

Generalized Decrease Schedule of Learning Parameters for SOM

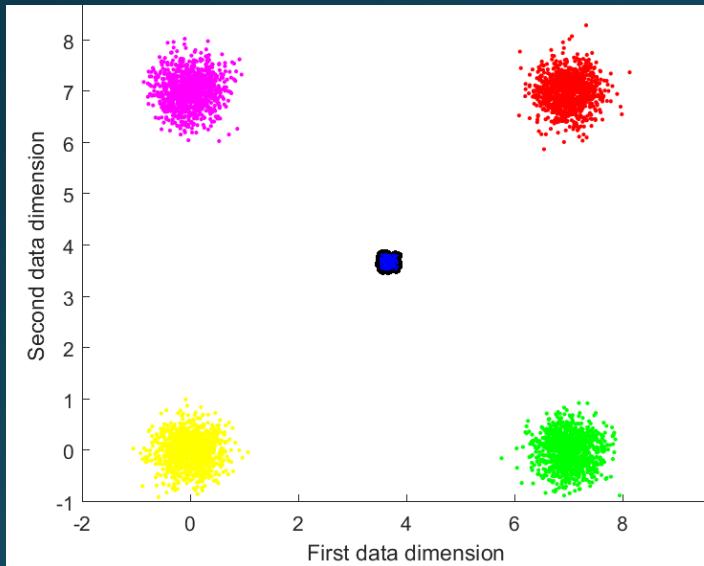
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Motivation

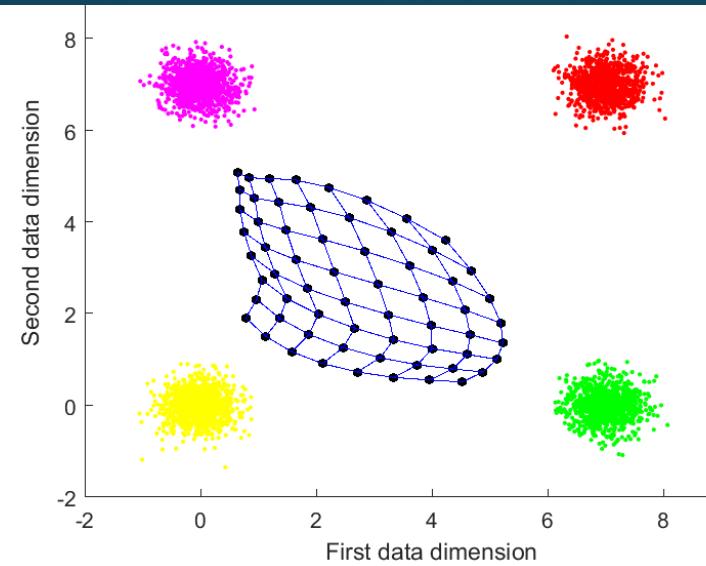
- SOM needs decreasing parameters
 - Learning rate, Neighborhood radius
- SOM learning methods have no objective function
 - No information about progress of algorithm
- Parameters schedule depends on the state of the network
 - Embedding: How well prototypes represent data distribution
 - Topology: Twisting, Topography
- How do we evaluate network state to dynamically change parameters?

Monitoring Learning

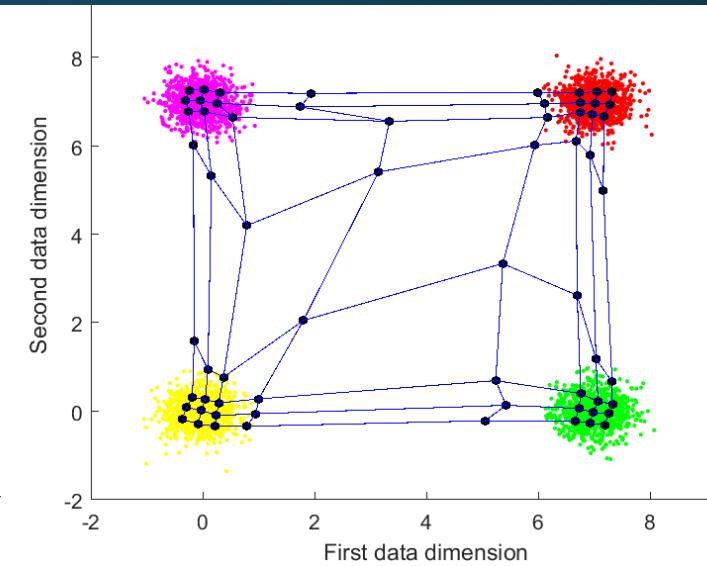
- *Embedding Error* = $(1 - \frac{\sigma_p^2}{\sigma_d^2})$
 - *Weights initialization:* $\mu_p = \mu_d, \sigma_p^2 = \frac{1}{10} \sigma_d^2$



Error = 0.99



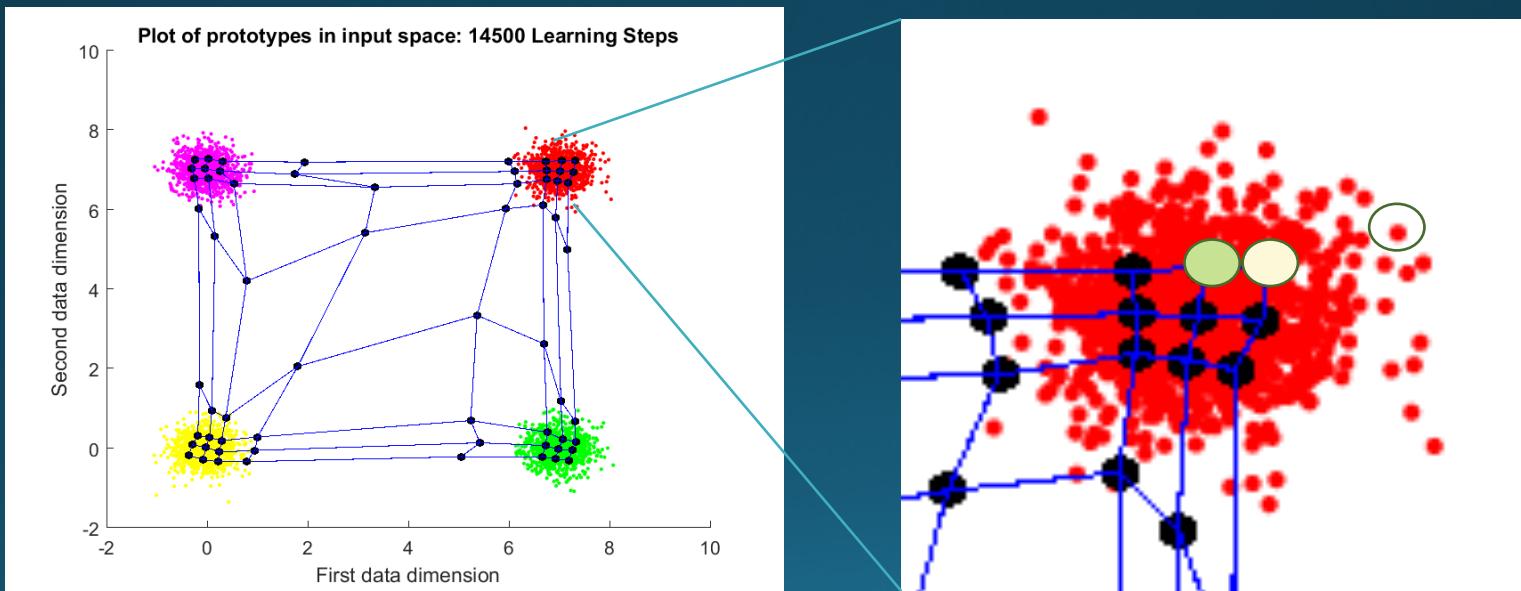
Error = 0.81



Error = 0.17

Monitoring Learning

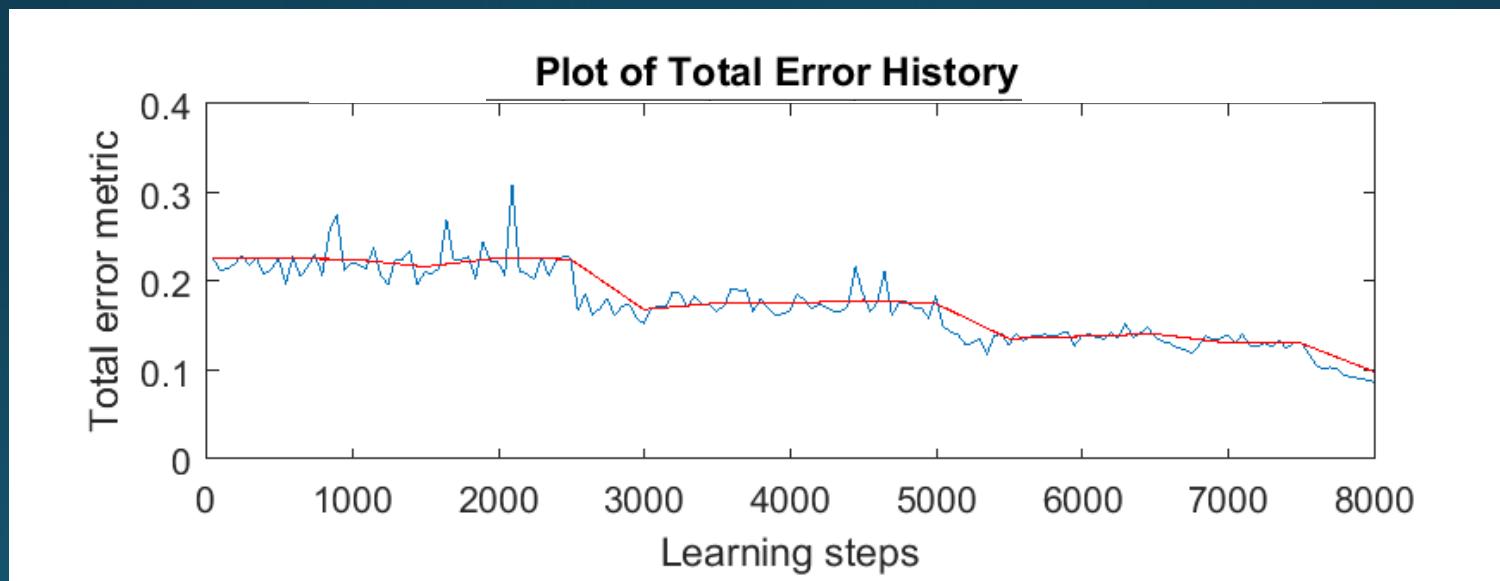
- *Topological Error* = $\frac{1}{n} \sum_{i=1}^n err(x_i)$ ⁽¹⁾



(1) Hamel L. (2016) SOM Quality Measures: An Efficient Statistical Approach. In: Merényi E., Mendenhall M., O'Driscoll P. (eds) Advances in Self-Organizing Maps and Learning Vector Quantization. Advances in Intelligent Systems and Computing, vol 428. Springer, Cham

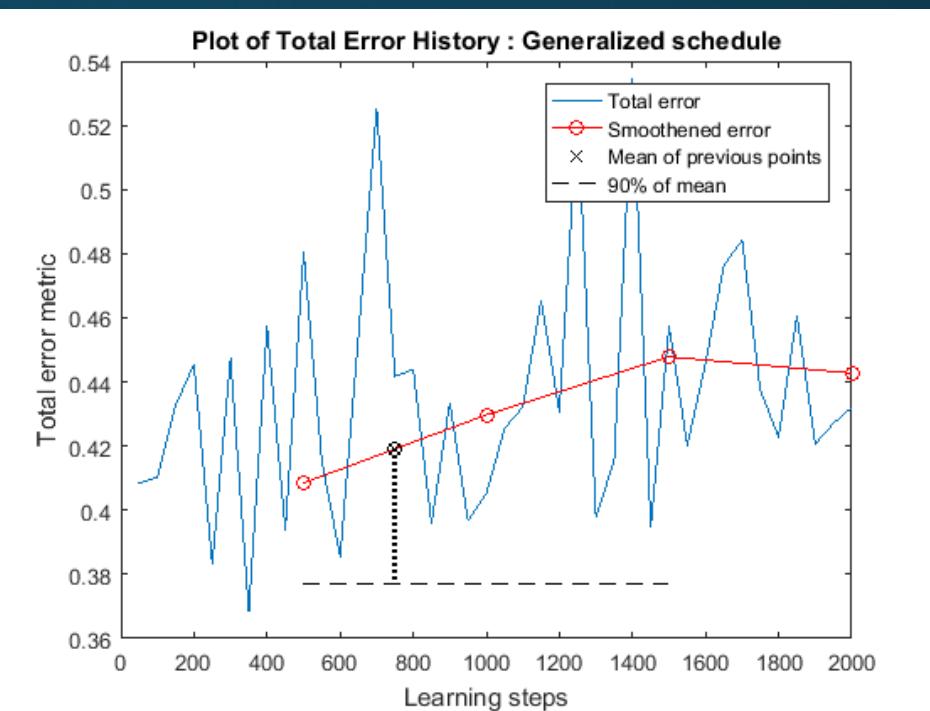
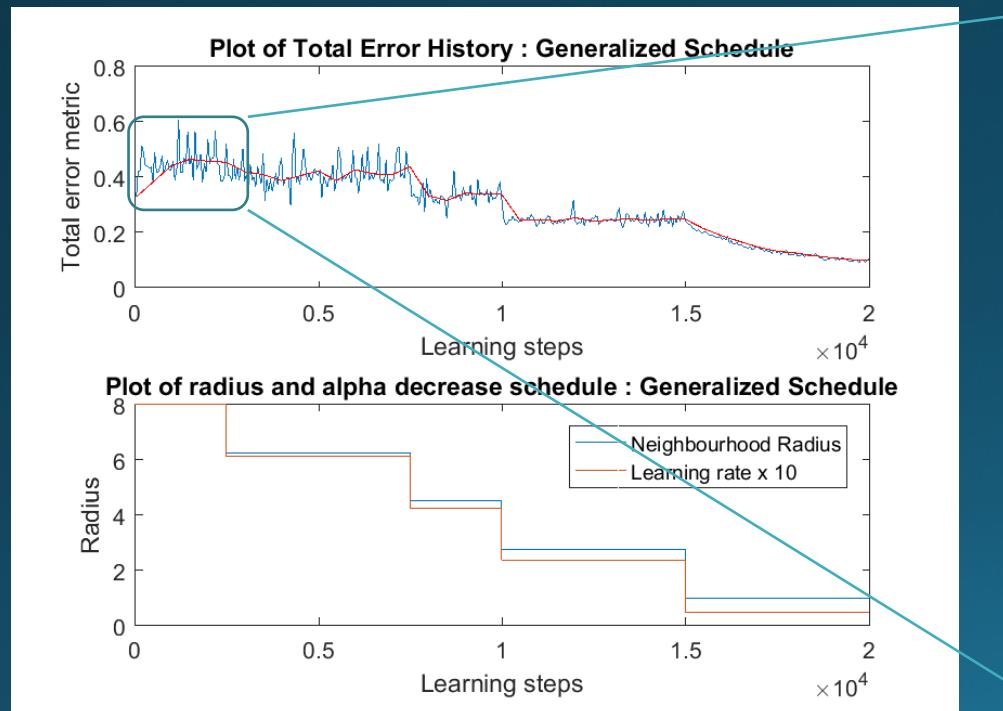
Error measure

- $Total\ Error = \alpha * Embedding\ Error + (1 - \alpha) * Topological\ Error$
 - Errors calculated every 50 learning steps (-)
 - Errors smoothed (-) : Moving average of every 10 data points (500 learn steps)

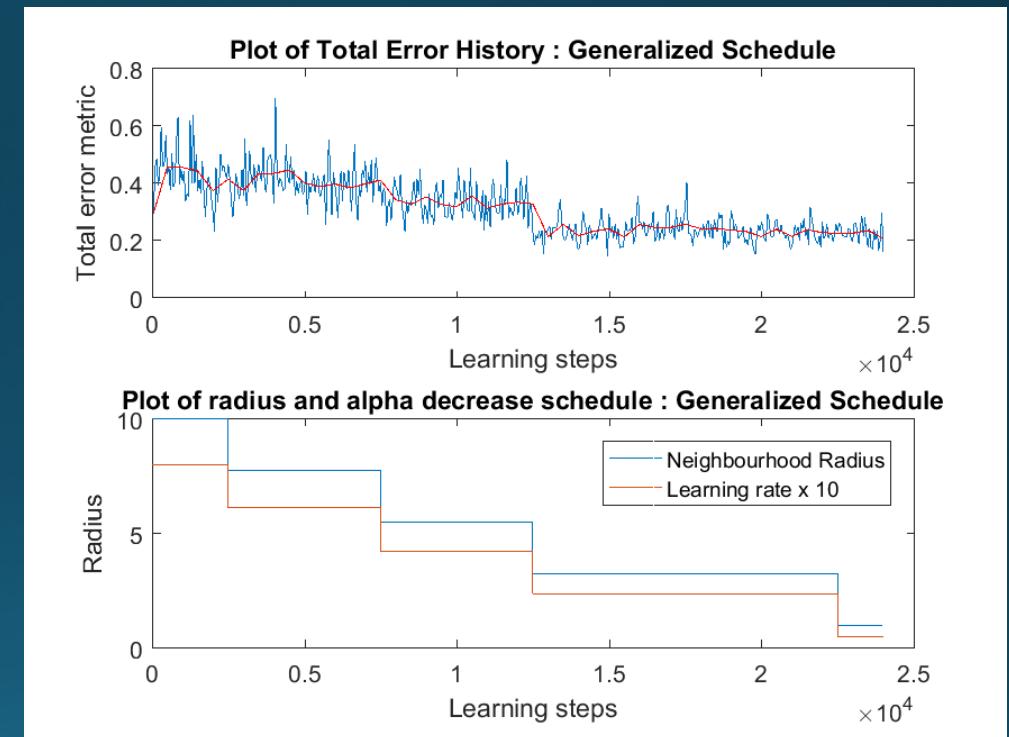
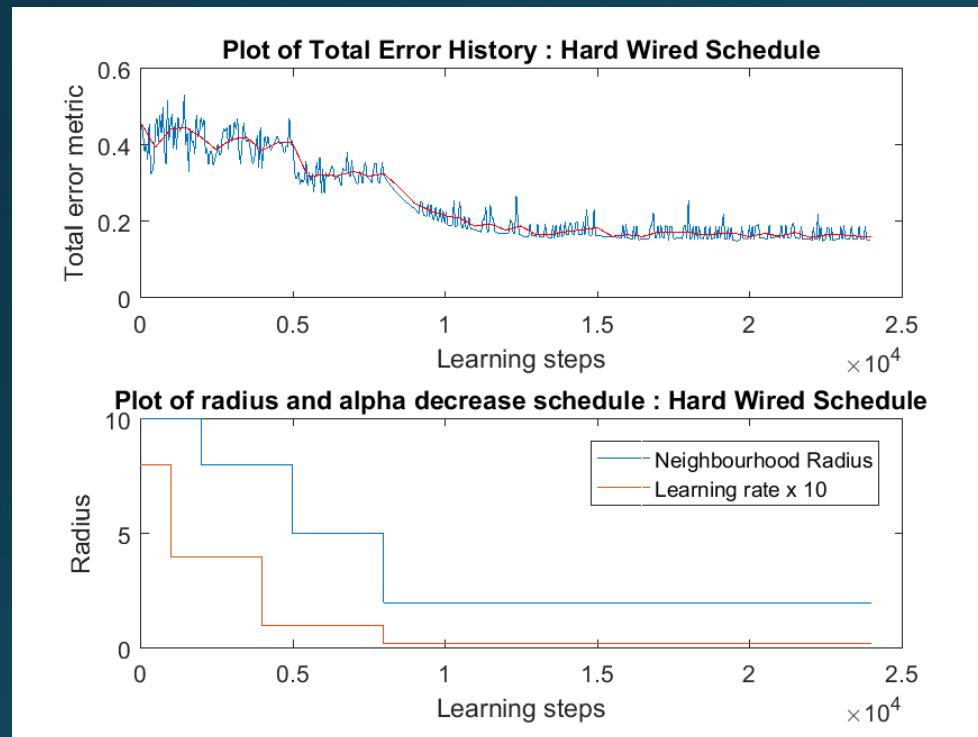


Decrease schedule

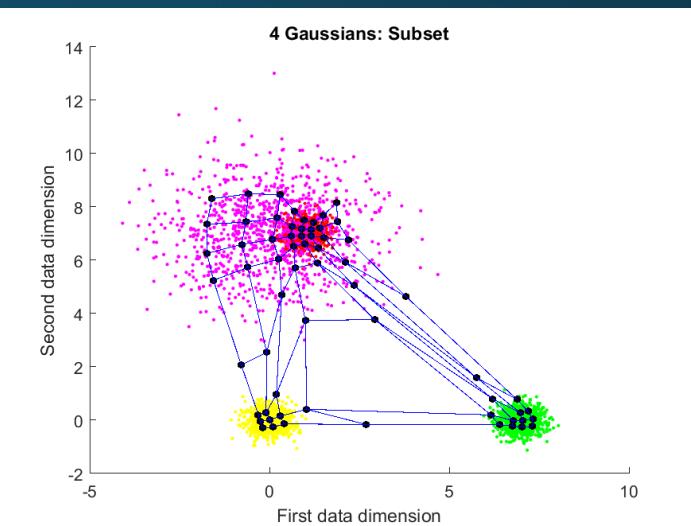
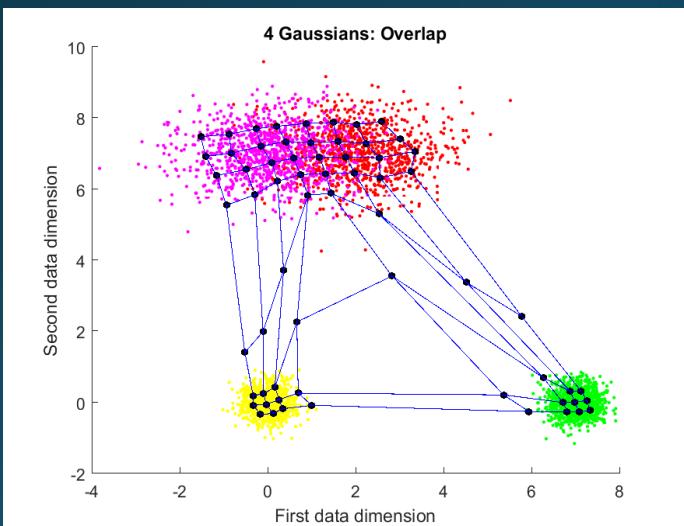
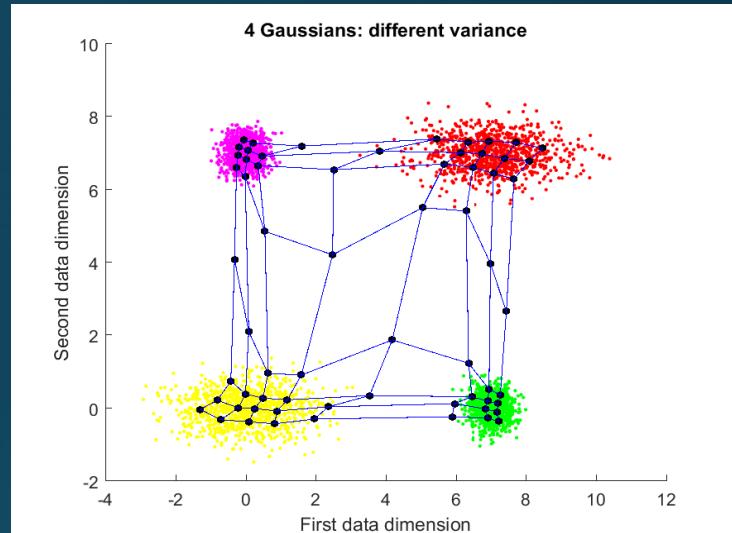
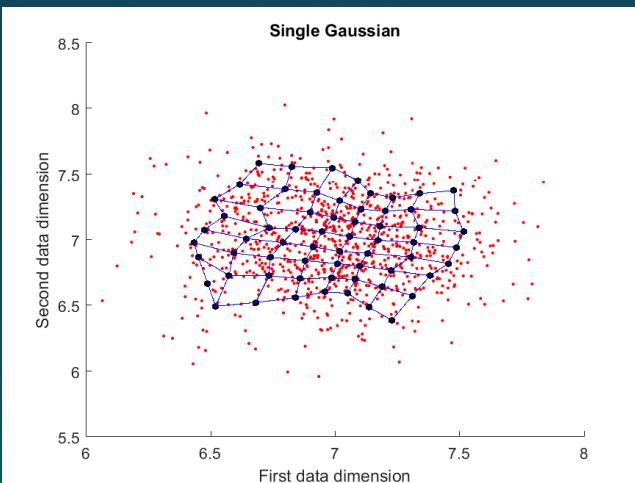
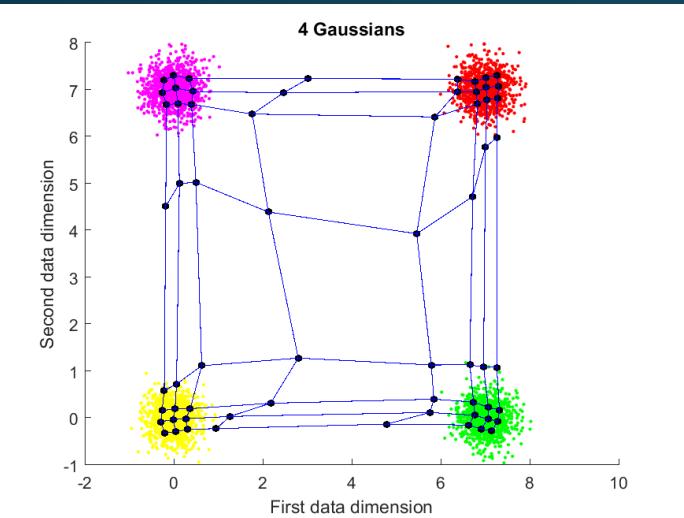
- Check smoothed error every 1500 learn steps
 - If non decreasing then lower both SOM parameters



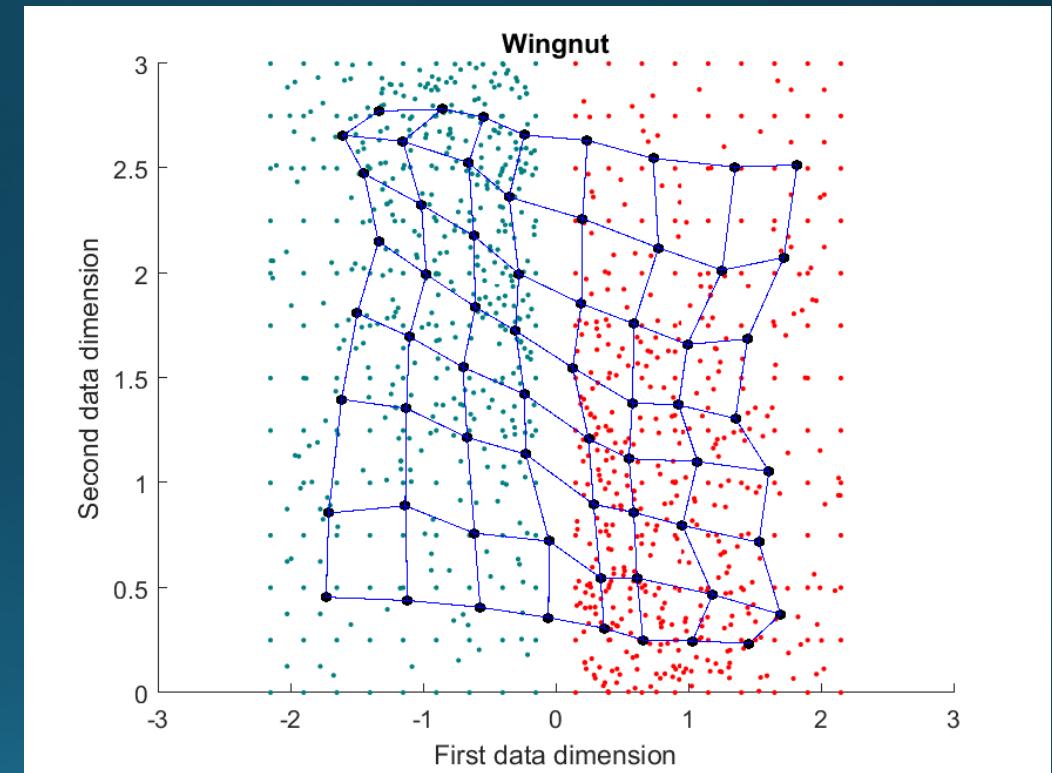
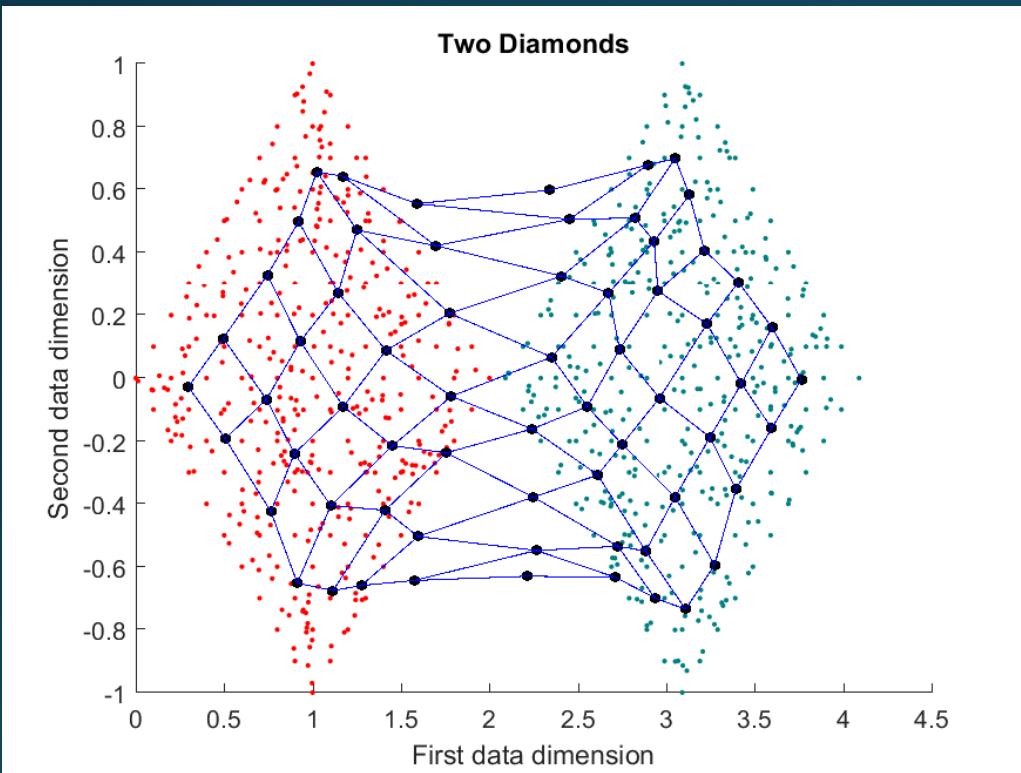
Learning Rate & Neighborhood Radius Schedule



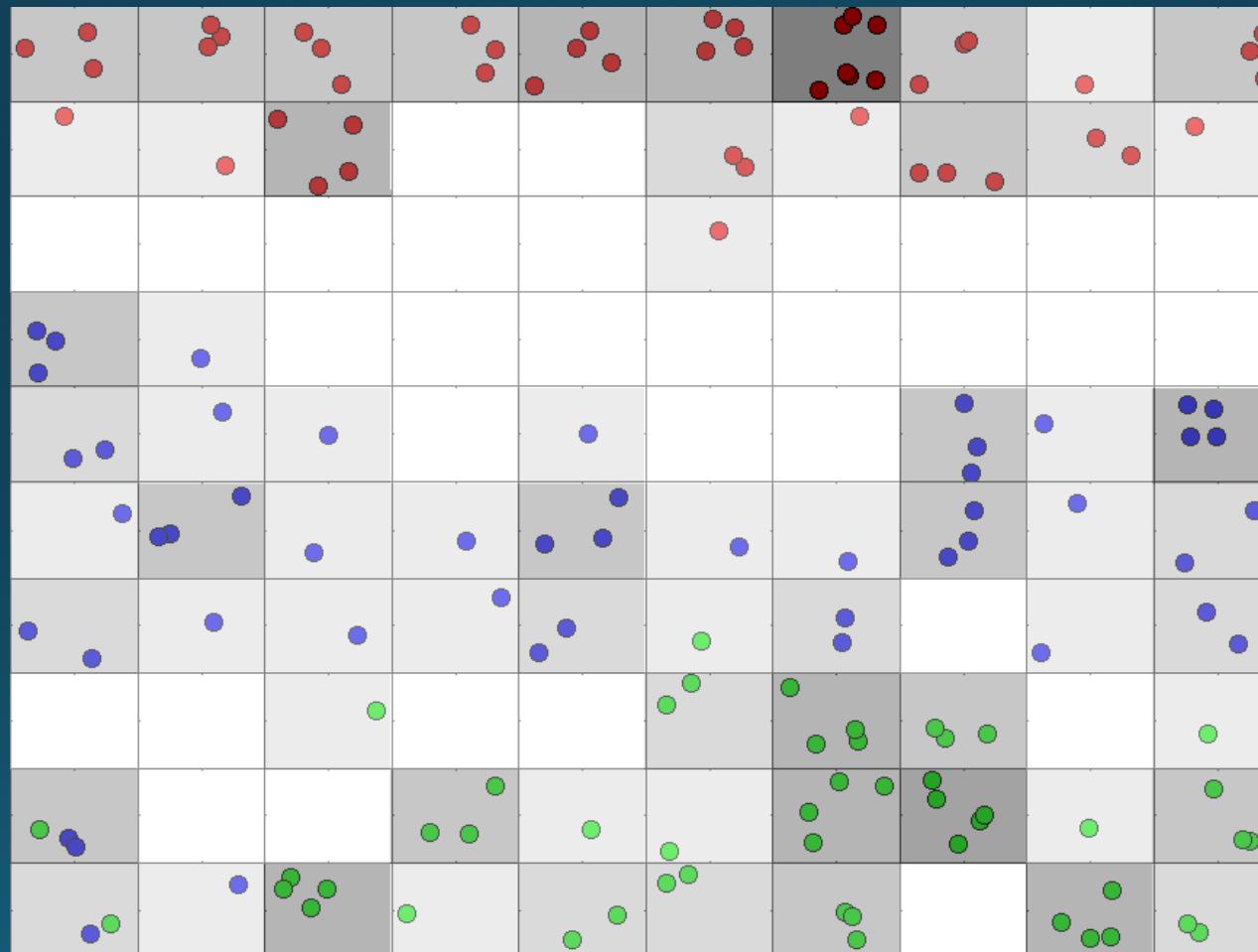
Converged SOM



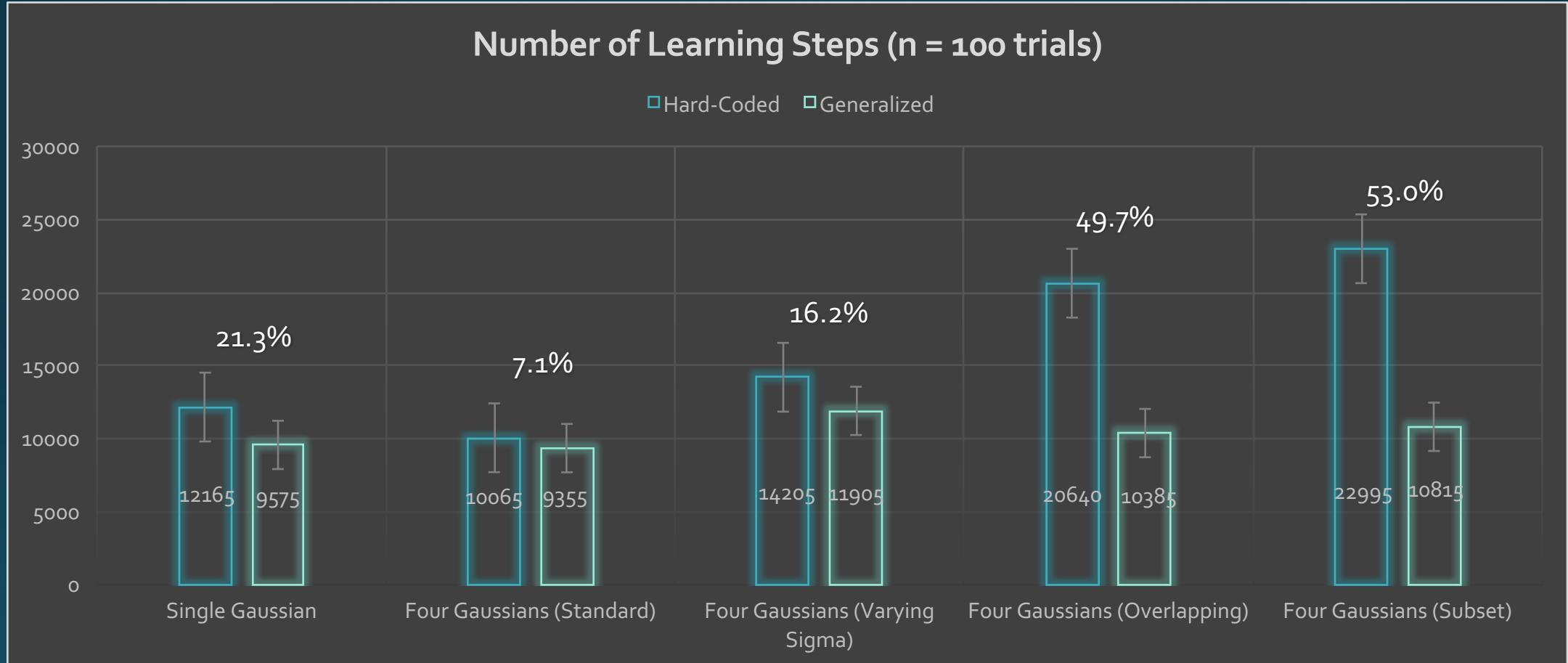
Converged SOM



Converged SOM – Iris Dataset



Generalized Schedule is Faster and More Reliable



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Conclusion

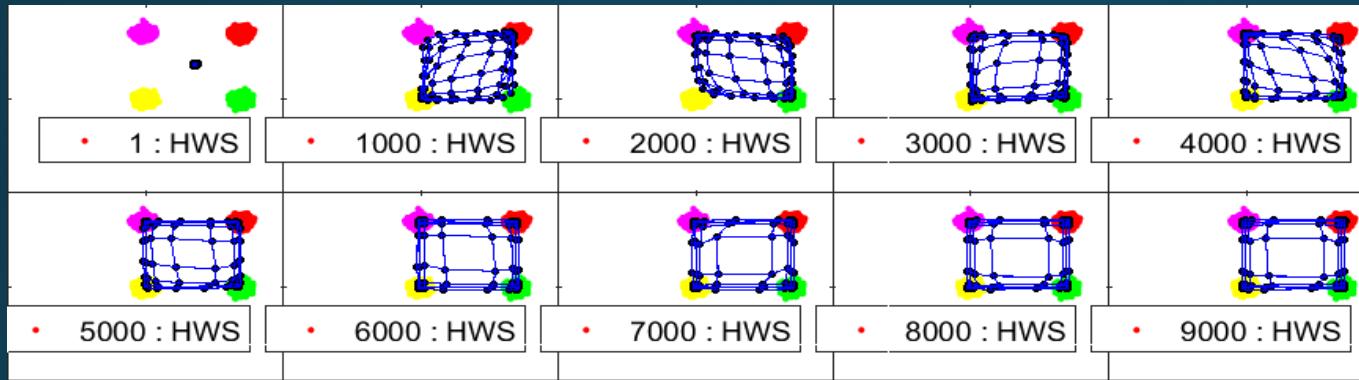
- Comparison between data and prototype mean and variance indicates the learning progress of SOM
- SOM embedding and topology information can be used to set parameters real-time
 - Useful as a default decrease schedule for any SOM
 - Leads to faster learning for most data sets

Questions?



Progression of clusters

- Hard-coded decrease schedule



- Generalized decrease schedule

