude.
PC 1 isolates the sine input (larger amplitude, zero-cross at t=0).
PC 2 isolates the cosine input (90° phase shift, smaller amplitude).
Together they recover the two underlying oscillatory drives from the noisy population data.

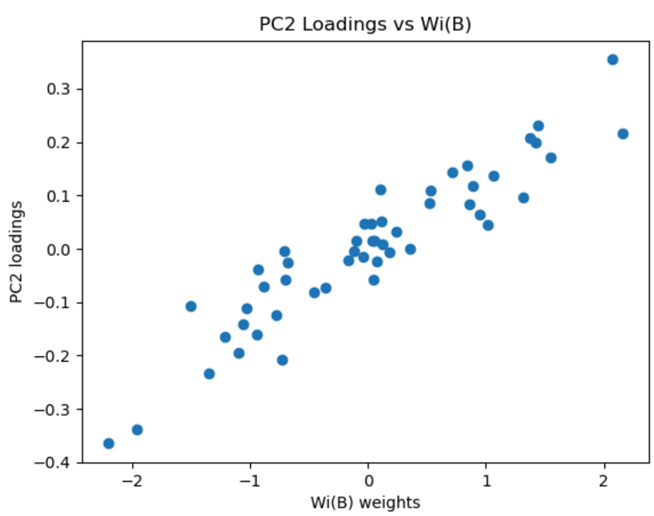




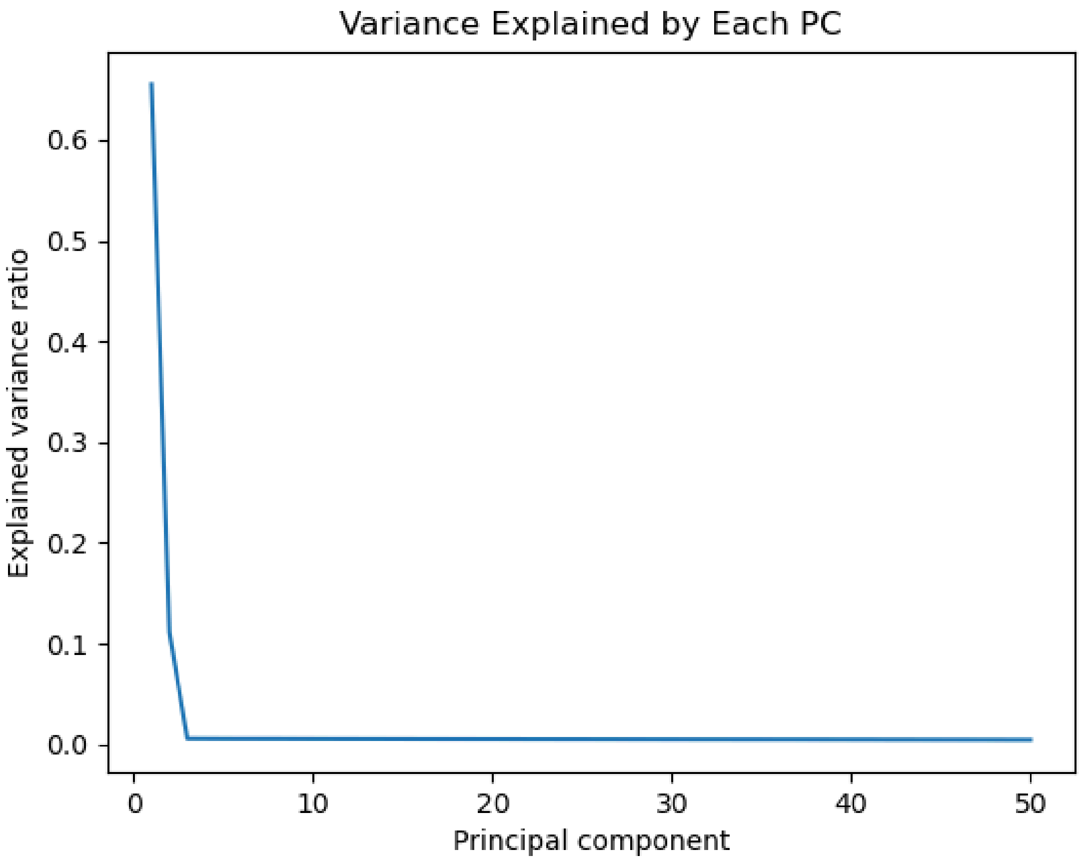
Part 2

f_A = 1 Hz, f_B = 0.5 Hz
In PC1, the tight negative slope shows that neurons with stronger (more positive) sine weights load more strongly
Input weights Wcos have larger PC 2 loadings. That confirms PC 2 is the cosine component.
Columns of COEFF against input weights,

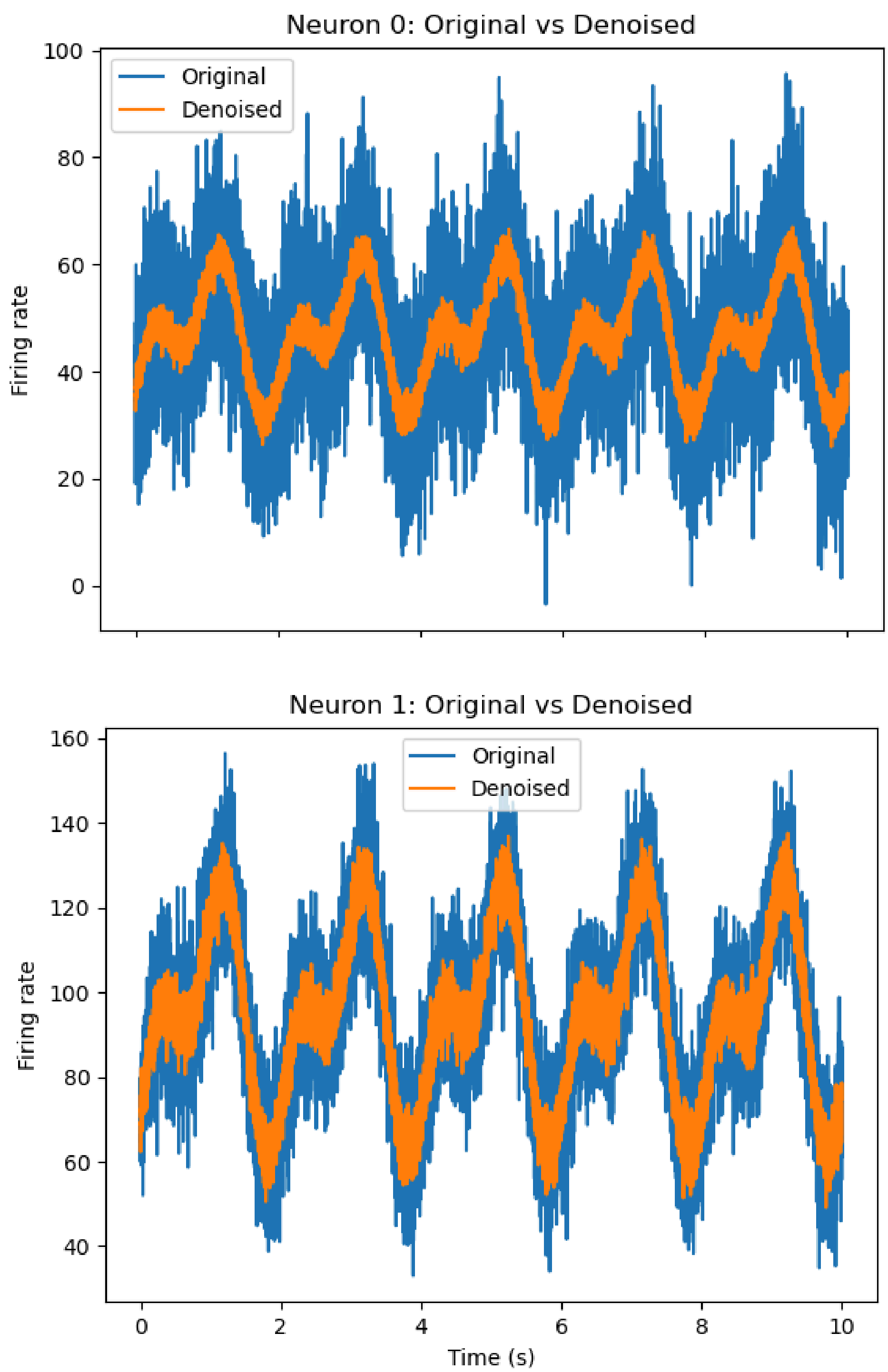




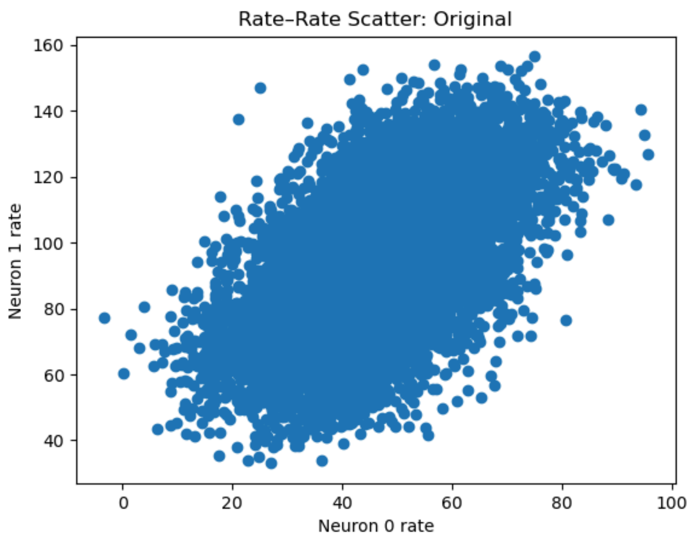
Step e
Same pattern as part 1.
PC 1 captures ~60% of the total variance (the dominant sine oscillation), PC 2 about ~10%
EXPLAINED



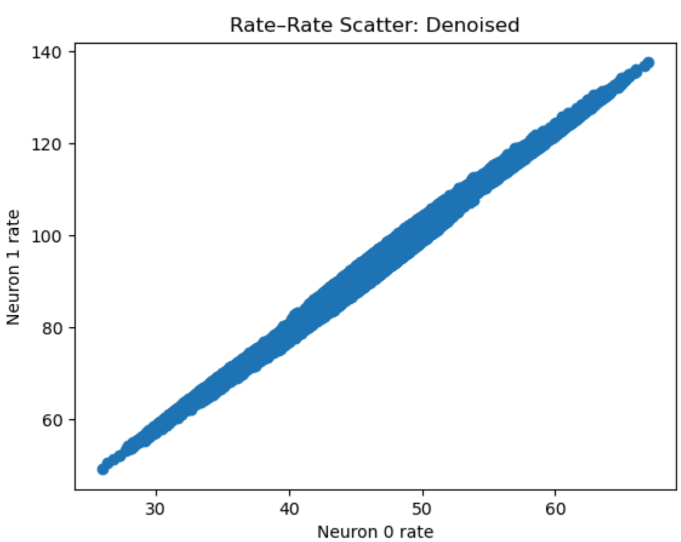
Step G
Similar as part 1
The effect of denoise differs in neurons.



Step h
Plotting neuron 0's rate versus neuron 1's produces a diffuse blob—noise makes their relationship look messy, even though they share the same two driving oscillations.
In plot 2 noise is removed. The rate-rate scatter is a more narrow ellipse.



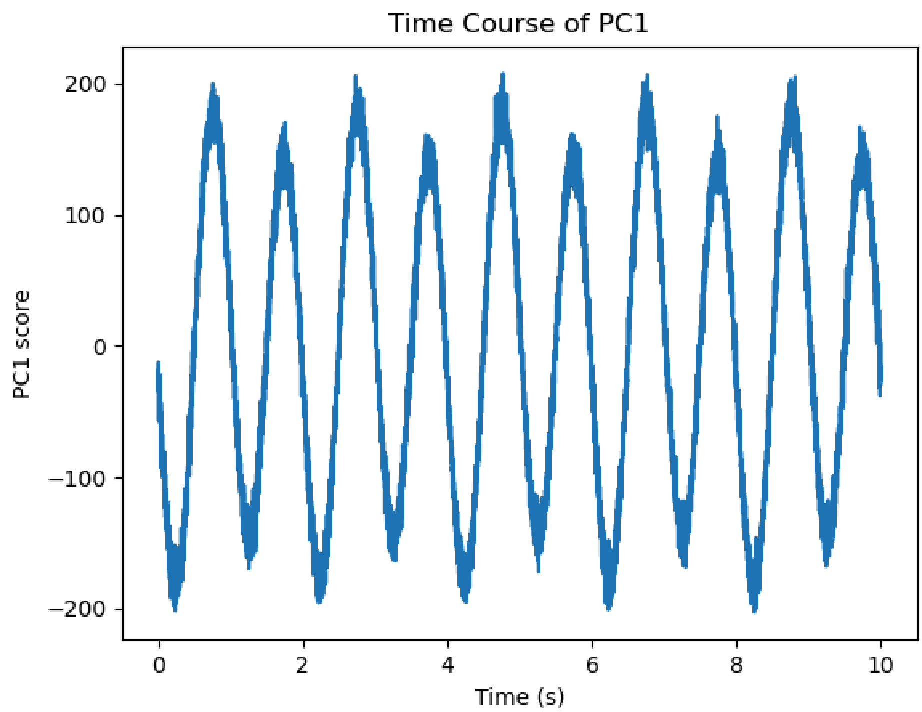
Plots of Rate of a Neuron to another: Original and Denoised

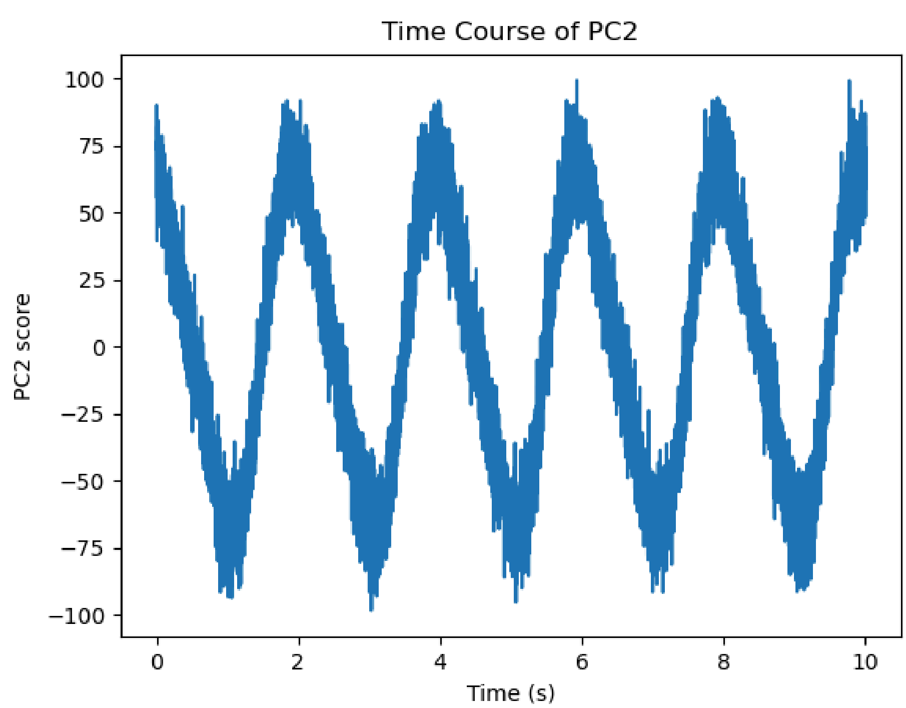


Step i

PC1 oscillates a time quicker than PC2. PC2 shifts by 90 degrees.

Plots of matrix SCORE





Part 3

PC 2 has zeroed in on the brief 4–5 s sine pulse.

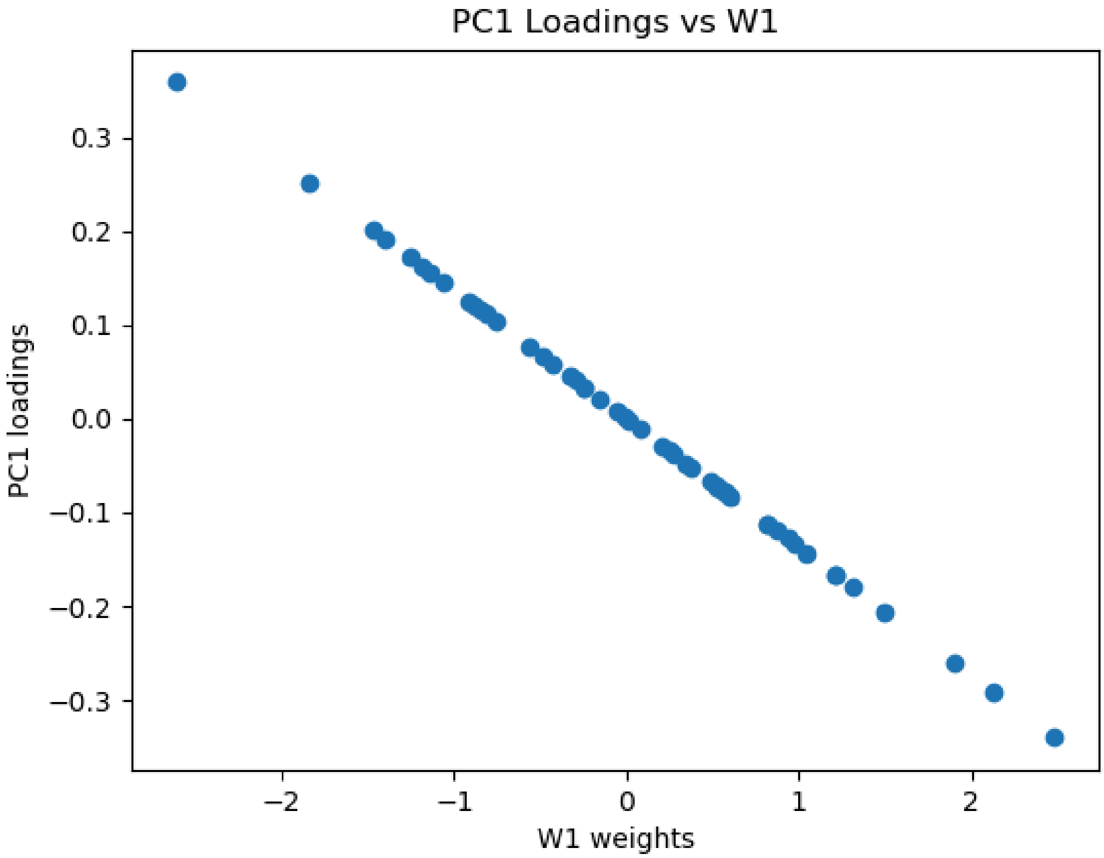
Variance explained has a similar pattern to before.

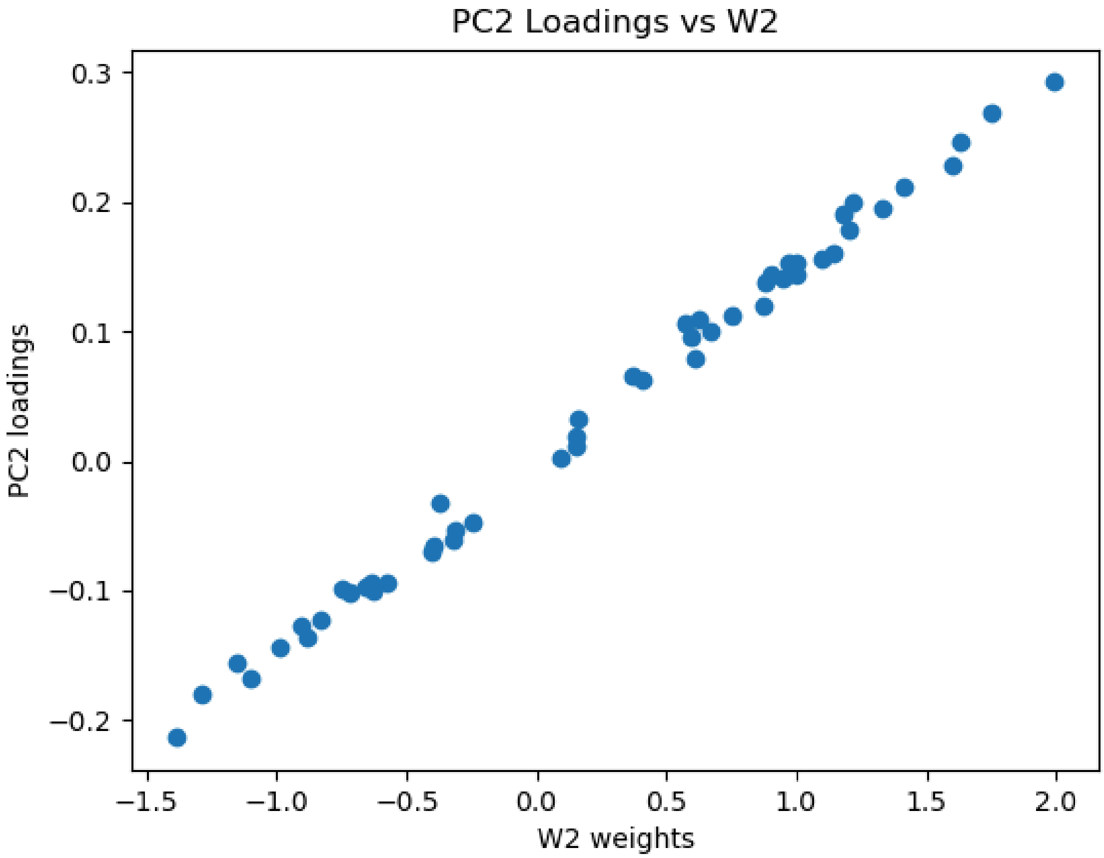
PC time courses
PC 1 climbs linearly over the full 0–10 s window, mirroring I1

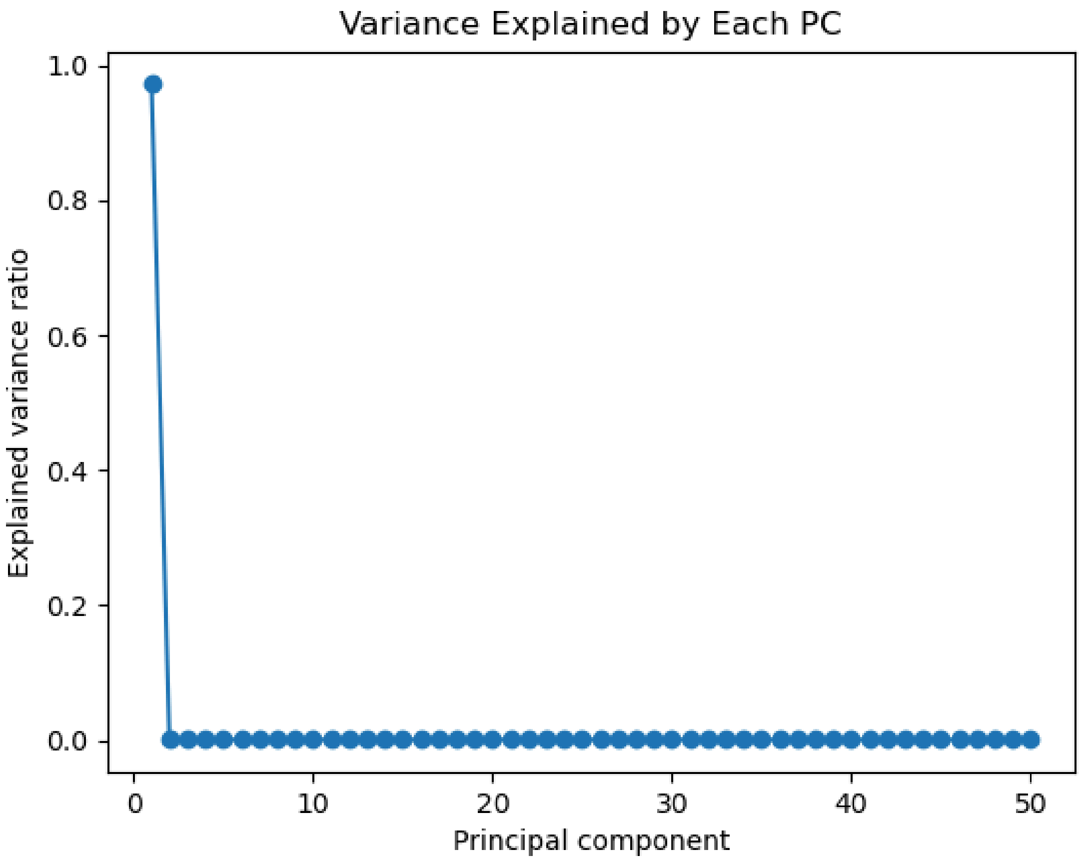
PC 2 stays near zero except for a pronounced bump exactly during the 4–5 s window, matching the brief sine burst in I2.

Original vs. denoised firing-rate traces
For two example neurons, the denoised traces (reconstructing only PCs 1–2) retain the smooth ramp plus the transient bump while discarding the high-frequency noise. This shows that those two components suffice to reconstruct the core dynamics.

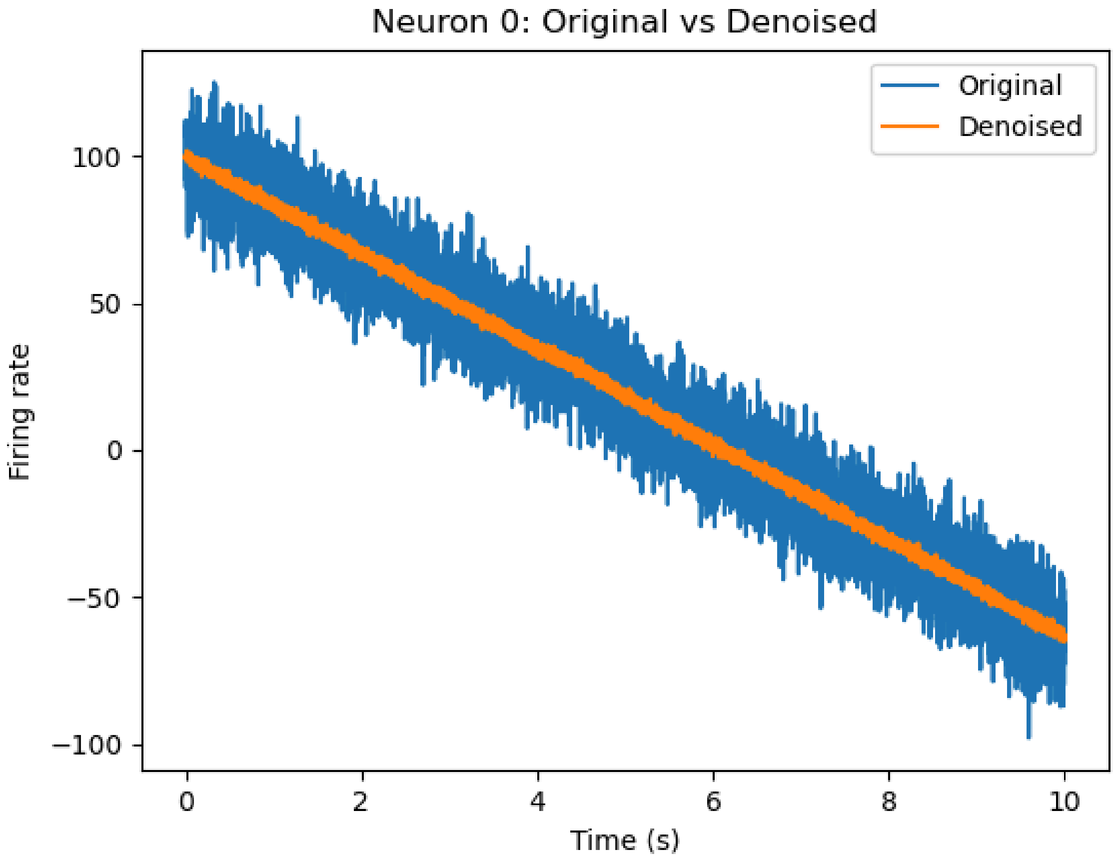
Rate–rate scatter plots
Before denoising, the scatter of neuron 0 vs. neuron 1 rates is a cloud. After denoising, the points collapse onto a much tighter curved band.


PC1 Loadings vs W1
PC1 loadings
W1 weights
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−2
−1
0
1
2

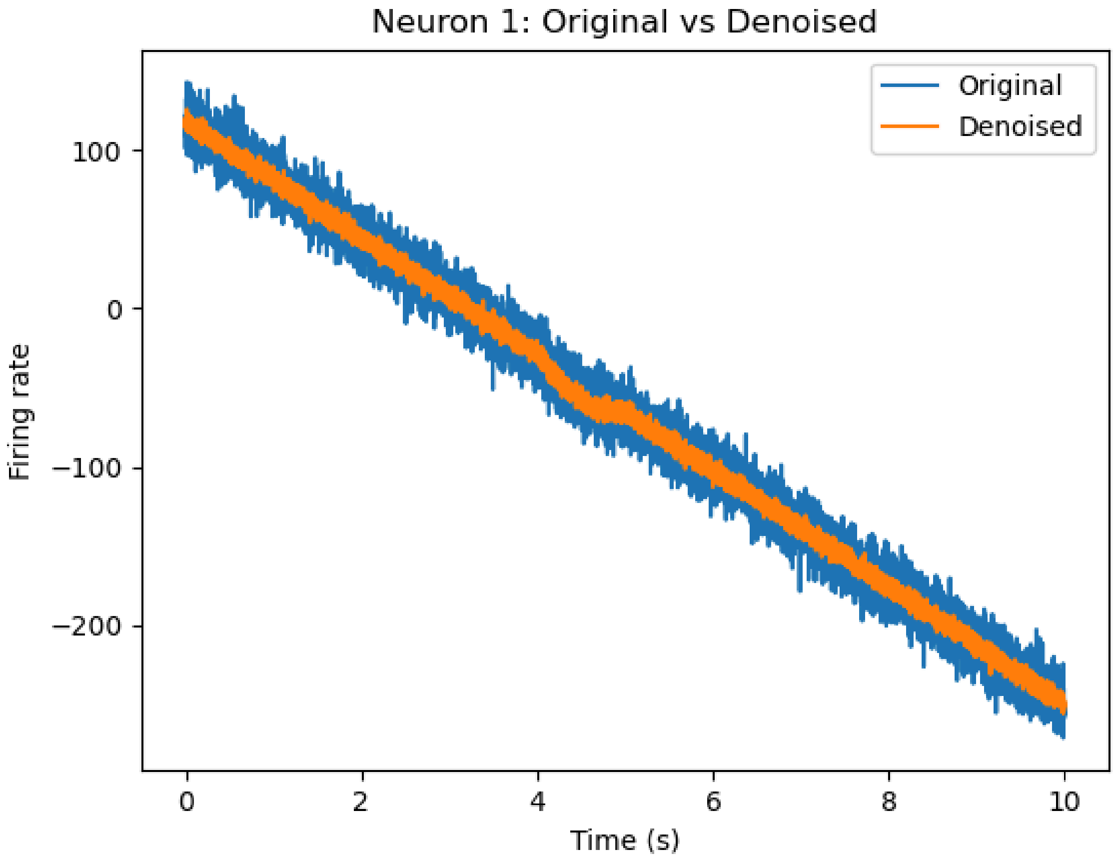

PC2 Loadings vs W2
PC2 loadings
W2 weights
0.3
0.2
0.1
0.0
−0.1
−0.2
−1.5
−1.0
−0.5
0.0
0.5
1.0
1.5
2.0

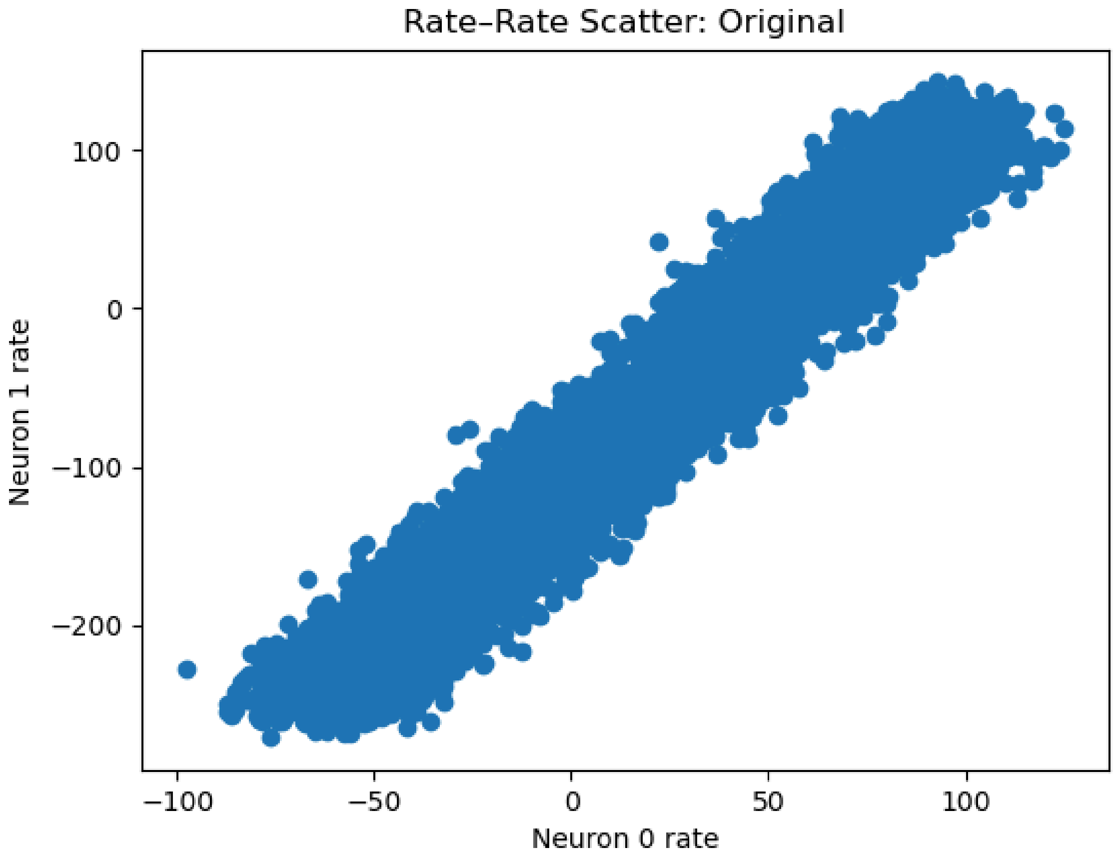


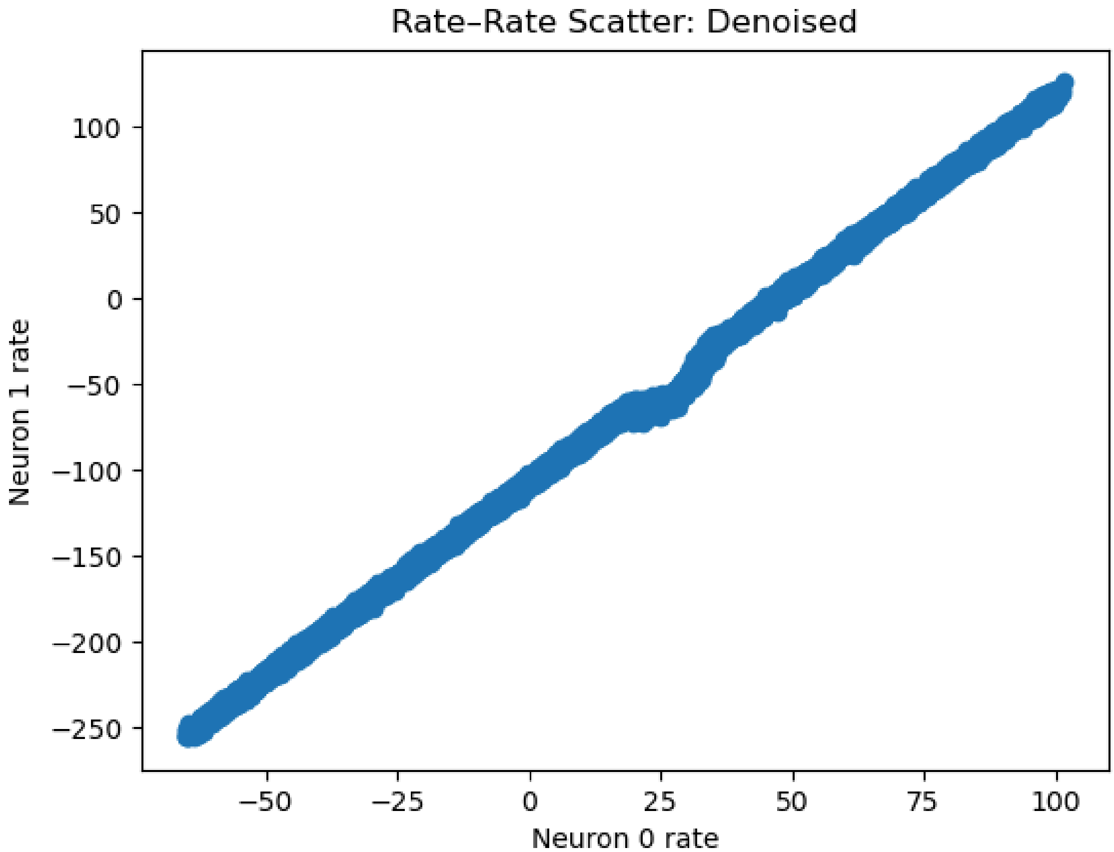
Variance Explained by Each PC
Explained variance ratio
1.0
0.8
0.6
0.4
0.2
0.0
0
10
20
30
40
50
Principal component

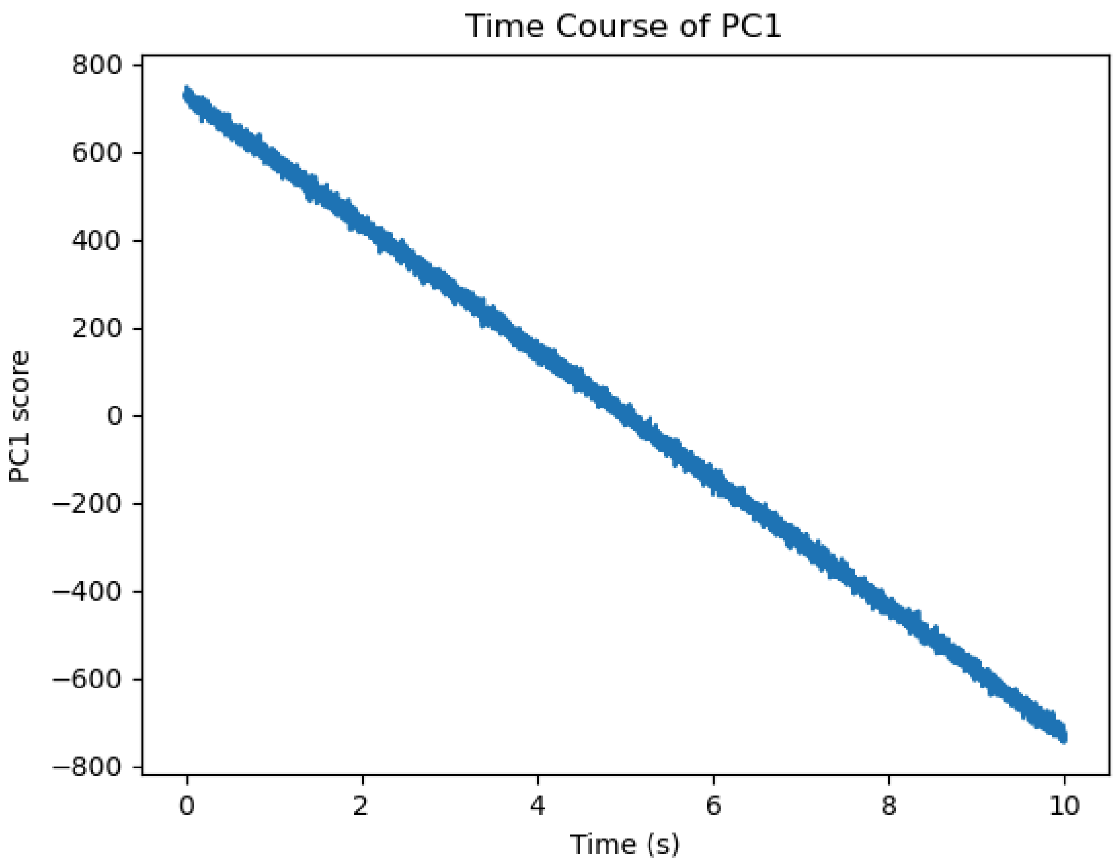


Neuron 0: Original vs Denoised
Original
Denoised
Firing rate
Time (s)
100
50
0
−50
−100
0
2
4
6
8
10

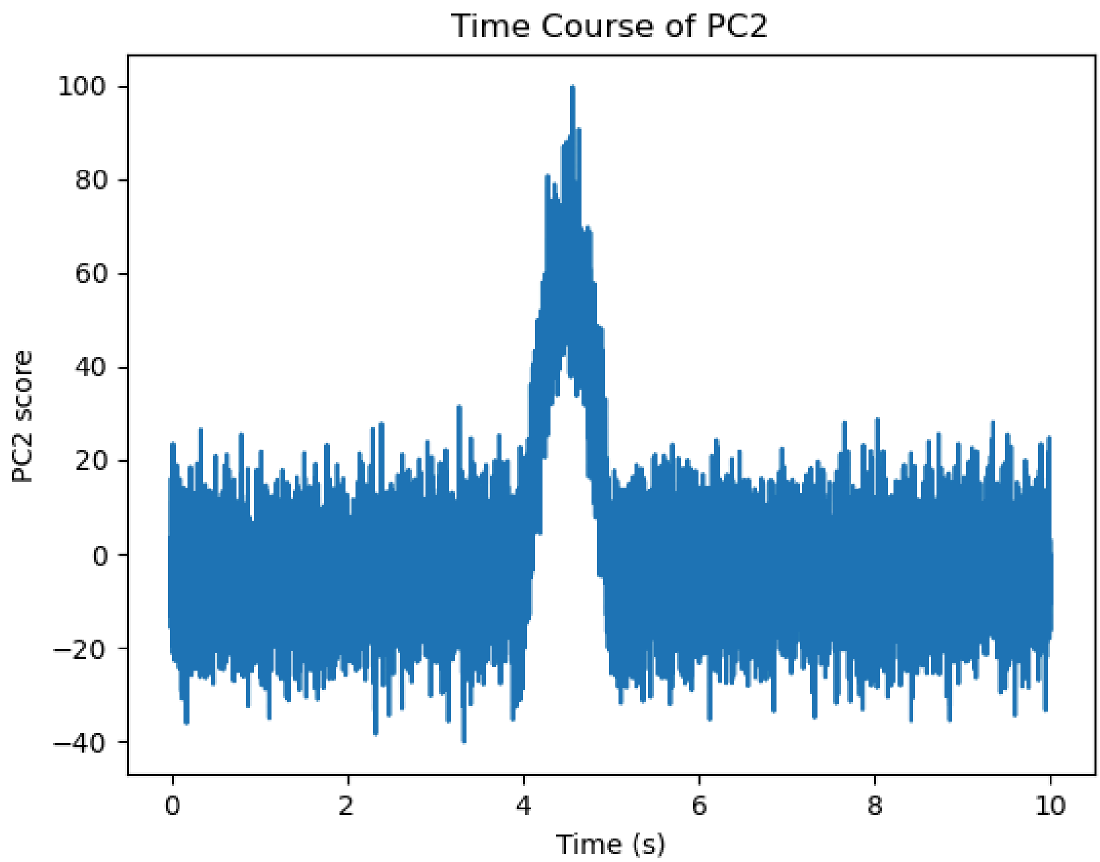

Neuron 1: Original vs Denoised
Original
Denoised
Firing rate
100
0
−100
−200
0
2
4
6
8
10
Time (s)


Rate–Rate Scatter: Original
Neuron 1 rate
Neuron 0 rate
100
0
−100
−200
−100
−50
0
50
100


Rate–Rate Scatter: Denoised
Neuron 1 rate
Neuron 0 rate
100
50
0
−50
−100
−150
−200
−250
−50
−25
0
25
50
75
100



Time Course of PC1
PC1 score
Time (s)
800
600
400
200
0
−200
−400
−600
−800
0
2
4
6
8
10


Time Course of PC2
PC2 score
Time (s)
100
80
60
40
20
0
−20
−40
0
2
4
6
8
10