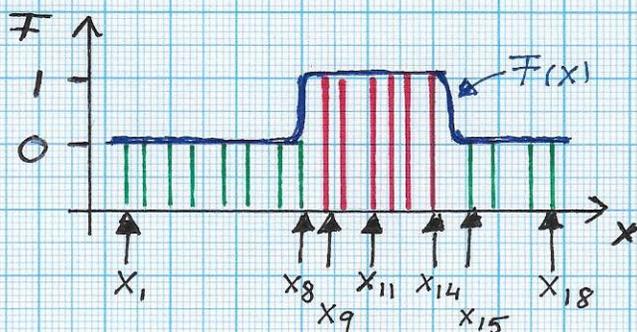


Stratoran■ RBFs AND CLASSIFICATION - Cont'd.

→ OPTIMIZATION, e.g., centers of RBFs, can be addressed via combinatorial optimization methods. SIMULATED ANNEALING is a simple, robust method for selecting  $K$  "very good" RBF centers from a set of  $N$  center candidates.

• Univariate example:

$$F(x) = \sum_{i=1}^7 c_i \gamma_i(x)$$

- 1D feature space ( $x$ )

-  $N=18$  (training) samples at locations

$x_1, \dots, x_{18}$

-  $K=7$  (example)  $\Rightarrow$

from all possibilities choose  $K$  "very good"

RBF centers:  $\binom{N}{K}$ .

-  $F(x)$  is optimal  $\Leftrightarrow$  The chosen  $7$  RBF centers define an expansion  $F(x)$  such that  $F$  maximizes "PD" and minimizes "PFA" for **class-red** points in feature space.

- Needed parameters for simulated annealing:

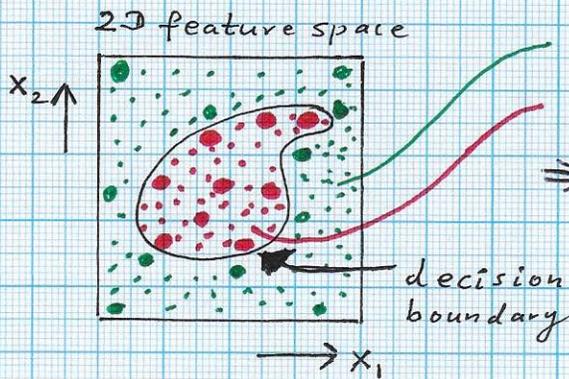
(i)  $K$ ; (ii) Cost/error/loss function to be optimized;

(iii) ANNEALING SCHEDULE.

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RBFs AND CLASSIFICATION - Cont'd.

→ Fundamentals of simulated annealing, e.g., for RBF center optimization



class-0 samples "C0"

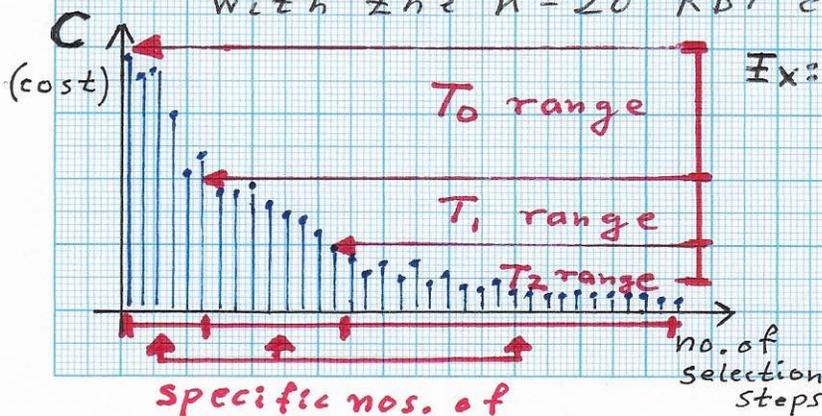
class-1 samples "C1"

⇒ select "optimally" a set {•} and set {•} from the samples as RBF centers that, for example, define the best possible "decision boundary".

• here: select K=20 RBF centers!

- For example, consider the classifier function F ("neuron") that must be (close to) 1 for C1 data (and 0 otherwise):  $F(x) = \sum_{i=1}^{20} c_i r_i(x)$ .

→ Using the term "cost function," the goal is to minimize the cost (defined itself via a proper combination of "PD" and "PFA") - with the K=20 RBF centers as parameters.



Ex: - cost to decrease geometrically - BUT can also INCREASE.

- number of selection steps performed per TEMPERATURE (range)  $T_i$  increases.

specific nos. of selection steps per  $T_i$

- permit larger cost increases in early stage of annealing process.

≈ BH