

模式识别作业4

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1 神经网络的训练

如下图所示是隐节点分别为5,10,20,40,100的情况的测试集的confusionTest matrix

从各个图中可以看出，随着隐节点的增多，混淆矩阵指示的准确性提高，训练误差逐渐降低，分析错误率同时降低，收敛速度也得到了提高。但是，当隐节点增多到一定程度后，出现了过拟合的情况，上面的各个评估指数的变化逐渐不明显

Confusion Matrix										
Output Class	1	2	3	4	5	6	7	8	9	10
	908 9.1%	0 0.0%	11 0.1%	20 0.2%	1 0.0%	36 0.4%	20 0.2%	0 0.0%	8 0.1%	6 0.1%
	0 0.0%	1095 10.9%	25 0.3%	2 0.0%	11 0.1%	2 0.0%	7 0.1%	19 0.2%	27 0.3%	4 0.0%
	4 0.0%	8 0.1%	872 8.7%	54 0.5%	3 0.0%	6 0.1%	7 0.1%	10 0.1%	6 0.1%	0 0.0%
	19 0.2%	2 0.0%	59 0.6%	822 8.2%	1 0.0%	74 0.7%	0 0.0%	31 0.3%	44 0.4%	12 0.1%
	3 0.0%	1 0.0%	7 0.1%	2 0.0%	876 8.8%	14 0.1%	8 0.1%	18 0.2%	11 0.1%	60 0.6%
	30 0.3%	1 0.0%	1 0.0%	30 0.3%	8 0.1%	655 6.6%	29 0.3%	0 0.0%	79 0.8%	17 0.2%
	11 0.1%	3 0.0%	22 0.2%	2 0.0%	17 0.2%	21 0.2%	883 8.8%	0 0.0%	24 0.2%	0 0.0%
	5 0.1%	2 0.0%	6 0.1%	27 0.3%	11 0.1%	6 0.1%	0 0.0%	891 8.9%	4 0.0%	35 0.4%
	0 0.0%	22 0.2%	26 0.3%	39 0.4%	2 0.0%	71 0.7%	4 0.0%	0 0.0%	752 7.5%	12 0.1%
	0 0.0%	1 0.0%	3 0.0%	12 0.1%	52 0.5%	7 0.1%	0 0.0%	59 0.6%	19 0.2%	863 8.6%
92.7% 96.5% 84.5% 81.4% 89.2% 73.4% 92.2% 86.7% 77.2% 85.5% 86.2% 7.3% 3.5% 15.5% 18.6% 10.8% 26.6% 7.8% 13.3% 22.8% 14.5% 13.8%										
Target Class										

图 1: 5隐节点测试集混淆矩阵

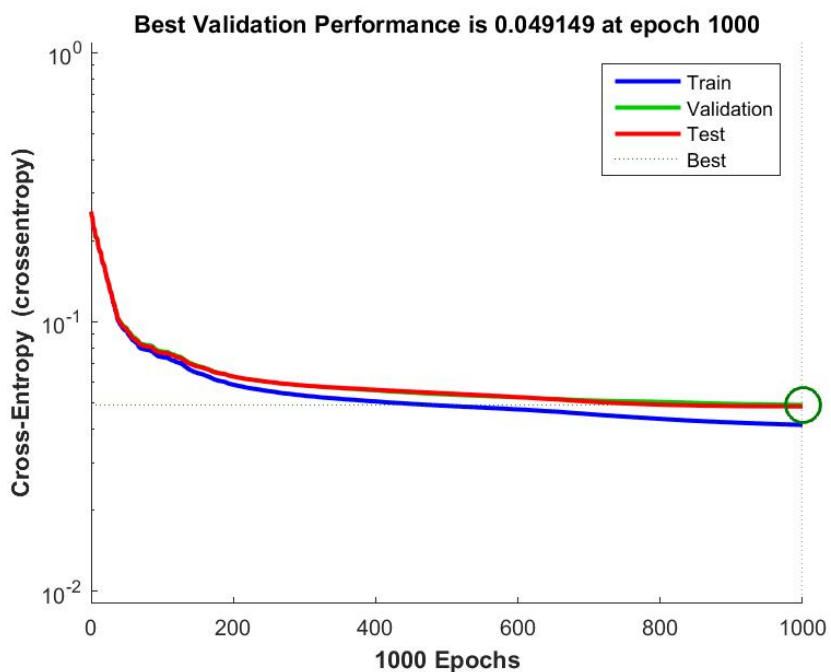


图 2: 5隐节点训练误差曲线

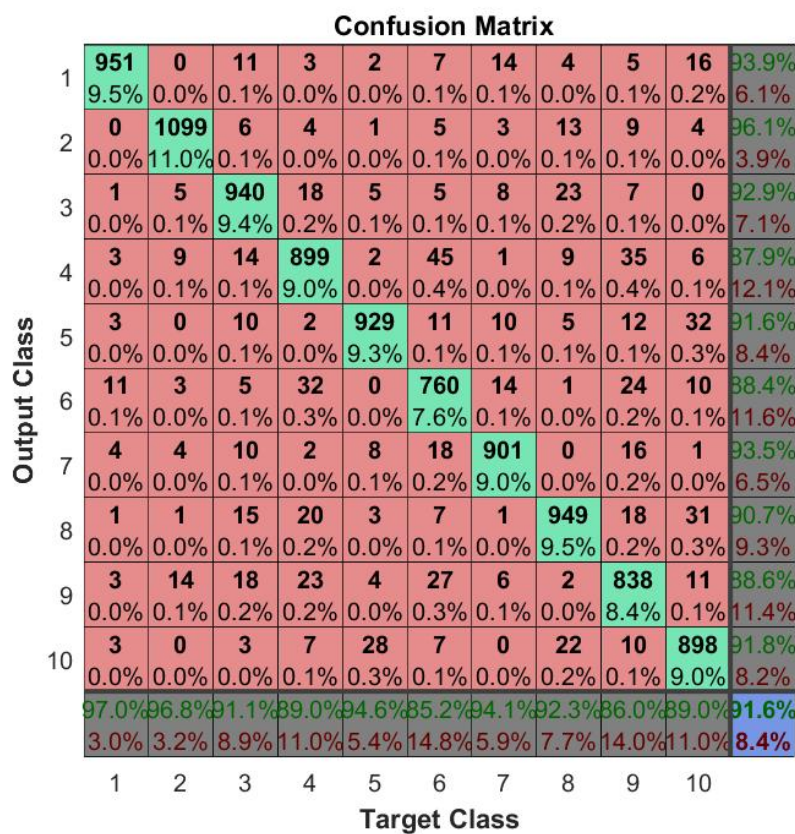


图 3: 10 隐节点测试集混淆矩阵

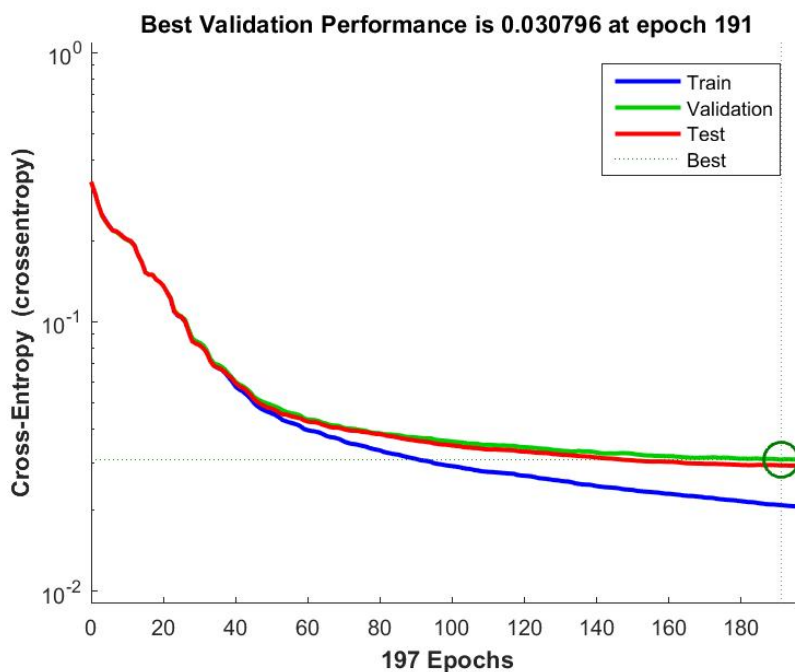


图 4: 10隐节点训练误差曲线

Confusion Matrix											
Output Class	1	2	3	4	5	6	7	8	9	10	
	947 9.5%	1 0.0%	7 0.1%	2 0.0%	2 0.0%	10 0.1%	7 0.1%	2 0.0%	7 0.1%	6 0.1%	95.6% 4.4%
	0 0.0%	1105 11.1%	4 0.0%	2 0.0%	1 0.0%	1 0.0%	3 0.0%	9 0.1%	3 0.0%	4 0.0%	97.6% 2.4%
	0 0.0%	4 0.0%	954 9.5%	18 0.2%	5 0.1%	4 0.0%	11 0.1%	17 0.2%	13 0.1%	1 0.0%	92.9% 7.1%
	2 0.0%	2 0.0%	10 0.1%	925 9.3%	1 0.0%	35 0.4%	0 0.0%	5 0.1%	19 0.2%	15 0.1%	91.2% 8.8%
	0 0.0%	0 0.0%	7 0.1%	2 0.0%	916 9.2%	7 0.1%	5 0.1%	7 0.1%	13 0.1%	17 0.2%	94.0% 6.0%
	9 0.1%	1 0.0%	4 0.0%	30 0.3%	0 0.0%	783 7.8%	14 0.1%	1 0.0%	18 0.2%	7 0.1%	90.3% 9.7%
	13 0.1%	4 0.0%	9 0.1%	1 0.0%	11 0.1%	10 0.1%	908 9.1%	0 0.0%	9 0.1%	2 0.0%	93.9% 6.1%
	4 0.0%	3 0.0%	9 0.1%	11 0.1%	3 0.0%	8 0.1%	4 0.0%	959 9.6%	8 0.1%	11 0.1%	94.0% 6.0%
	4 0.0%	15 0.1%	23 0.2%	11 0.1%	6 0.1%	24 0.2%	4 0.0%	4 0.0%	876 8.8%	11 0.1%	89.6% 10.4%
	1 0.0%	0 0.0%	5 0.1%	8 0.1%	37 0.4%	10 0.1%	2 0.0%	24 0.2%	8 0.1%	935 9.3%	90.8% 9.2%
	96.6% 3.4%	97.4% 2.6%	92.4% 7.6%	91.6% 8.4%	93.3% 6.7%	87.8% 12.2%	94.8% 5.2%	93.3% 6.7%	89.9% 10.1%	92.7% 7.3%	93.1% 6.9%
Target Class											

图 5: 20隐节点测试集混淆矩阵

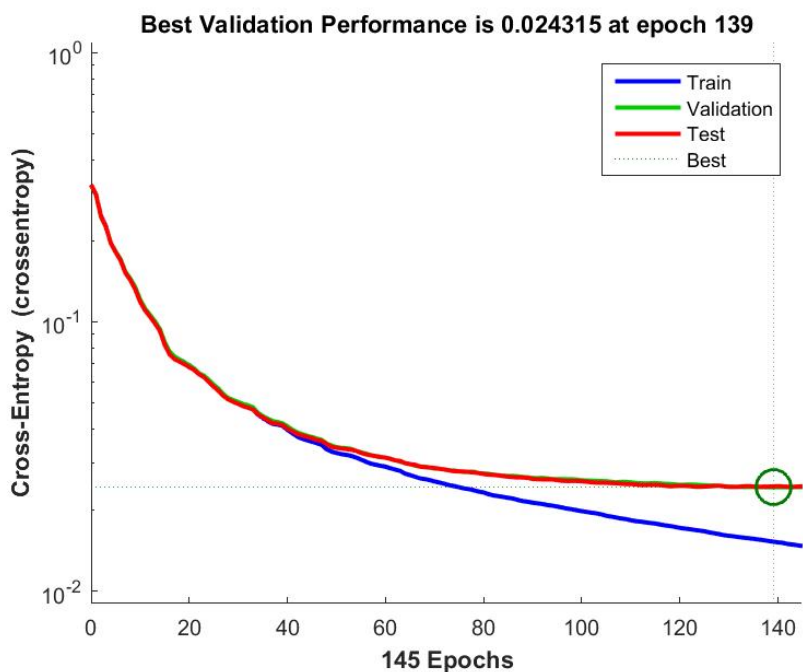


图 6: 20隐节点训练误差曲线

Confusion Matrix										
Output Class	1	2	3	4	5	6	7	8	9	10
	958 9.6%	0 0.0%	9 0.1%	3 0.0%	4 0.0%	9 0.1%	12 0.1%	1 0.0%	6 0.1%	2 0.0%
	0 0.0%	1118 11.2%	2 0.0%	0 0.0%	0 0.0%	1 0.0%	4 0.0%	7 0.1%	2 0.0%	7 0.1%
	5 0.1%	3 0.0%	977 9.8%	8 0.1%	1 0.0%	1 0.0%	5 0.1%	20 0.2%	8 0.1%	3 0.0%
	1 0.0%	2 0.0%	9 0.1%	958 9.6%	0 0.0%	13 0.1%	0 0.0%	10 0.1%	14 0.1%	8 0.1%
	0 0.0%	0 0.0%	3 0.0%	3 0.0%	939 9.4%	2 0.0%	9 0.1%	4 0.0%	9 0.1%	23 0.2%
	6 0.1%	2 0.0%	0 0.0%	11 0.1%	0 0.0%	837 8.4%	16 0.2%	0 0.0%	16 0.2%	6 0.1%
	5 0.1%	4 0.0%	7 0.1%	1 0.0%	8 0.1%	13 0.1%	905 9.0%	0 0.0%	7 0.1%	2 0.0%
	1 0.0%	2 0.0%	7 0.1%	13 0.1%	4 0.0%	3 0.0%	3 0.0%	965 9.7%	7 0.1%	14 0.1%
	0 0.0%	4 0.0%	15 0.1%	8 0.1%	2 0.0%	7 0.1%	4 0.0%	6 0.1%	892 8.9%	6 0.1%
	4 0.0%	0 0.0%	3 0.0%	5 0.1%	24 0.2%	6 0.1%	0 0.0%	15 0.1%	13 0.1%	938 9.4%
	97.8% 2.2%	98.5% 1.5%	94.7% 5.3%	94.9% 5.1%	95.6% 4.4%	93.8% 6.2%	94.5% 5.5%	93.9% 6.1%	91.6% 8.4%	93.0% 7.0%
	95.4% 4.6%	98.0% 2.0%	94.8% 5.2%	94.4% 5.6%	94.7% 5.3%	93.6% 6.4%	95.1% 4.9%	94.7% 5.3%	94.5% 5.5%	93.1% 6.9%
	94.9% 5.1%	93.0% 7.0%	94.9% 5.1%	94.9% 5.1%	95.6% 4.4%	93.8% 6.2%	94.5% 5.5%	93.9% 6.1%	91.6% 8.4%	93.0% 7.0%
	94.9% 5.1%	93.0% 7.0%	94.9% 5.1%	94.9% 5.1%	95.6% 4.4%	93.8% 6.2%	94.5% 5.5%	93.9% 6.1%	91.6% 8.4%	93.0% 7.0%

图 7: 40隐节点测试集混淆矩阵

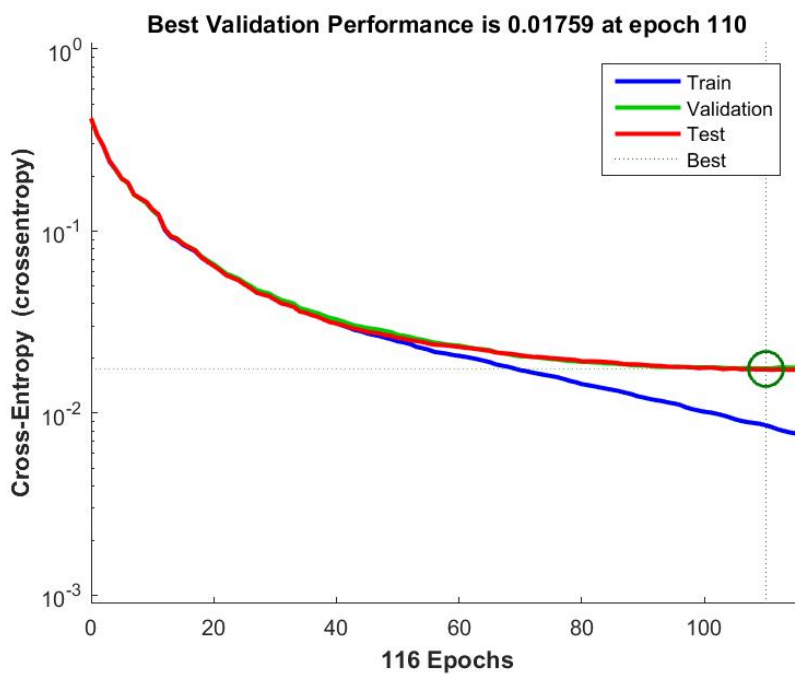


图 8: 40隐节点训练误差曲线



图 11: 训练集中的图像

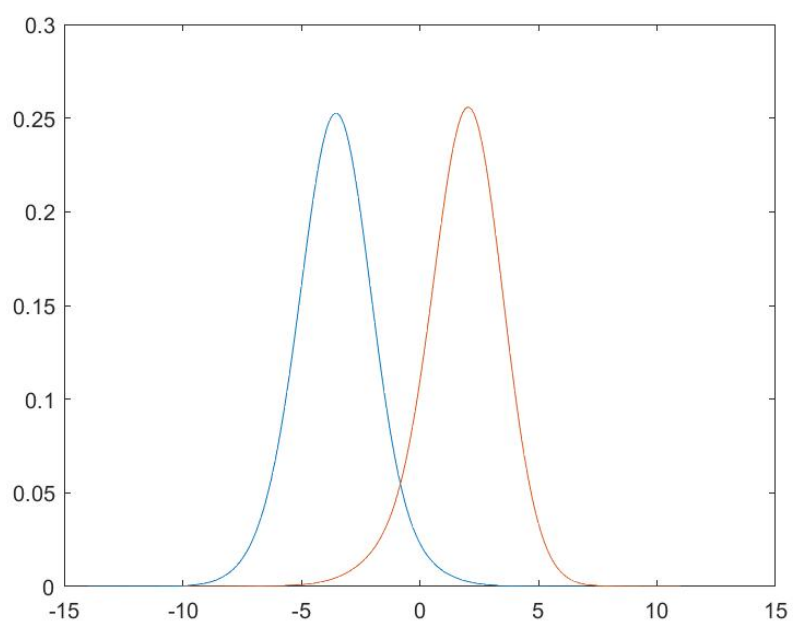


图 12: 概率密度图像

2 神经网络准确性和线性方法的比较

从图9可得神经网络中出现误差较大的识别组为‘7’和‘9’两组，正确率达到98.57

2.1 Fisher方法

如图12所示是Fisher得到的概率密度图像，经过学习可以得到正确率为95.73%

2.2 Logistic方法

Logistic方法学习迭代1000次可以得到正确率96.02%

2.3 总结

可以看出神经网络在准确度上明显优于Logistic方法，这可以理解为神经网络是一种复杂化了的Logistic方法。而Fisher方法相对于Logistic方法的准确度相对较差，但并不明显