### Perceptron

### 讨论题

T2-1 神经元的组成是怎样的？

T2-2 单个神经元可以用来做什么？

T2-3 广义神经元与神经元有怎样的不同？

T2-4 什么样的问题被称为是线性可分问题？

### 作业题

2-1 考察二元逻辑函数AND、NOT、OR和XOR，它们各自 (1) 是否是线性可分的？(2)若是，请设计perceptron对其进行实现。

2-2 对于上述中的线性可分逻辑函数，通过对学习算法编写计算机程序获得perceptron来实现它们。请将得到的结果与2-1的进行比较。

2-3 分类手写数字0，1，2，。。。，9，如果采用一对多策略，至少需要用多少个二分类器来完成。

2-4 请问计算机系统中的奇偶检验问题是一个逻辑问题吗？是否可用perceptron来实现？

### 上机作业题

C2-1 构建一个二分类问题：逻辑与(AND)的一般问题。

1. 生成数据：正样本服从高斯分布，均值为[1,1]；负样本服从三个高斯分布的混合高斯分布，这三个高斯分布的均值分别为[0,0], [0,1], [1,0]，每个高斯分布的协方差矩阵均为(sigma\*单位矩阵，并设sigma=0.001)。
2. 学习：请依上面的分布生成正负样本各300个，运用perceptron learning algorithm从数据中学习出一个perceptron，实现对正负样本的二分类。
3. 实验与讨论：请通过编程实验，讨论如下问题：a. 学习算法的收敛性与哪些因素存在怎样的关系？b. 讨论当sigma取值不断变大（如取值从0.01-1）情况下，学习算法的收敛性问题，由此可以得出怎样的结论？

上述问题，用英文表达如下：

CHAPTER: PERCEPTRON

DISCUSSION

T2-1.What is the composition of a perceptron?

T2-2. What can a perceptron do, for classification and/or for regression?

T2-3. How is the difference between a perceptron and a generalized perceptron?

T2.4. What kind of problems is called linearly separable problem?

HOMEWORKS

2-1 Examine binary logic functions ‘AND’, ‘NOT’, ‘OR’ and ‘XOR’, (1) which are linearly separable, and which are linearly inseparable? (2) Design a perceptron to implement each of the linearly separable ones.

2-2 For each of the linearly separable logic functions mentioned in 2-1, learn a perceptron by coding and running the learning algorithm. Compare the result by learning with that obtained (in 2-1) and that by designing.

2-3 For classifying ten handwritten digits 0,1,2,... , 9 by using one-vs-rest scheme, one needs to train multiple binary classifiers. A) How many binary classifies one needs to train from data? B) write the coding matrix of the labels ‘0’,’1’,...,’9’. C) How to relabel data for the training of each binary classifier?

2-4 Is parity check a logic operation problem? Can it be implemented by a perceptron? If not, why?

COMPUTER EXPERIMENT

C2-1 A more general logic ‘AND’ problem.

1. DATA GENERATION: 300 samples following Gaussian distribution with mean value of [0,0], [0,1], [1,0], [1,1] are generated (i.e., altogether 900 samples are generated). The covariance matrix of each Gaussian is set sigma\*identity matrix with sigma being set small (e.g., 0.001). Label the samples following the Gaussian with the mean of [0,0] as positive samples, and these following the Gaussian with the mean of [0,1], [1,0], and [1,1] as negative samples. This is a typical binary classification problem however the number of positive samples and that of negative samples are seriously imbalanced.
2. LEARNING: use the perceptron learning algorithm to learn a perceptron from the data to realize the classification of positive and negative samples.
3. EXPERIMENT AND DISCUSSIONS: discuss the following problems through programming experiments: a. visualizing the convergence of the learning algorithm; b. draw the decision boundary learned from data. c. what factors influence the convergence? d. if the value of sigma is increased (e.g. from 0.01-1), discuss the convergence of the learning algorithm.