Brain Synapse Density

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Significance

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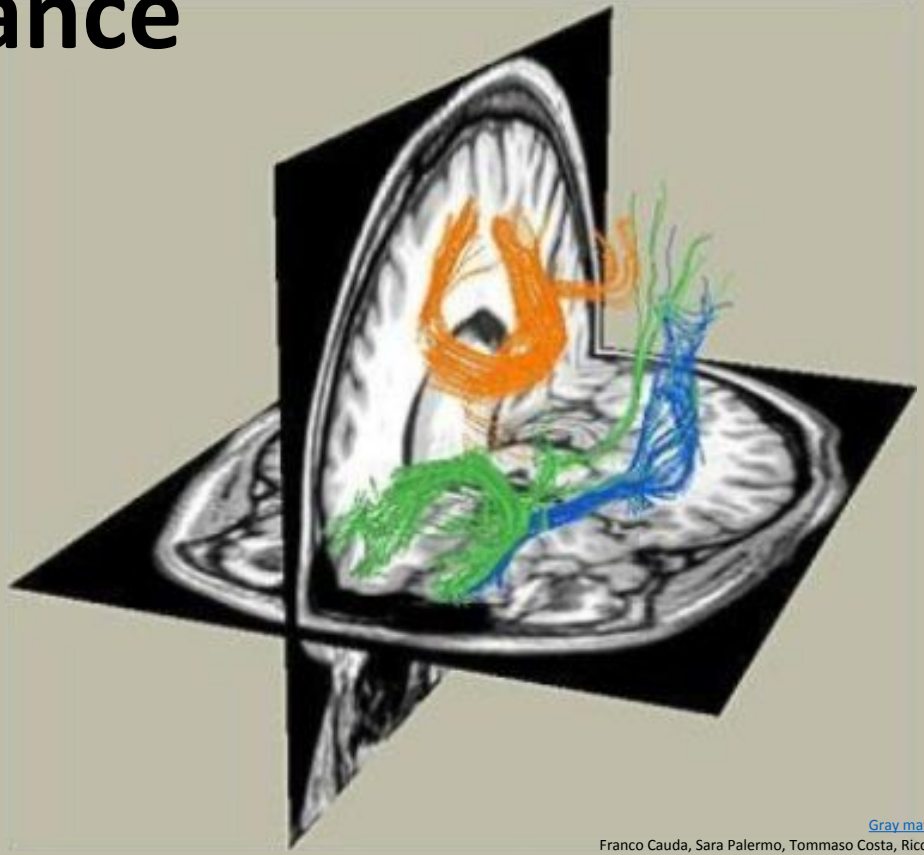

Gray matter alterations in chronic pain: A network-oriented meta-analytic approach
Franco Cauda, Sara Palermo, Tommaso Costa, Riccardo Torta, Sergio Duca, Ugo Vercelli, Giuliano Geminiani, Diana M.E. Torta
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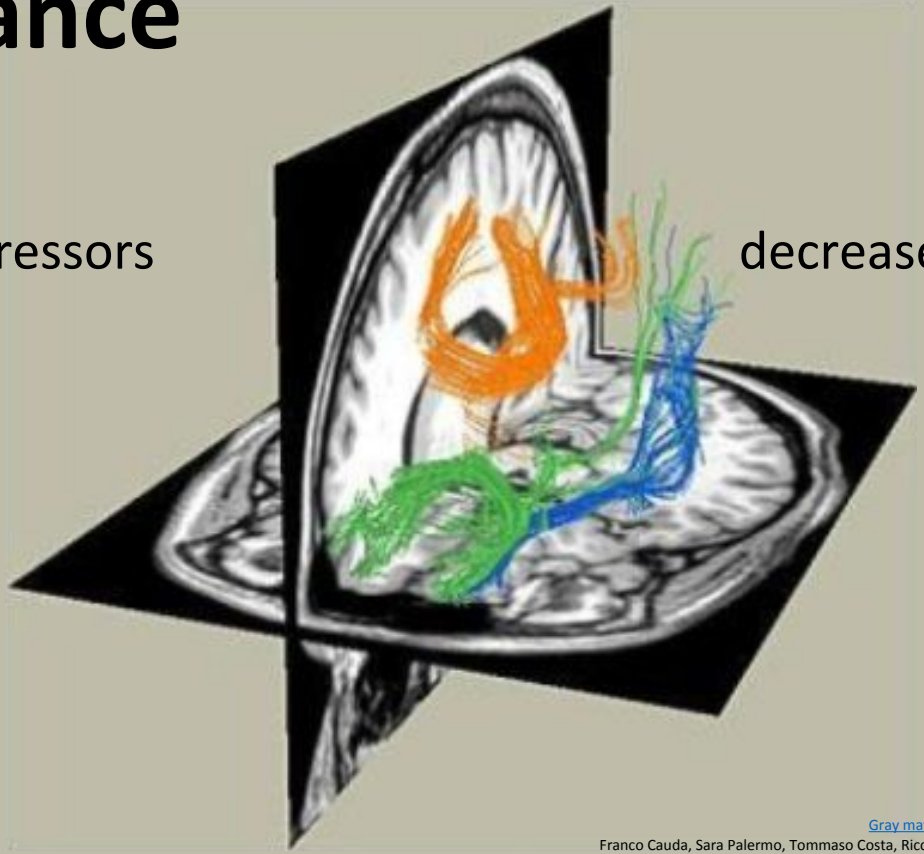
Northwestern University. "Baffling Chronic Pain Linked To Weird Rewiring Of Brain." ScienceDaily. ScienceDaily, 27 November 2008. <www.sciencedaily.com/releases/2008/11/081126133353.htm>

Significance

Physiological stressors



decrease grey matter density

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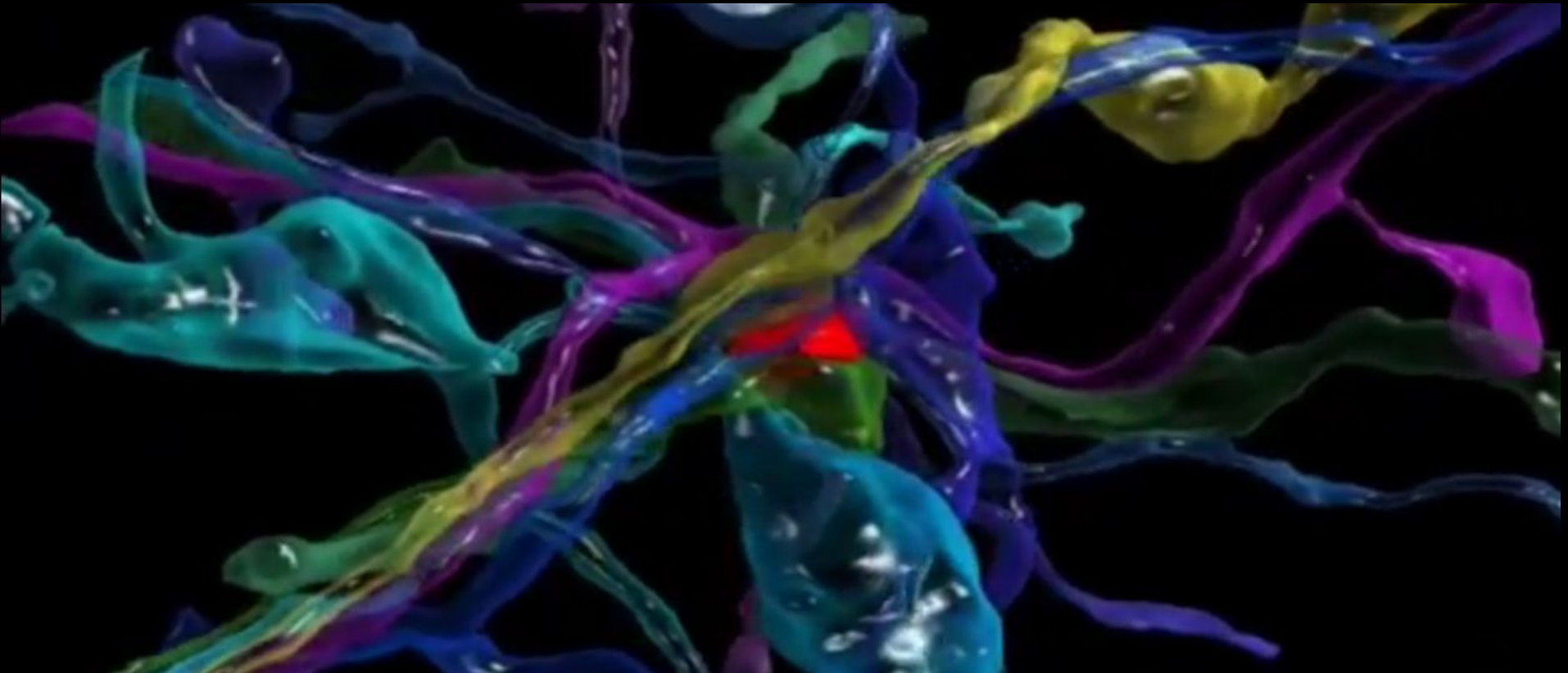
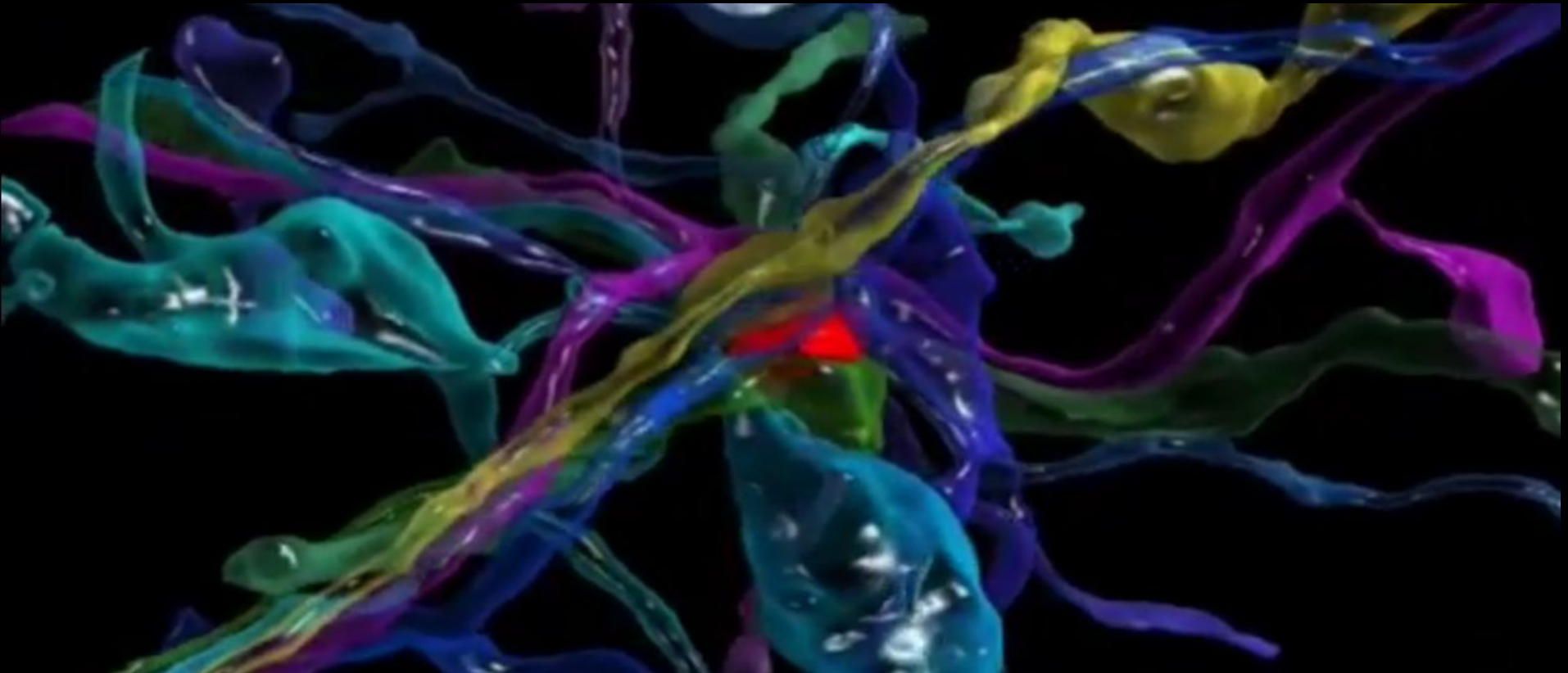
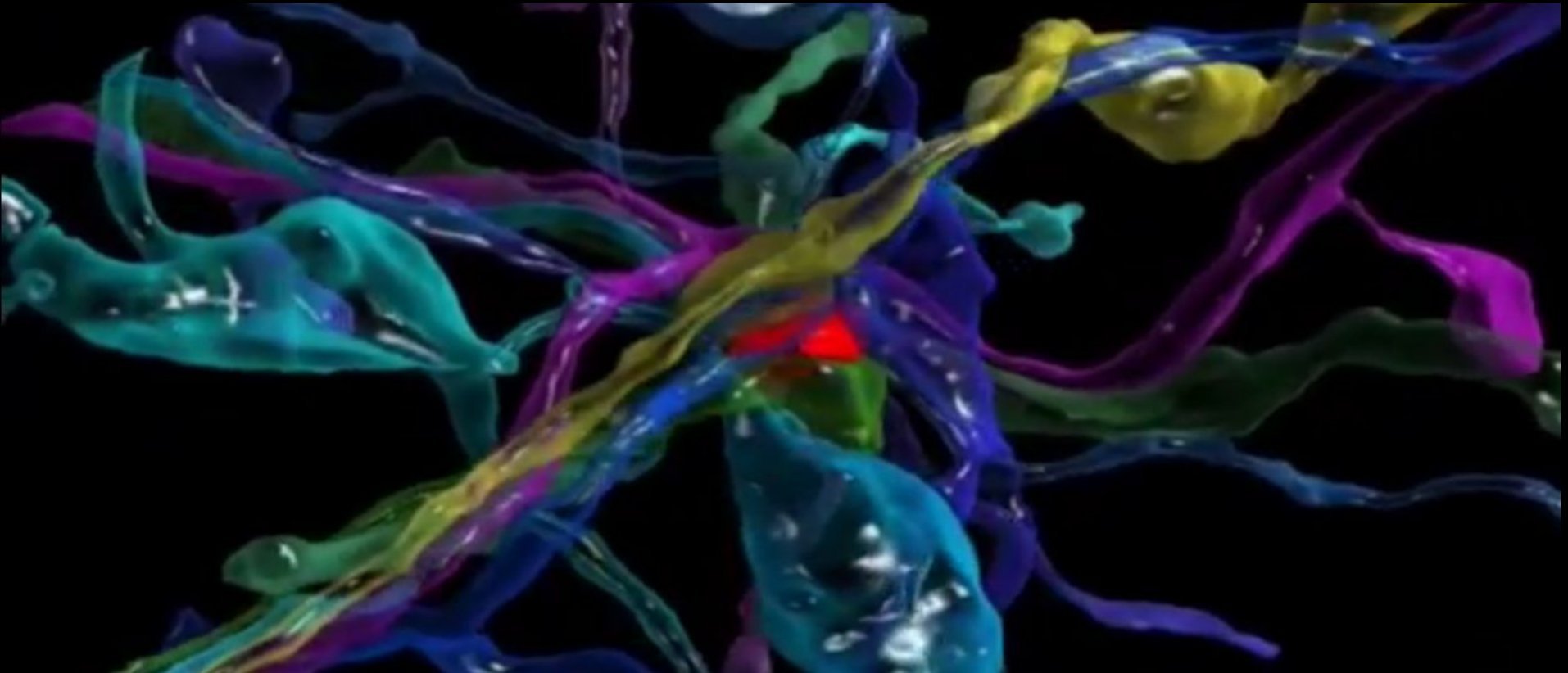
Synapse
Density



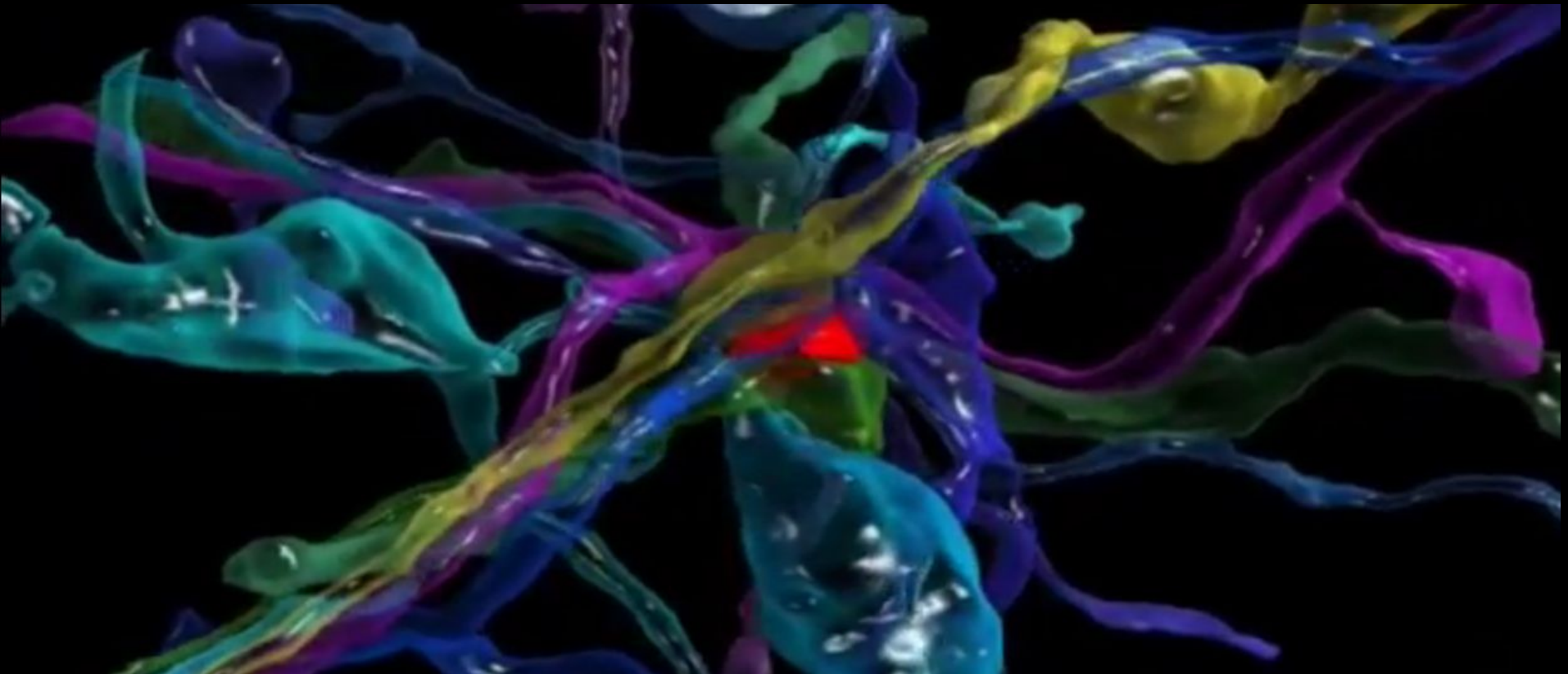
Synapse Density → Neural Structure



Synapse Density → Neural Structure → Neural Network Activity



Synapse Density → Neural Structure → Neural Network Activity → Mental Function



Gap

http://www.engadget.com/2014/10/21/graphene-brain-sensor/

Gap

Incomplete understanding of neural networks

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Gap

Incomplete understanding of neural networks

Incomplete modeling of distributed synapses

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Challenge

Large data set

Lack of clarity & labels

Only do regression

Difficult to
interpret & understand

Formal Statement of Problem

Independent variables: $X \in \mathbb{R}^4 \text{ s.t. } x_i = (c_x, c_y, c_z, s)$

Dependent variables: $Y \in \mathbb{R}$

Unknown parameters: $\theta \in \Theta$

Regression: find a conditional distribution for Y|X, parameterized by θ

$$\text{i.e. } y_i = f(x_i; \theta)$$

For estimated $\hat{\theta}$, loss is function of $y_i, \hat{y}_i \text{ s.t } \hat{y}_i = f(x_i; \hat{\theta})$

In other words, $\hat{\theta} = \text{argmin}_\theta l(y_i, \hat{y}_i)$

Model assumptions

- (X, Y) are iid
- Y is conditionally dependent on X

Algorithms

- Linear Regression

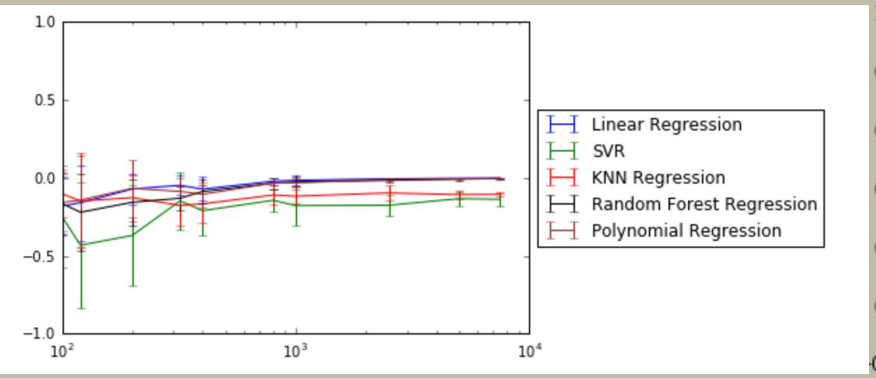
-Support Vector Regression (SVR)

-K-Nearest Neighbor Regression (KNN)

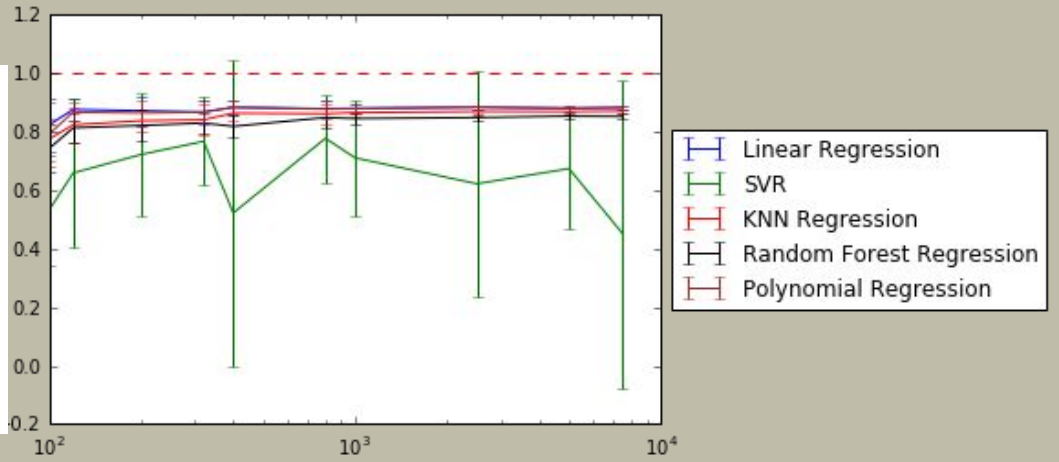
-Random Forest Regression (RF)

-Polynomial Regression (degree = 2)

Simulated regressions (10 fold cross validation)



Null model



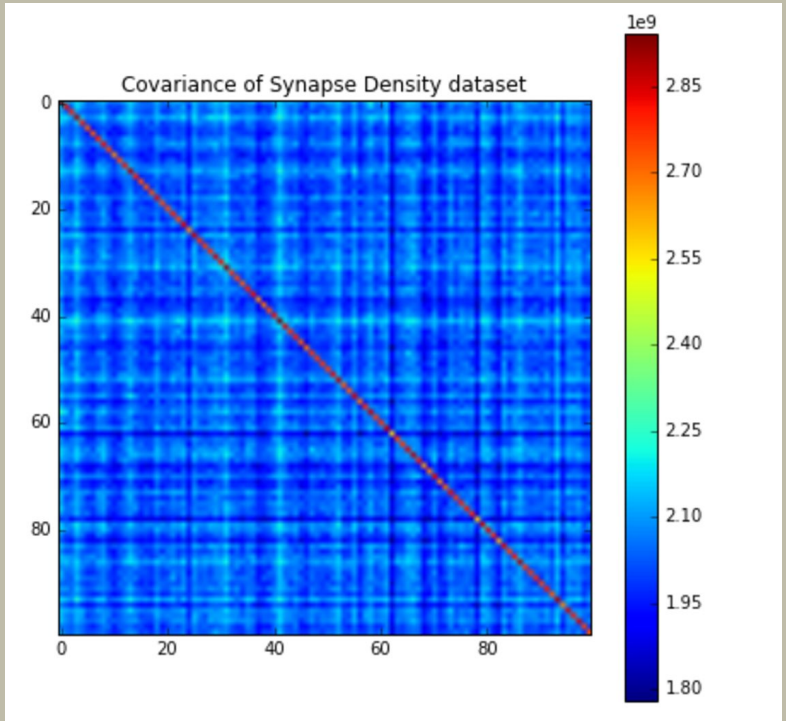
Alternate model

Regressions on actual data (10 fold cross validation)

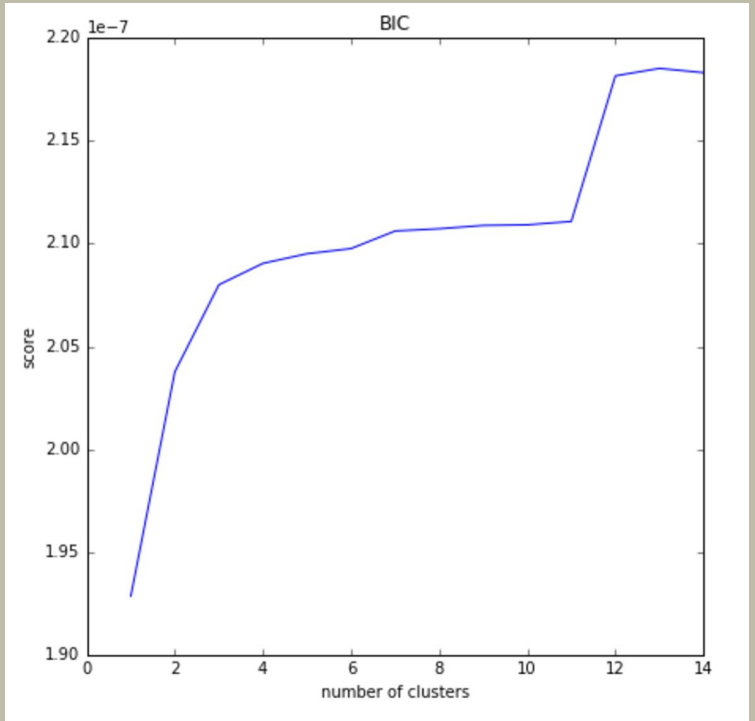
```
R^2 of Linear Regression: 0.62 (+/- 0.40)
R^2 of SVR: 0.57 (+/- 0.18)
R^2 of KNN Regression: 0.25 (+/- 2.54)
R^2 of Random Forest Regression: 0.79 (+/- 0.51)
R^2 of Polynomial Regression: 0.85 (+/- 0.27)
```

Model checking

Independence? Yes



Identical distributions? No



What's next?

- Interpret regression results

```
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```

- More regressions? Is the success of our regressions mainly due to strong dependence between synapses and unmasked?
  - I.e. what's the marginal distribution for synapses?