Predicting Behavior From Neural Dynamics In C.elegans

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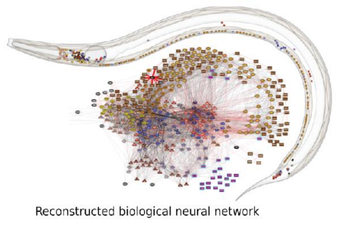
ABSTRACT

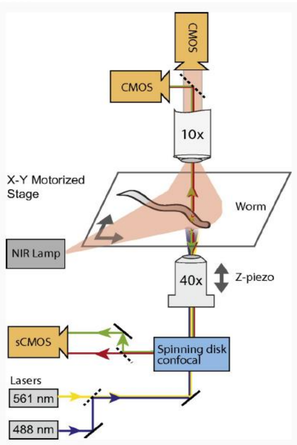
- Caenorhabditis elegans has a compact nervous system whose neural activity can be measured simultaneously with behavior in freely moving worms.
- I predict the behavior of C.elegans from the neural acitivity :
  - (1) The continuous variable velocity is predicted with regression method.
  - (2) The discrete behavior states are predicted with classification method.
- First 10% of PC components can explain 80% of variance in neural data.
- I use Hidden Markov Model to learn the neural dynamics and find correlation between hidden states and behavior states.

BACKGROUND AND DATA

Simultaneously record whole-brain neural activity and behavior in freely moving worm



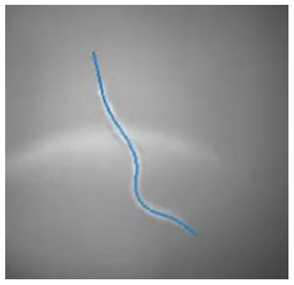
Reconstructed biological neural network

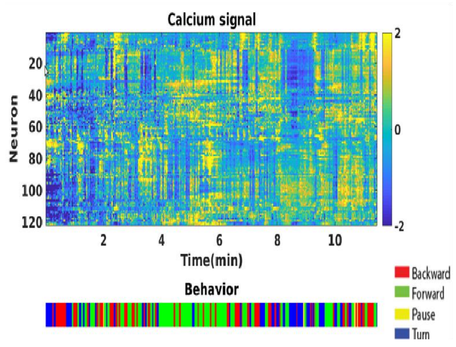


Nguyen, Jeffrey P., et al. , PNAS 113.8 (2016)

Caenorhabditis elegans, C.elegans in short, is a transparent nematode. C.elegans have a compact nervous system which contains only 302 neurons

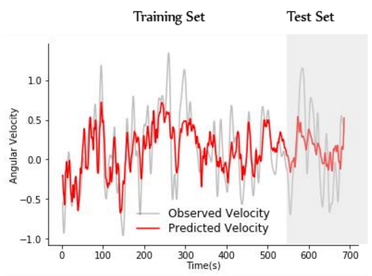
Behavior Image



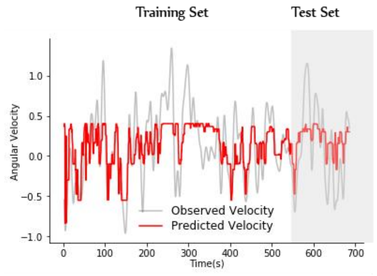


PREDICT VELOCITY FROM NEURAL SIGNAL

LASSO



Random Forest



BEHAVIOR PREDICTION FROM DIFFERENT MODELS

	Lasso	Elastic Net	Random Forest	Gradient Boosting
R^2(Train)	0.60	0.47	0.42	0.49
R^2(Test)	0.33	0.27	0.34	0.28

The R^2 of Predicting Velocity From Neural Signal(With Dynamics)

(1) Predicting continuous variable velocity from neural signal

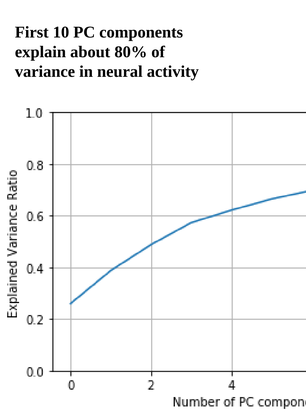
	Linear SVC	Kernel SVC	Logistic Regression	Random Forest
Accuracy(Train)	0.85	0.99	0.65	0.74
Accuracy(Test)	0.59	0.56	0.55	0.57

: The Accuracy of Predicting Behavior State From Neural Signal(With Dynamics)

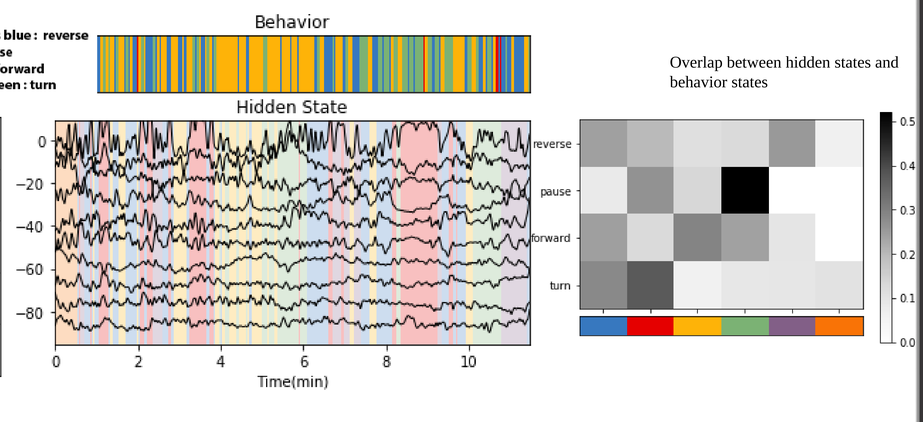
(2) Predicting discrete behavior states from neural signal. Behavior states include: forward, backward, turn, pause.

HIDDEN MARKOV MODEL FIND LATENT STATES

First 10 PC components explain about 80% of variance in neural activity



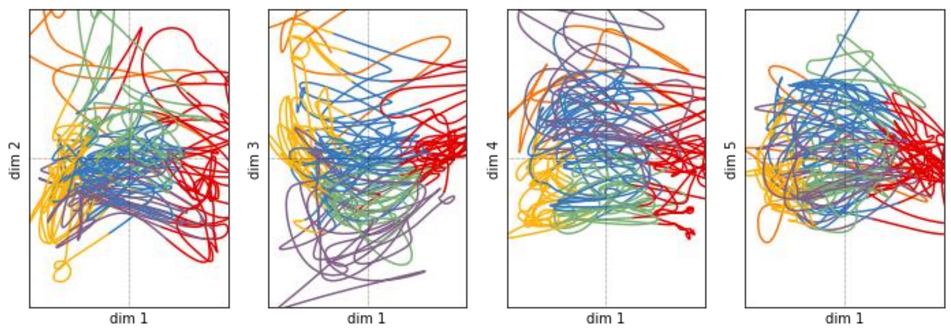
windows blue : reverse
red : pause
amber : forward
faded green : turn



Overlap between hidden states and behavior states

NEURAL DYNAMICS IN PC SPACE

Different hidden states are separated in PC space.



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REFERENCES

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2. M. Scholz, A. N. Linder, F. Randi, A. K. Sharma, X. Yu, J. W. Shaevitz, and A. M. Leifer.,"Predicting natural behavior from whole-brain neural dynamics.,"bioRxiv, 2018

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