1.

课程名称:

实验名称:

实验内容:

1.(i) $\frac{\partial E(w_1, w_0 | Z_{train})}{\partial w_0} = \frac{1}{N}\sum_{t=1}^{N}(r_t - (w_1 x_t + w_0))(-2) = 0$

$\sum_{t=1}^{N}(r_t - w_1 x_t - w_0) = 0$

$w_0 = \sum_{t=1}^{N}(-w_1 x_t + r_t)$

$= \bar{r} - w_1 \bar{x}$

$\frac{\partial E(w_1, w_0 | Z_{train})}{\partial w_1} = \frac{1}{N}\sum_{t=1}^{N}(-x_t)(r_t - (w_1 x_t + w_0)) = 0$

$\sum_{t=1}^{N}(-x_t r_t + w_1 x_t^2 + w_0 x_t) = 0$

$w_1 \sum_{t=1}^{N} x_t^2 + w_0 \sum_{t=1}^{N} x_t - \sum_{t=1}^{N} x_t r_t = 0$

$w_1 \sum_{t=1}^{N} x_t^2 + (\bar{r} - \bar{x} w_1) \sum_{t=1}^{N} x_t - \sum_{t=1}^{N} x_t r_t = 0$

$\frac{1}{N} w_1 \sum_{t=1}^{N} x_t^2 + (\bar{r} - \bar{x} w_1)\bar{x} - \frac{1}{N}\sum_{t=1}^{N} x_t r_t = 0$

$\frac{1}{N} w_1 \sum_{t=1}^{N} x_t^2 + \bar{r}\bar{x} - \bar{x}^2 w_1 - \frac{1}{N}\sum_{t=1}^{N} x_t r_t = 0$

$w_1 (\frac{1}{N}\sum_{t=1}^{N} x_t^2 - \bar{x}^2) = \frac{1}{N}\sum_{t=1}^{N} x_t r_t - \bar{r}\bar{x}$

$w_1 = \frac{\frac{1}{N}\sum_{t=1}^{N} x_t r_t - \bar{r}\bar{x}}{\frac{1}{N}\sum_{t=1}^{N} x_t^2 - \bar{x}^2}$

Therefore, $\begin{cases} w_1 = \frac{\frac{1}{N}\sum_{t=1}^{N} x_t r_t - \bar{r}\bar{x}}{\frac{1}{N}\sum_{t=1}^{N} x_t^2 - \bar{x}^2} \\ w_0 = \bar{r} - w_1 \bar{x} \end{cases}$

(ii) $E(V_2, V_1, V_0 | \mathcal{Z}_{train}) = \frac{1}{N} \sum_{t=1}^{N} (r_t - (V_2 x_t^{20} + V_1 x_t^3 + V_0))^2$

$$\frac{\partial E}{\partial V_2} = \frac{1}{N} \sum_{t=1}^{N} 2 (r_t - (V_2 x_t^{20} + V_1 x_t^3 + V_0)) \cdot (-1)(x_t^{20}) = 0$$

$$= \sum_{t=1}^{N} r_t x_t^{20} - \sum_{t=1}^{N} (V_2 x_t^{40}) - \sum_{t=1}^{N} V_1 x_t^{23} - \sum_{t=1}^{N} V_0 x_t^{23} = 0$$

$$\sum_{t=1}^{N} V_2 x_t^{40} + \sum_{t=1}^{N} V_1 x_t^{23} + \sum_{t=1}^{N} V_0 x_t^{20} = \sum_{t=1}^{N} r_t x_t^{20}$$

$$\frac{\partial E}{\partial V_1} = \frac{1}{N} \sum_{t=1}^{N} 2 (r_t - (V_2 x_t^{20} + V_1 x_t^3 + V_0))(-1)(x_t^3) = 0$$

$$\sum_{t=1}^{N} r_t x_t^3 - \sum_{t=1}^{N} V_2 x_t^{23} - \sum_{t=1}^{N} V_1 x_t^6 - \sum_{t=1}^{N} V_0 x_t^3 = 0$$

$$\sum_{t=1}^{N} V_2 x_t^{23} + \sum_{t=1}^{N} V_1 x_t^6 + \sum_{t=1}^{N} V_0 x_t^3 = \sum_{t=1}^{N} r_t x_t^3$$

$$\frac{\partial E}{\partial V_0} = \frac{1}{N} \sum_{t=1}^{N} 2 (r_t - (V_2 x_t^{20} + V_1 x_t^3 + V_0))(-1) = 0$$

$$\sum_{t=1}^{N} r_t - \sum_{t=1}^{N} V_2 x_t^{20} - \sum_{t=1}^{N} V_1 x_t^3 - \sum_{t=1}^{N} V_0 = 0$$

$$\sum_{t=1}^{N} V_2 x_t^{20} + \sum_{t=1}^{N} V_1 x_t^3 + \sum_{t=1}^{N} V_0 = \sum_{t=1}^{N} r_t$$

Let $A = bX$ to show this

$$A = \begin{bmatrix} \sum_{t=1}^{N} r_t x_t^{20} \\ \sum_{t=1}^{N} r_t x_t^3 \\ \sum_{t=1}^{N} r_t \end{bmatrix} \quad b = \begin{bmatrix} \sum_{t=1}^{N} x_t^{40} & \sum_{t=1}^{N} x_t^{23} & \sum_{t=1}^{N} x_t^{20} \\ \sum_{t=1}^{N} x_t^{23} & \sum_{t=1}^{N} x_t^6 & \sum_{t=1}^{N} x_t^3 \\ \sum_{t=1}^{N} x_t^{20} & \sum_{t=1}^{N} x_t^3 & N \end{bmatrix} \quad X = \begin{bmatrix} V_2 \\ V_1 \\ V_0 \end{bmatrix}$$

Therefore, $X = b^{-1} A$

山东财经大学实验报告

学院: 班级: 姓名: 学号: 年 月 日

课程名称:

实验名称:

实验内容:

(iii)

No, I don't think professor Gopher's claim is correct. Since if we let $w_1^* = 1$, $w_0^* = 0$, That's means that the Training set is the points of $y = x$, the empirical error is 0. For $E(v_2^*, v_1^*, v_0^* | Z_{train})$, it could be showed as $y = x$ since thee is no X in the function. The empirical error of it must be greater than 0. So $E(v_2^*, v_1^*, v_0^* | Z_{train}) > E(w_1^*, w_0^* | Z_{train})$

Therefore, Professor Gopher's claim is not cnoect.

2. (i) $tr(A) = 1+2+9+64 = 76$

$tr(A^T) = tr(A) = 76$

$tr(A^TA) = 4+85+880+4369 = 5278$

$tr(AA^T) = tr(A^TA) = 5278$

(ii) The absolute value of $|A|$ is the directed area or volume of a superparallelepiped consisting of row or column vectors in a determinant.

(iii) Yes, the rows of A linearly independent.

Since the rank of A is 4, which is equal the number of rows. Therefore, it's independent.

3.

(i)

Error rates for LinearSVC with Boston50											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.09999999999999998	0.21999999999999997	0.30000000000000004	0.09999999999999998	0.18000000000000005	0.09999999999999998	0.33999999999999997	0.21999999999999997	0.33999999999999997	0.52	0.242	0.12851459061133877

Error rates for LinearSVC with Boston25											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.19999999999999996	0.020000000000000018	0.26	0.06000000000000005	0.33999999999999997	0.0	0.06000000000000005	0.18000000000000005	0.18000000000000005	0.16000000000000003	0.14600000000000005	0.10394221681491625

Error rates for LinearSVC with Digits											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.12290502793296088	0.05027932960893855	0.12290502793296088	0.11731843575418999	0.05586592178770955	0.04469273743016755	0.03910614525139666	0.07262569832402233	0.12290502793296088	0.011173184358754888	0.07597765363128492	0.03991180725121235

Error rates for SVC with Boston50											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.38	0.24	0.56	0.31999999999999995	0.36	0.14	0.28	0.28	0.16000000000000003	0.040000000000000036	0.276	0.13763720427268203

Error rates for SVC with Boston25											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.339999999999997	0.020000000000018	0.48	0.160000000000003	0.060000000000005	0.020000000000018	0.060000000000005	0.14	0.319999999999995	0.079999999999996	0.168	0.150253119767943 56

Error rates for SVC with Digits											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.067039106145251 44	0.011173184357541 888	0.055865921787709 55	0.016759776536312 887	0.022346368715083 775	0.011173184357541 888	0.016759776536312 887	0.011173184357541 888	0.016759776536312 887	0.0	0.022905027932960 908	0.020212349178911 238

Error rates for LogisticRegression with Boston50											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.12	0.180000000000005	0.12	0.12	0.180000000000005	0.060000000000005	0.319999999999995	0.300000000000004	0.040000000000036	0.160000000000003	0.16	0.086717933554715 19

Error rates for LogisticRegression with Boston25											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.26	0.020000000000018	0.24	0.060000000000005	0.079999999999996	0.0	0.060000000000005	0.180000000000005	0.160000000000003	0.12	0.118000000000002	0.085064681272546 96

Error rates for LogisticRegression with Digits											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.094	0.039	0.122	0.067	0.055	0.050	0.050	0.083	0.111	0.0	0.067	0.034

9720 6703 9106 1	1061 4525 1396 66	9050 2793 2960 88	0391 0614 5251 44	8659 2178 7709 55	2793 2960 8938 55	2793 2960 8938 55	7988 8268 1564 21	7318 4357 5418 99		5977 6536 3128 49	8390 2084 3952 76

(ii)

Error rates for LinearSVC with Boston50											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.149 6062 9921 2598 38	0.188 9763 7795 2755 9	0.173 2283 4645 6692 94	0.220 4724 4094 4881 94	0.196 8503 9370 0787 38	0.244 0944 8818 8976 4	0.283 4645 6692 9133 9	0.480 3149 6062 9921 3	0.204 7244 0944 8818 87	0.385 8267 7165 3543 3	0.252 7559 0551 1811 04	0.099 0030 2825 2671 18

Error rates for LinearSVC with Boston25											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.125 9842 5196 8503 94	0.212 5984 2519 6850 35	0.173 2283 4645 6692 94	0.165 3543 3070 8661 46	0.125 9842 5196 8503 94	0.149 6062 9921 2598 38	0.102 3622 0472 4409 49	0.094 4881 8897 6378 01	0.228 3464 5669 2913 42	0.149 6062 9921 2598 38	0.152 7559 0551 1811 04	0.041 5461 6049 8497 374

Error rates for LinearSVC with Digits											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.071 1111 1111 1111 12	0.053 3333 3333 3333 344	0.057 7777 7777 7777 82	0.051 1111 1111 1111 11	0.042 2222 2222 2222 27	0.055 5555 5555 5555 58	0.068 8888 8888 8888 89	0.037 7777 7777 7777 8	0.055 5555 5555 5555 58	0.071 1111 1111 1111 12	0.056 4444 4444 4444 464	0.010 8502 7165 8429 951

Error rates for SVC with Boston50											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.220 4724 4094 4881	0.307 0866 1417 3228	0.267 7165 3543 3070	0.267 7165 3543 3070	0.220 4724 4094 4881	0.314 9606 2992 1259	0.307 0866 1417 3228	0.157 4803 1496 0629	0.196 8503 9370 0787	0.220 4724 4094 4881	0.248 0314 9606 2992	0.050 3259 8797 2519

94	36	83	83	94	84	36	97	38	94	13	02

Error rates for SVC with Boston25											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.157 4803 1496 0629 97	0.102 3622 0472 4409 49	0.141 7322 8346 4566 9	0.102 3622 0472 4409 49	0.133 8582 6771 6535 42	0.141 7322 8346 4566 9	0.236 2204 7244 0944 9	0.228 3464 5669 2913 42	0.188 9763 7795 2755 9	0.149 6062 9921 2598 38	0.158 2677 1653 5433 1	0.044 0452 4809 7470 86

Error rates for rSVC with Digits											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.006 6666 6666 6666 71	0.006 6666 6666 6666 71	0.013 3333 3333 3333 308	0.01 5555 5555 5555 5545	0.022 2222 2222 2222 254	0.013 3333 3333 3333 308	0.011 1111 1111 1111 072	0.006 6666 6666 6666 71	0.017 7777 7777 7777 78	0.020 0000 0000 0000 018	0.013 3333 3333 3333 341	0.005 3518 1981 2796 569

Error rates for LogisticRegression with Boston50											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.133 8582 6771 6535 42	0.244 0944 8818 8976 4	0.181 1023 6220 4724 42	0.149 6062 9921 2598 38	0.212 5984 2519 6850 35	0.157 4803 1496 0629 97	0.149 6062 9921 2598 38	0.196 8503 9370 0787 38	0.259 8425 1968 5039 35	0.251 9685 0393 7007 87	0.193 7007 8740 1574 8	0.044 2909 0113 5197 59

Error rates for LogisticRegression with Boston25											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.062 9921 2598 4251 97	0.070 8661 4173 2283 45	0.023 6220 4724 4094 446	0.070 8661 4173 2283 45	0.047 2440 9448 8189 003	0.110 2362 2047 2440 97	0.110 2362 2047 2440 97	0.070 8661 4173 2283 45	0.094 4881 8897 6378 01	0.039 3700 7874 0157 52	0.070 0787 4015 7480 32	0.027 3784 8606 4116 09

Error rates for LogisticRegression with Digits											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD

0.037 7777 7777 7777 8	0.046 6666 6666 6666 634	0.028 8888 8888 8888 853	0.035 5555 5555 5555 56	0.044 4444 4444 4444 4	0.026 6666 6666 6666 616	0.048 8888 8888 8888 87	0.022 2222 2222 2222 254	0.015 5555 5555 5555 545	0.026 6666 6666 6666 616	0.033 3333 3333 3333 31	0.010 5643 2384 3559 742

4.

Error rates for LinearSVC with X1											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.094 9720 6703 9106 1	0.078 2122 9050 2793 32	0.106 1452 5139 6648 1	0.150 8379 8882 6815 65	0.167 5977 6536 3128 54	0.094 9720 6703 9106 1	0.050 2793 2960 8938 55	0.083 7988 8268 1564 21	0.167 5977 6536 3128 54	0.067 0391 0614 5251 44	0.106 1452 5139 6648 06	0.039 6608 7005 4299 115

Error rates for LinearSVC with X2											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.050 2793 2960 8938 55	0.0	0.067 0391 0614 5251 44	0.033 5195 5307 2625 66	0.022 3463 6871 5083 775	0.022 3463 6871 5083 775	0.005 5865 9217 8770 999	0.011 1731 8435 7541 888	0.039 1061 4525 1396 66	0.0	0.025 1396 6480 4469 275	0.021 2363 9978 6310 856

Error rates for SVC with X1											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.486 0335 1955 3072 6	0.402 2346 3687 1508 4	0.513 9664 8044 6927 4	0.502 7932 9608 9385 5	0.491 6201 1173 1843 6	0.497 2067 0391 0614 5	0.519 5530 7262 5698 3	0.391 0614 5251 3966 5	0.391 0614 5251 3966 5	0.005 5865 9217 8770 999	0.420 1117 3184 3575 4	0.146 5519 7704 6432 1

Error rates for SVC with X2											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.871 5083 7988	0.837 9888 2681	0.871 5083 7988	0.849 1620 1117	0.832 4022 3463	0.837 9888 2681	0.854 7486 0335	0.821 2290 5027	0.737 4301 6759	0.005 5865 9217	0.751 9553 0726	0.251 3867 1612

8268 1	5642 5	8268 1	3184 4	6871 6	5642 5	1955 3	9329 6	7765 4	8770 999	257	9073 93

Error rates for LogisticRegression with X1											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.150 8379 8882 6815 65	0.022 3463 6871 5083 775	0.122 9050 2793 2960 88	0.100 5586 5921 7877 1	0.083 7988 8268 1564 21	0.089 3854 7486 0335 21	0.044 6927 3743 0167 55	0.094 9720 6703 9106 1	0.106 1452 5139 6648 1	0.0	0.081 5642 4581 0055 86	0.043 8609 7525 4503 97

Error rates for LogisticRegression with X2											
F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Mean	SD
0.055 8659 2178 7709 55	0.0	0.083 7988 8268 1564 21	0.027 9329 6089 3854 775	0.027 9329 6089 3854 775	0.016 7597 7653 6312 887	0.005 5865 9217 8770 999	0.016 7597 7653 6312 887	0.033 5195 5307 2625 66	0.0	0.026 8156 4245 8100 575	0.024 9590 0324 4344 878