Spike Sorting for Neural Decoding

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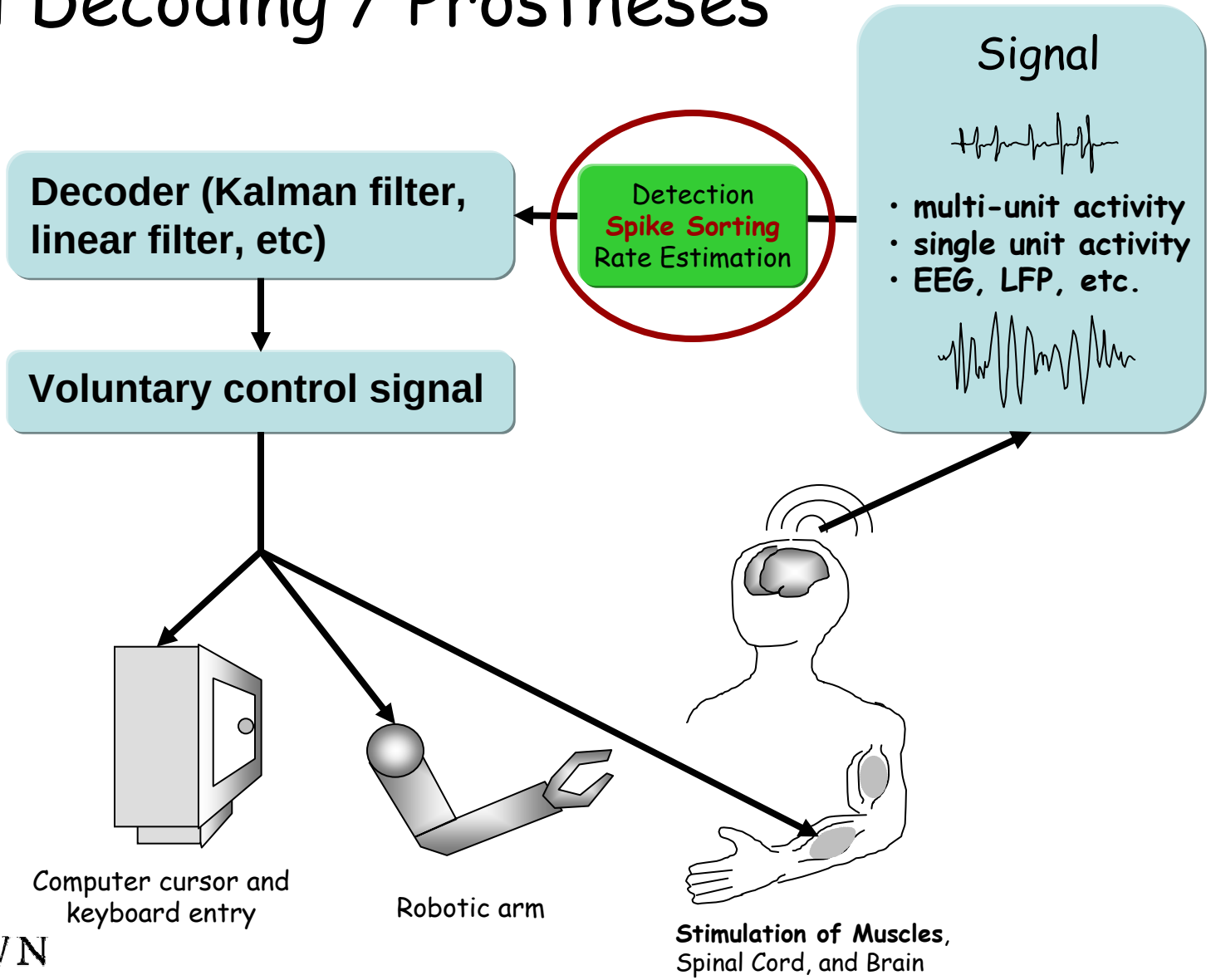
Neural Decoding / Prostheses



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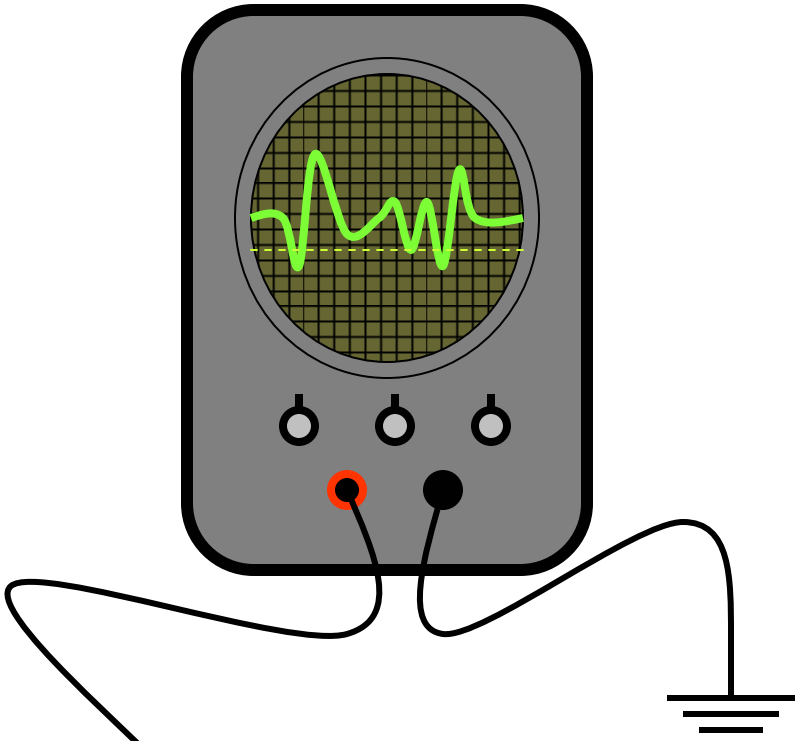
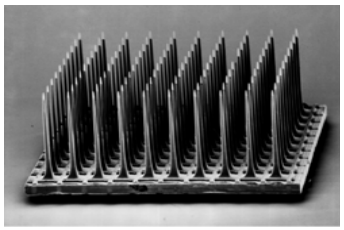
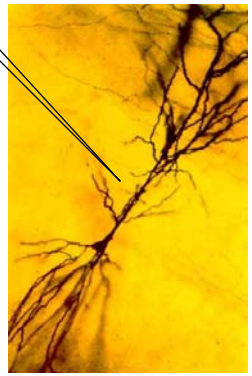
Spike Sorting

- Our definition: waveforms captured at threshold crossings are "sorted" by deciding :
  - which are "spikes"
  - how many neurons there are
  - which neurons each came from.
  - *Not detection!*
- Results from Bionic microelectrode array.







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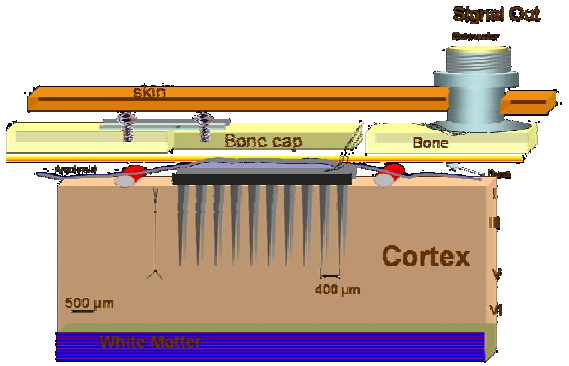
Spike Sorting's dirty little secret.

- Inspired by Harris et al (2000) we conducted a study of spike sorting subjectivity.
  - Real data
    - 5 Expert sorters
    - 20 Representative channels



Subject	A	B	C	D	E
Spikes	99160	50796	150917	77194	202351
Units	28	32	27	18	35

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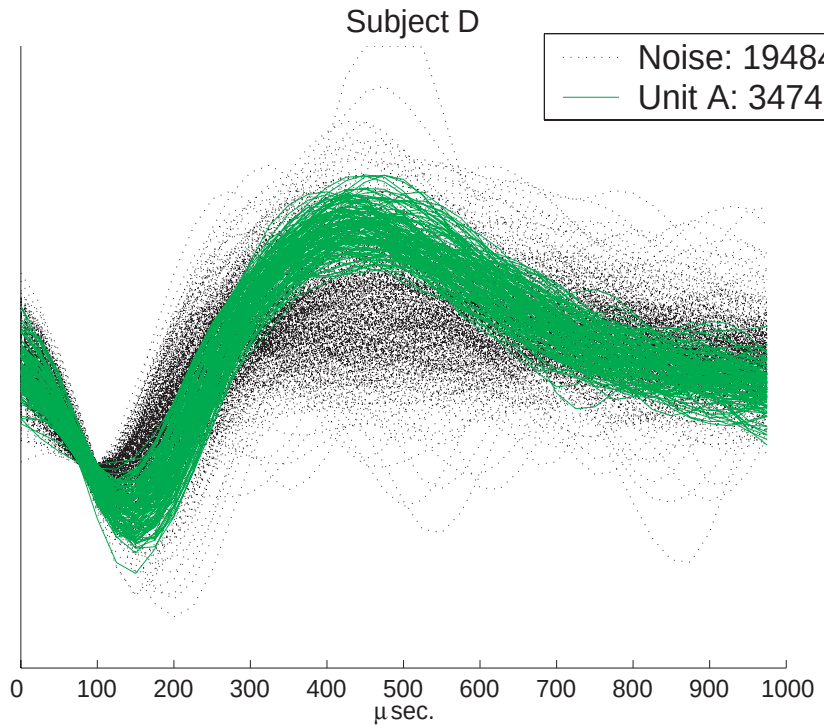
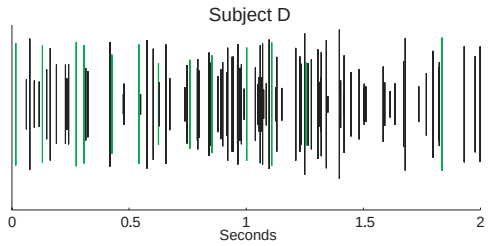
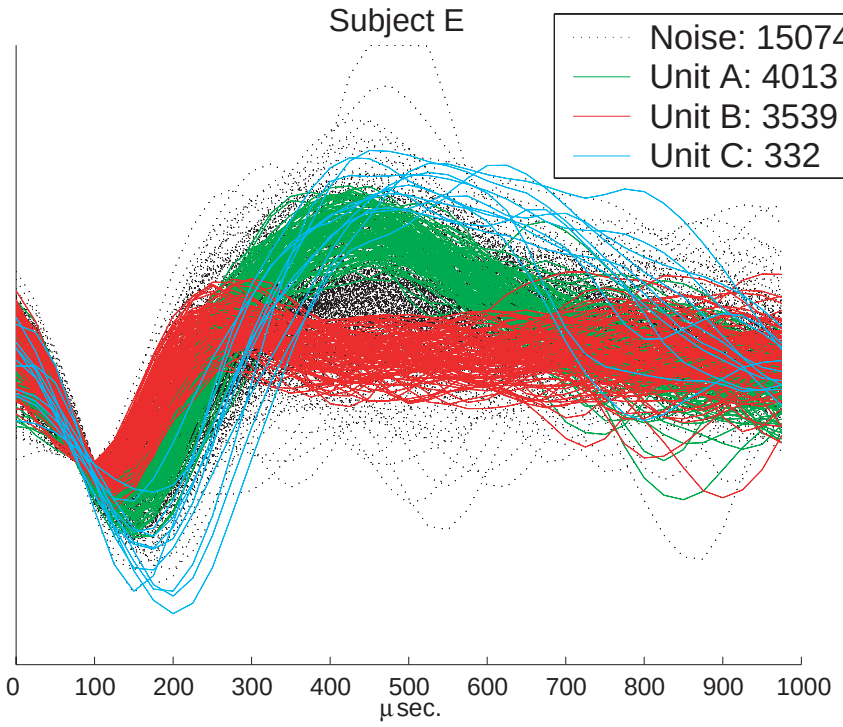
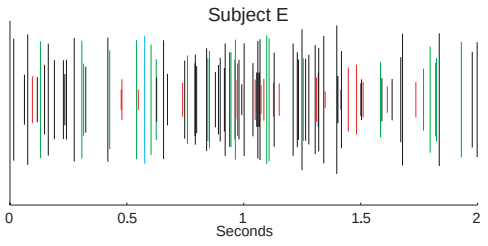
Two people sorting the same channel.









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Our Goal

- Better decoding accuracy by way of improved spike sorting.
- Better spike sorting for neuroscience would be great to achieve as well but is a slightly different goal.

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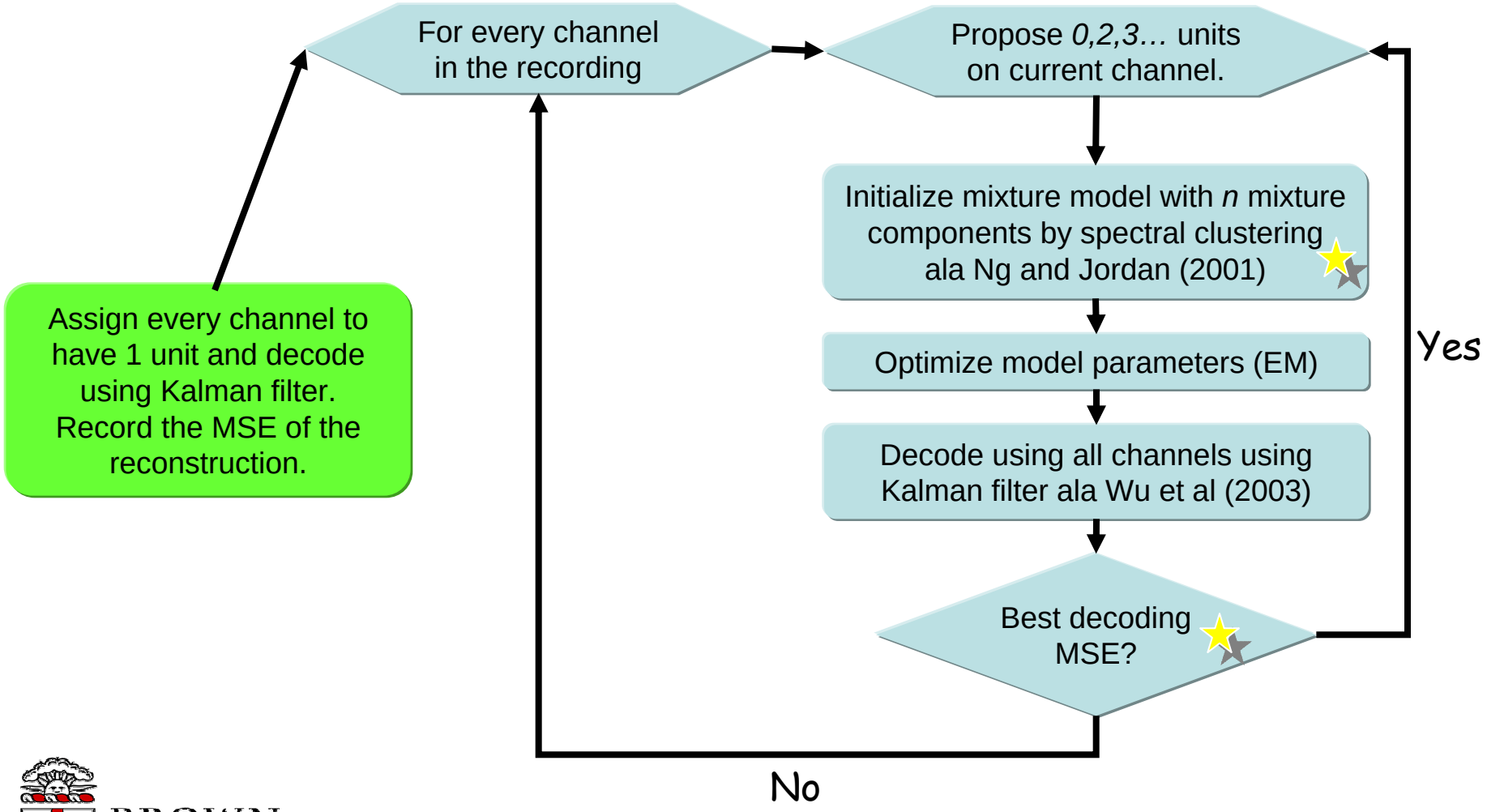
A Greedy Automatic Spike Sorting Algorithm



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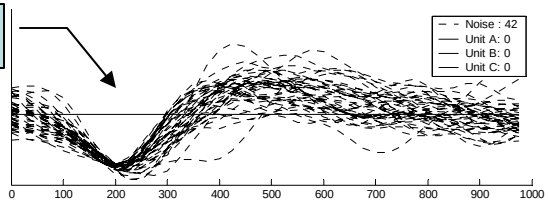
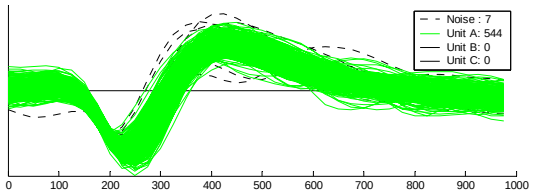
For full details see the paper.

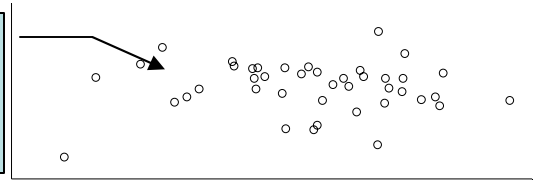
Automatic Spike Sorting Visual Results

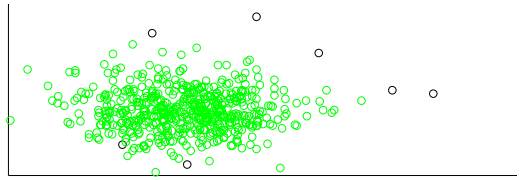
Waveforms

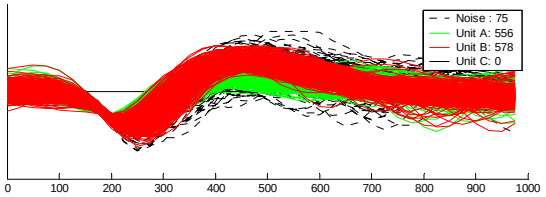


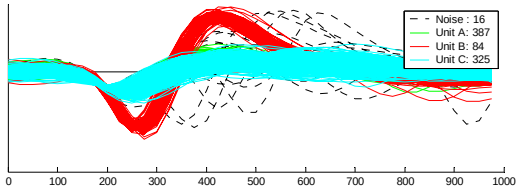


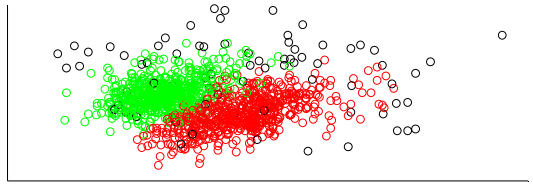
Corresponding 2 largest PCA coefficients.

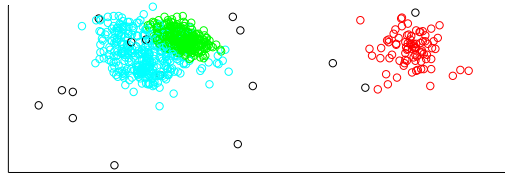












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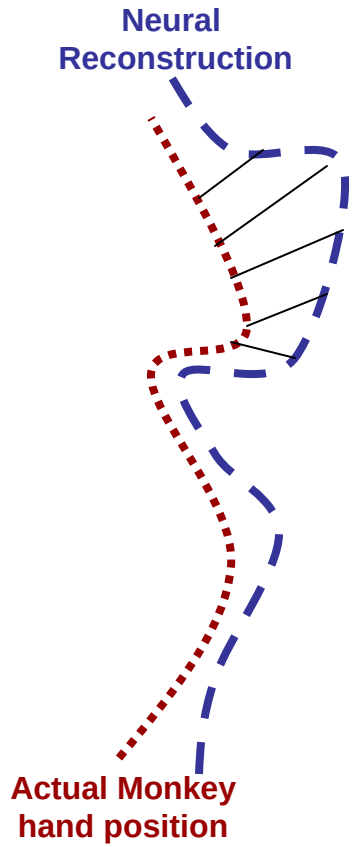
Decoding Results

Subject	Neurons	Spikes	MSE (cm^2)
A	107	757674	11.45 +/- 1.39
B	96	335656	16.16 +/- 2.38
C	78	456221	13.37 +/- 1.52
D	88	642422	12.37 +/- 1.22
Ave. Human	92	547993	13.46 +/- 2.54



Rank: Auto Sorted → No Sorting → Randomly Sorted → Human Sorted !

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Conclusions and Discussion

- This automatic sorting algorithm produces better spike trains for neural decoding.
- Maybe spike sorting isn't necessary for good decoding?
  - Hints at using a different signal instead?
- Linking decoding to sorting may not identify physiological neurons.

- Next Steps
  - Fully leverage probabilistic interpretation for enhanced rate estimation.
  - Different cost function.
  - Extend to continuous signal.

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Questions?

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