

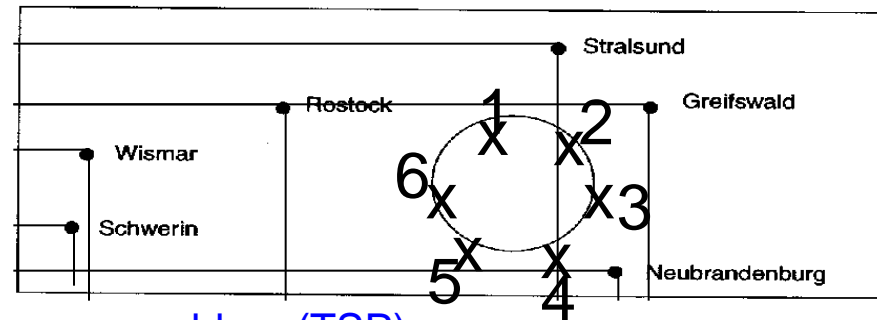
# Exercises

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- Show that in the SOM algorithm the winner neuron for an input  $x$  is the neuron  $k$  whose weight vector  $w_k$  maximizes the inner product  $\langle w_k, x \rangle$  of  $x$  and  $w_k$ , with  $x$  and  $w_k$  normalized.
- Consider the one dimensional input space  $S=\{0.1, 0.2, 0.4, 0.5\}$ . Cluster  $S$  using a one dimensional SOM network with:
  - 2 nodes.
  - learning rate equal to 0.1.
  - Neighborhood function which is equal to 1 for the winner neuron and is 0 otherwise.
  - Weight initialization:
    - $w_1=0.15, w_2=0.45$
    - $w_1=0.3, w_2=0.9$
  - Stopping criterion:  $\sum_{i=1}^2 |w_i^{old} - w_i^{new}| < 0.01$

Comment on the two clusterings you obtained using the two different weight initializations.

# Exercise TSP



- Program a SOM to solve the traveling salesman problem (TSP):
- Input layer contains just two neurons called “Xcoord” and “Ycoord”
- The Kohonen lattice is thought of as a circle containing at least as many neurons as we have cities (usage of more neurons is possible), the neurons are numbered in round about fashion.
- Each neuron  $n(i)$  (numbered by  $i$ ) on the circle is connected to “Xcoord” and “Ycoord” and the weights on these edges are the initial  $x$  and  $y$  coordinates of the neuron in the plane (see picture)
- The input patterns are the  $(x,y)$  coordinates of all target cities.
- When applying one concrete city pattern the winner is of course the neuron with lies closest to the given city. Only the weights of the winning neuron will be adapted according to the learning rule, no other neighboring weights are changed. This “moves” the neuron closer to “its” city.
- After some cycles there is just ONE neuron closest to each city. These build pairs  $(n(i), \text{City}(\text{closest to } n(i)))$ .
- If we sort this pairs according to the number of the neurons “ $i$ ” this will give a journey for the respective cities, which solves the TSP approximately.
- Use tools like ICONNECT, TSPLIB or alike to do the programming, compare runtime, memory and achieved length of path.