

Self-Organizing Maps

Topology Preserving Maps

- Lateral excitation and inhibition
Mexican Hat activation
[Willshaw & van der Malsburg]
- Updating a neighborhood
Self Organizing Maps
[Kohonen]

Learning Principle

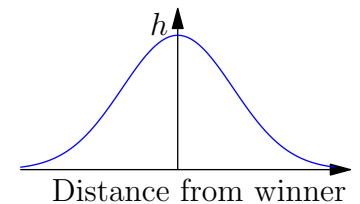
Competitive learning where winning "spills over" to **neighbors**

- 1 Topology Preserving Maps
- 2 Neighborhood
- 3 Self Organizing Maps
- 4 Example

Self Organizing Maps — SOM

$$\Delta \vec{w} = \eta h(\vec{x} - \vec{w})$$

All units are updated
 h — Neighborhood level
decreases with distance from the
winning unit



Neighbors of the winning node are also allowed to update, even if they are not even close to winning!

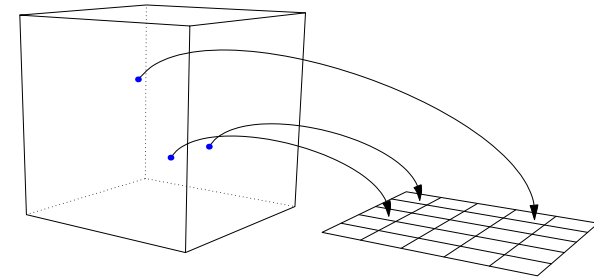
Role of the neighborhood

- Large neighborhood
 - Good global ordering
 - Bad local fit
- Small neighborhood
 - Bad global ordering
 - Good local fit

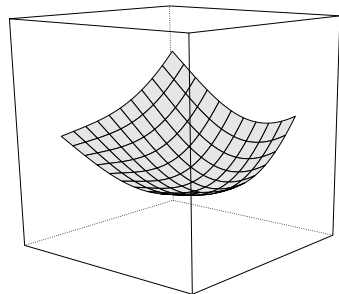
By gradually shrinking the neighborhood we can get the best of both!

- 1 Ordering phase (large neighborhood)
- 2 Convergence phase (small neighborhood)

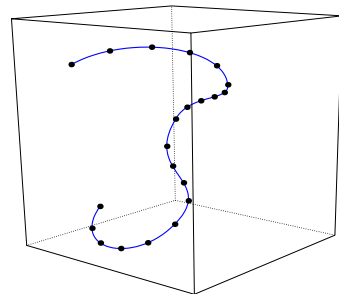
Self Organizing Maps — SOM



- Topological map, despite dimensionality reduction
- Reflects the density of the input data



Mapping to 2D



Mapping to 1D

	Dove	Hen	Duck	Goose	Owl	Hawk	Eagle	Fox	Dog	Wolf	Cat	Tiger	Lion	Horse	Zebra	Cow
Small	1	1	1	1	1	1	0	0	0	0	1	0	0	0	0	0
Medium	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0
Large	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
2 legs	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
4 legs	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Fur	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1
Hoofs	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1
Mane	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0
Feathers	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
Hunter	0	0	0	0	1	1	1	1	0	1	1	1	1	1	0	0
Runner	0	0	0	0	0	0	0	0	1	1	0	1	1	1	1	0
Flyer	1	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
Swimmer	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0

Dog	.	.	Fox	.	.	Cat	.	.	Eagle
.
.	.	.	.	.	.	.	.	.	Owl
.	.	.	.	.	.	Tiger	.	.	.
Wolf	.	.	.	.	.	.	.	.	Hawk
.	.	.	Lion	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	Dove
Horse	.	.	.	.	.	.	Hen	.	.
.	.	.	.	Cow	.	.	.	.	Goose
Zebra	.	.	.	.	.	.	Duck	.	.

Dog	Dog	Fox	Fox	Fox	Cat	Cat	Cat	Eagle	Eagle
Dog	Dog	Fox	Fox	Fox	Cat	Cat	Cat	Eagle	Eagle
Wolf	Wolf	Wolf	Fox	Cat	Tiger	Tiger	Tiger	Owl	Owl
Wolf	Wolf	Lion	Lion	Lion	Tiger	Tiger	Tiger	Hawk	Hawk
Wolf	Wolf	Lion	Lion	Lion	Tiger	Tiger	Tiger	Hawk	Hawk
Wolf	Wolf	Lion	Lion	Lion	Owl	Dove	Hawk	Dove	Dove
Horse	Horse	Lion	Lion	Lion	Dove	Hen	Hen	Dove	Dove
Horse	Horse	Zebra	Cow	Cow	Cow	Hen	Hen	Dove	Dove
Zebra	Zebra	Zebra	Cow	Cow	Cow	Hen	Hen	Duck	Goose
Zebra	Zebra	Zebra	Cow	Cow	Cow	Duck	Duck	Duck	Goose