1 K-NN and /decision Trees

Distances, $d(x^{(i)}, x^{(q)}) =$

Manhattan	L1	$\sum_{k=1}^{K} \lvert x_k^{(i)} - x_k^{(q)} \rvert$
Euclidean	L2	$\sqrt{\sum_{k=1}^{K} (x_k^{(i)} - x_k^{(q)})^2}$
Chebyshev	L∞	$\max_{k=1}^{K} \lvert x_k^{(i)} - x_k^{(q)} \rvert$

$$\text{Types} = \begin{array}{cc} \text{Inverse} & \frac{1}{d(x^{(i)}, x^{(q)})} \\ \text{Gaussian} & \frac{1}{\sqrt{2\pi}} \exp(-\frac{d(x^{(i)}, x^{(q)})^2}{2}) \end{array}$$

$$\text{Entropy} = H(X) = \begin{array}{c} -\sum_k^K P(x_k) \log_2(P(x_k)) \\ -\int_k f(x) \log_2(f(x)) \end{array}$$

$$\text{Information Gain} = \text{IG}(\text{dataset}, \text{subsets})$$
$$= H(dataset) - \sum_{S \in \text{subsets}} \frac{|S|}{|\text{dataset}| H(S)}$$
$$|\text{dataset}| = \sum_{S \in \text{subsets}} |S|$$

2 Evaluation of Machine Learning Systems

Confusion Matrix

	Class 1 Predicted	Class 2 Predicted
Class 1 Actual	**TP** True Positive	**FN** False Negative
Class 2 Actual	**FP** False Positive	**TN** False Negative

Accuracy $= \frac{TP+TN}{TP+TN+FP+FN}$

Precision $= \frac{TP}{TP+FP}$

Recall $= \frac{TP}{TP+FN}$

F-measure $= F_1 = 2\frac{Precision*Recall}{Precision+Recall}$

MSE $= \frac{1}{N}\sum_{i=1}^{N}(Y_i - \hat{Y}_i)^2$

Sample Error:

$error_s(h) = \frac{1}{N}\sum_{x \in S} \delta(f(x), h(x))$

Confidence interval:

$error_s(h) \pm Z_N \sqrt{\frac{error_s(h)*(1-error_s(h))}{n}}$

3 Neural Networks

Activation Functions:

Function	$g(z)$	$g'(z)$
Sigmoid	$\frac{1}{1+e^{-x}}$	$g(z)(1-g(z))$
Tanh	$\frac{e^x - e^{-x}}{e^x + e^{-x}}$	$1 - g(z)^2$
ReLU	0 for $x \leq 0$ x for $x > 0$	0 for $x \leq 0$ 1 for $x > 0$
Softmax	$\frac{e^{Z_i}}{\sum_k e^{Z_k}}$	$\frac{\delta L}{\delta z} = \frac{1}{N}(\hat{y} - y)$

Back Propagation:

$\frac{\delta \text{Loss}}{\delta W} = \frac{\delta \text{Loss}}{\delta Z} \cdot \frac{\delta Z}{\delta W}$

$\frac{\delta \text{Loss}}{\delta b} = \frac{\delta \text{Loss}}{\delta Z} \cdot \frac{\delta Z}{\delta b}$

$\frac{\delta \text{Loss}}{\delta X} = \frac{\delta \text{Loss}}{\delta Z} \cdot \frac{\delta Z}{\delta X}$

$\frac{\delta \text{Loss}}{\delta X} = \frac{\delta \text{Loss}}{\delta Z} \cdot W^T$

$\frac{\delta \text{Loss}}{\delta W} = X^T \cdot \frac{\delta \text{Loss}}{\delta Z}$

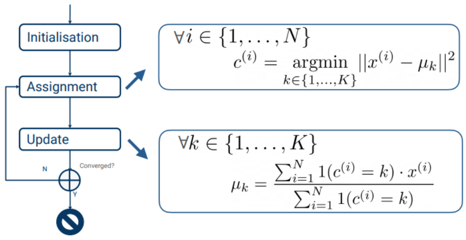
$\frac{\delta \text{Loss}}{\delta b} = 1^T \cdot \frac{\delta \text{Loss}}{\delta Z}$

$\frac{\delta \text{Loss}}{\delta b} = \frac{\delta \text{Loss}}{\delta A} \circ g'(Z)$

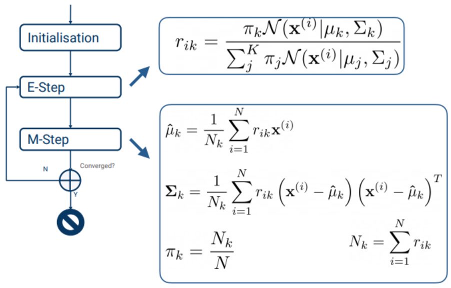
where $A = g(Z)$

4 Unsupervised Learning

K-means



GMM-EM



5 Evolutionary Algorithms

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