



Rochester Institute of Technology,
Department of Computer Science
ARTIFICIAL INTELLIGENCE
INTRODUCTION TO ARTIFICIAL
INTELLIGENCE

Mini Project 2

Application of Neural Networks for Pattern Recognition and Prediction

Due: November 8, 2004

General Contents

1. This project introduces you into the area of experimental computer science. You will conduct experiments with different neural networks or change neural network parameters in order to design more efficient algorithms.
2. The project consists of two tasks: one for recognizing hand written digits, another one for data driven forecasting. These two tasks represent two application areas, where a neural network methodology is applied most frequently.
3. Students, who do this mini-project as a group should do both tasks.
4. Students, who do this mini project alone may choose one task for implementation.
5. You have to design, develop (write a code), run, test and evaluate the software, which could be applied for solving a problem specified in the task description.
6. You can either write a code in any conventional programming language or apply a specialized tool such as Matlab or another tool available to you.
7. You have to develop and submit a proper documentation (see project report section).
8. You have to document :
 - a. the product itself and guidelines how to use it,
 - b. testing, you performed, and how you evaluated the product based on test results,
 - c. the development process (for group projects only): how you distributed the workload, who did what, how much time you spent on different aspects, etc.

Project work:

Task1: Recognition of hand written digit patterns

Draw a few fonts A, B, C, D, E, F each on the 5x5 grid. You can draw as many examples of each font as you wish. This will be your basic set.

Write a computer program to classify letters from different fonts using neural network learning. You can apply any type of the neural network you wish or their combination. Use as many output units as you have different letters in your training set. Convert the letters to binary form. (You may wish to enter the pixels as "1" and "0")

Repeat your classification for several letters. After training with each letter, test the ability of the net to classify noisy versions of the training pattern. Try 5, 10, 20 pixels wrong (change them randomly) and the same level of missing data (not known).

You have two options to treat unknown data:

1. assign them randomly and proceed with further training and recognition,

2. if you wish, you can exclude them from training and later from recognition

You have to conduct enough experiments to be able to answer the questions A,B,C given below. You may experiment with other letters also.

Question A: How does recognition accuracy change with an increase of the rate of wrong data and/or missing data.

Question B: What happens with recognition accuracy, when we increase the training set size?

Question C: Are some patterns harder to learn than others? Why?

In your report, please, provide answers to the questions given above.

Task 2: Data driven forecasting based on neural networks

The attachment (MS Excel file is available, please, request if you need) gives you monthly data on arrival of the US tourists to Japan along with some economic indicators. You have to predict the tourist numbers for the next few years based on these data.

You can see that different economic indicators are given. You can use all of them as inputs to your neural network forecaster. However, some indicators could be very important for the predictor, some are less important, others might be not important at all. Describe your methodology: which data you will use, which neural networks you will apply and how, etc. Explain all your decisions.

Submission Requirements for Project 2.

(1) Submission deadline is 11.59 pm, November 8, 2004

(2) Please, submit your project by email to icss455@cs.rit.edu

You have to submit:

a file named `pr1_yourname.*` should contain your documentation in doc, txt or pdf formats.

An archived file named `pr1_yourname.ext`, which contains both source and executable codes (if any).

GOOD LUCK!

Attachment

	USA	USA Personal	USA	USA	USA	Japan	Exch.Rate	
Month	Arrivals	Income	CPI	Imports	Exports	CPI	One Yen= US\$:	Own Trade
Jan-78	19806	1736.4	41.15	14.4222	9.8628		0.004143	0.015876
Feb-78	17471	1753.4	41.34	15.4322	9.9385		0.004189	0.016586
Mar-78	25720	1777.2	41.61	15.0952	11.1426		0.004496	0.017153
Apr-78	29767	1803.2	41.93	15.6043	11.6284		0.004486	0.017143
May-78	34254	1820.3	42.33	15.0902	11.7762		0.004476	0.016912
Jun-78	29617	1839.4	42.66	15.029	12.2636		0.004885	0.017181
Jul-78	30042	1861.9	42.98	15.7608	11.6556		0.005244	0.017094
Aug-78	23818	1880.3	43.25	15.2756	12.2861		0.005258	0.017184
Sep-78	26164	1896.1	43.64	16.1217	13.2749		0.005287	0.018328
Oct-78	33416	1918.9	44.03	15.9443	12.9012		0.005682	0.017747
Nov-78	25421	1935.8	44.3	16.0809	13.4476		0.005063	0.018168
Dec-78	18124	1956.4	44.56	16.2098	13.2823		0.005139	0.018145
Jan-79	18177	1977.1	44.95	17.8025	13.2649		0.004968	0.019066
Feb-79	16678	1994.9	45.41	15.7415	13.6155		0.004946	0.018017
Mar-79	23204	2018.6	45.87	16.5454	14.2983		0.004778	0.018929
Apr-79	25387	2022.6	46.33	16.987	13.979		0.004577	0.018992
May-79	27442	2041.5	46.86	17.7385	14.0836		0.00455	0.019517
Jun-79	27608	2059.4	47.38	18.1874	14.8186		0.004608	0.020243
Jul-79	28359	2090	47.91	18.1295	15.6923		0.004604	0.020597
Aug-79	24837	2109.7	48.36	19.7392	15.7171		0.004545	0.021592
Sep-79	29702	2125.9	48.82	19.691	15.8248		0.004478	0.021629
Oct-79	33058	2154.5	49.35	20.3357	16.6815		0.004207	0.022468
Nov-79	27919	2178.5	49.87	20.0745	16.9287		0.004019	0.02246
Dec-79	19555	2205.3	50.46	21.2748	16.7417		0.004172	0.023075
Jan-80	19114	2234.8	51.19	22.2989	17.4194		0.004188	0.024028
Feb-80	18453	2248.8	51.84	22.9471	16.9844		0.004003	0.024157
Mar-80	25267	2260.7	52.56	22.0477	18.2651		0.004005	0.024388
Apr-80	28268	2258.4	53.09	20.8122	18.5671		0.004184	0.024319
May-80	29250	2265.4	53.61	21.6826	17.6468		0.004458	0.024288
Jun-80	28282	2282.5	54.14	21.403	18.4403		0.004596	0.024606
Jul-80	26554	2314.9	54.21	20.0742	18.2667		0.004405	0.023715
Aug-80	25597	2336.2	54.6	20.6646	19.0865		0.004566	0.024587
Sep-80	29867	2366.1	55.06	20.8367	18.8284		0.004713	0.024534
Oct-80	36231	2409.8	55.58	21.2444	19.2136		0.004728	0.024587
Nov-80	32379	2439.6	56.17	20.7513	18.7151		0.004615	0.023984
Dec-80	19755	2470	56.7	22.3635	19.2509		0.004926	0.025289
Jan-81	20356	2491.7	57.22	23.679	18.902		0.004885	0.025384
Feb-81	18668	2508.7	57.75	22.917	19.7882		0.004789	0.025458
Mar-81	25229	2531.4	58.14	21.9826	21.2778		0.004739	0.025789
Apr-81	29709	2530	58.47	23.2657	19.7861		0.004651	0.025845
May-81	34141	2547.1	58.86	22.2481	18.899		0.004462	0.024702
Jun-81	30530	2571.4	59.39	23.0329	19.7498		0.004429	0.025683
Jul-81	31216	2629	60.05	21.0735	19.2894		0.004176	0.023946
Aug-81	29424	2656.7	60.51	24.3979	19.0308		0.004386	0.025765
Sep-81	32350	2671.3	61.1	22.3165	19.5507		0.004297	0.024838
Oct-81	45268	2675.1	61.29	24.1941	19.1632		0.004277	0.026029
Nov-81	34559	2689.3	61.56	23.5683	19.1529		0.004666	0.025648

Dec-81	21701	2690.9	61.75	20.6994	18.8854		0.004548	0.023765
Jan-82	22977	2695.4	61.95	23.5982	18.5836		0.004338	0.02575
Feb-82	21272	2712.8	62.15	20.3986	18.6136		0.004219	0.023816
Mar-82	30423	2720	62.15	20.8889	18.4616		0.004057	0.024022
Apr-82	35440	2739.5	62.34	18.5084	18.0052		0.004254	0.022194
May-82	40096	2758	62.93	21.4217	18.1243		0.004107	0.024038
Jun-82	34945	2764.6	63.66	22.1288	18.8229		0.003937	0.024892
Jul-82	38502	2780.2	63.98	20.7563	18.0596		0.003883	0.023706
Aug-82	34549	2786.9	64.11	23.9924	17.4633		0.003821	0.025319
Sep-82	36202	2792.1	64.11	21.5182	17.3203		0.003711	0.02372
Oct-82	53719	2807.6	64.38	21.9324	16.6714		0.003606	0.02356
Nov-82	35557	2825.4	64.31	19.737	15.8519		0.003951	0.02172
Dec-82	26126	2838.2	64.11	20.0018	16.3466		0.004255	0.022183
Jan-83	24154	2843.7	64.25	21.0752	17.232		0.004203	0.023112
Feb-83	21093	2849.2	64.31	19.682	16.312		0.004247	0.021716
Mar-83	31945	2867.9	64.38	20.3867	16.69		0.004177	0.022369
Apr-83	39375	2884.7	64.84	20.8212	16.095		0.004219	0.021759
May-83	43730	2914.5	65.1	22.4064	15.655		0.004196	0.022434
Jun-83	42412	2928.5	65.23	21.8524	16.959		0.004172	0.022876
Jul-83	44069	2955	65.49	22.8575	16.486		0.004137	0.022784
Aug-83	40469	2958.4	65.69	23.7461	16.582		0.004055	0.023354
Sep-83	42478	2992.4	65.89	23.4773	17.257		0.004235	0.023589
Oct-83	63208	3026.1	66.15	25.4649	17.033		0.00428	0.024115
Nov-83	39307	3055.4	66.35	24.185	17.063		0.004274	0.023406
Dec-83	29085	3087.3	66.54	24.0328	17.298		0.004307	0.023453
Jan-84	28785	3116.9	67	27.397	17.889		0.00426	0.025148
Feb-84	25154	3155.2	67.33	27.5874	17.208		0.004283	0.024876
Mar-84	39565	3184	67.53	28.1778	17.906		0.00445	0.025591
Apr-84	45197	3220.4	67.79	29.4007	17.52		0.004426	0.025622
May-84	49874	3233.4	67.92	27.2623	17.978		0.00432	0.024704
Jun-84	47686	3266	68.05	26.4605	17.705		0.004211	0.024117
Jul-84	45229	3294.4	68.31	32.925	19.154		0.004073	0.028195
Aug-84	41170	3328.1	68.51	28.2127	18.123		0.004144	0.025086
Sep-84	49042	3360.3	68.71	29.753	18.21		0.004073	0.025967
Oct-84	64254	3350.1	68.97	28.0638	18.411		0.004077	0.024973
Nov-84	42086	3377.3	69.1	28.6166	18.395		0.00406	0.025261
Dec-84	33083	3411.7	69.23	27.1757	19.142		0.003982	0.024888
Jan-85	29898	3426.6	69.36	29.6867	19.401	87.93	0.003927	0.004978
Feb-85	26205	3444.9	69.76	29.2989	17.853	87.85	0.003854	0.004853
Mar-85	43230	3470.2	70.09	29.4922	18.446	87.85	0.00396	0.004963
Apr-85	52357	3475.3	70.22	29.6289	17.779	88.11	0.003964	0.004974
May-85	55535	3486.5	70.35	30.0799	17.414	88.02	0.003971	0.004968
Jun-85	54250	3506.2	70.55	30.8532	17.438	88.55	0.004017	0.005042
Jul-85	51406	3515.9	70.68	27.9202	17.412	88.73	0.004226	0.005305
Aug-85	46555	3527.5	70.81	27.3267	17.423	88.73	0.004215	0.005282
Sep-85	53189	3540.9	70.94	33.282	17.732	88.46	0.004608	0.005746
Oct-85	67086	3576.8	71.2	28.8211	17.368	88.73	0.004728	0.005892
Nov-85	44702	3585.8	71.53	31.6574	17.976	88.82	0.00495	0.006146
Dec-85	33616	3623.6	71.86	34.3974	17.024	88.99	0.004988	0.006177
Jan-86	32352	3630.1	72.12	31.955	18.5571	89.17	0.005214	0.006447
Feb-86	28453	3647.7	71.99	29.7897	18.5201	89.26	0.005565	0.0069
Mar-86	43826	3674.8	71.6	30.7098	17.9988	88.89	0.005568	0.006913

Apr-86	51902	3674.3	71.33	31.8742	18.7616	88.51	0.005942	0.007373	0.02582
May-86	56281	3686.6	71.53	31.0175	19.0229	88.51	0.005821	0.007203	0.025516
Jun-86	53209	3703.7	71.79	31.564	20.0377	88.42	0.006061	0.007465	0.026313
Jul-86	50178	3721.3	71.86	32.5391	19.7308	88.51	0.006481	0.007983	0.026408
Aug-86	44726	3734.6	71.92	31.5272	17.9698	88.33	0.006406	0.007868	0.025007
Sep-86	50783	3752	72.19	32.9322	18.2818	88.14	0.00651	0.007948	0.025875
Oct-86	61784	3756.6	72.32	32.4365	19.7281	88.05	0.006192	0.007539	0.026216
Nov-86	46436	3770.6	72.45	33.951	19.2949	88.14	0.006158	0.007492	0.026759
Dec-86	32252	3797	72.71	31.9992	19.2548	88.23	0.006285	0.007627	0.025758
Jan-87	31914	3823.8	73.11	33.6035	18.3786	88.14	0.006557	0.007905	0.025934
Feb-87	26260	3854	73.37	32.5537	19.3725	88.23	0.006534	0.007857	0.025906
Mar-87	41332	3878.7	73.63	33.7106	19.982	88.33	0.006859	0.008228	0.026787
Apr-87	51772	3886.7	73.96	33.8136	20.2503	88.51	0.007168	0.008578	0.026689
May-87	55629	3922	74.16	35.0163	20.1136	88.51	0.006944	0.008288	0.027215
Jun-87	52393	3937.2	74.48	35.6579	21.3815	88.61	0.006803	0.008094	0.028157
Jul-87	51443	3961.6	74.68	36.5197	22.4754	88.61	0.006698	0.007947	0.028881
Aug-87	46256	3998.9	75.01	36.0817	20.8465	88.7	0.007022	0.008304	0.027869
Sep-87	51859	4016.6	75.27	35.5021	21.6694	88.8	0.006833	0.008061	0.027988
Oct-87	64026	4057.6	75.47	37.8689	22.1368	88.7	0.007215	0.00848	0.028875
Nov-87	44857	4082.4	75.73	36.7581	23.3281	88.7	0.007544	0.008836	0.028914
Dec-87	32520	4130.4	75.86	37.3559	24.1872	88.89	0.008097	0.009488	0.029615
Jan-88	34309	4132.5	76.12	36.7732	23.685	88.98	0.007862	0.00919	0.0289
Feb-88	27222	4155.3	76.26	37.9044	24.5432	88.98	0.007813	0.009116	0.029851
Mar-88	42291	4182.6	76.45	37.9188	27.4204	88.98	0.007974	0.009281	0.031233
Apr-88	46250	4206.5	76.91	36.8822	26.2684	88.8	0.00801	0.009248	0.029836
May-88	50355	4223.1	77.11	37.6532	27.6078	88.7	0.007984	0.009184	0.030833
Jun-88	45548	4253.6	77.44	38.828	26.6557	88.8	0.007553	0.008661	0.030938
Jul-88	47672	4288.6	77.76	36.542	26.2097	88.98	0.007544	0.008633	0.029496
Aug-88	41162	4305.4	78.09	39.2172	27.3919	89.26	0.007407	0.008466	0.03131
Sep-88	46106	4332.2	78.42	38.2146	27.5022	89.45	0.007432	0.008477	0.03089
Oct-88	58279	4368.6	78.68	38.6206	28.2114	89.64	0.007952	0.00906	0.031012
Nov-88	42878	4385.2	78.95	39.6444	27.7279	89.83	0.008214	0.009346	0.031262
Dec-88	34187	4431.4	79.21	41.3438	29.2029	89.92	0.007946	0.00902	0.032735
Jan-89	37533	4493.2	79.54	39.0228	28.3808	89.92	0.007743	0.008753	0.030901
Feb-89	29132	4511.8	79.8	39.6841	28.494	89.83	0.007874	0.008864	0.031256
Mar-89	45530	4547.7	80.19	41.5345	30.6593	90.01	0.007573	0.0085	0.033097
Apr-89	48645	4566.3	80.78	40.3211	30.5692	90.95	0.00755	0.008501	0.032324
May-89	50620	4564.9	81.18	42.5842	30.6895	91.23	0.007008	0.007876	0.033411
Jun-89	50842	4589.2	81.44	41.1461	31.2953	91.42	0.00694	0.00779	0.033031
Jul-89	48374	4607.1	81.7	40.6617	29.9336	91.61	0.007228	0.008105	0.032037
Aug-89	42132	4616.5	81.7	42.2805	30.1675	91.61	0.00693	0.007771	0.032878
Sep-89	43737	4628.6	81.9	40.5484	30.4146	91.7	0.007179	0.008038	0.032204
Oct-89	55636	4659.2	82.29	43.3983	31.1596	92.26	0.007027	0.007878	0.033719
Nov-89	43740	4695.7	82.62	42.3147	30.526	91.7	0.006995	0.007764	0.032942
Dec-89	35704	4717.1	82.88	39.6983	31.522	92.17	0.006971	0.007752	0.032209
Jan-90	39574	4766.4	83.67	43.4919	31.6132	92.73	0.006937	0.007688	0.033548
Feb-90	33857	4807.4	84	40.9067	31.7096	93.02	0.006739	0.007463	0.032436
Mar-90	45826	4828.7	84.39	43.5627	33.1874	93.02	0.006361	0.007011	0.034282
Apr-90	47363	4865.1	84.59	41.5038	32.0444	93.11	0.006275	0.006907	0.032777
May-90	51411	4869.6	84.72	42.5997	32.5112	93.39	0.006592	0.007267	0.033473
Jun-90	51975	4903.1	85.25	41.9306	33.6959	93.3	0.00654	0.007158	0.033703
Jul-90	53546	4935	85.64	43.26	32.3077	93.48	0.006787	0.007408	0.033739

Aug-90	45915	4943.9	86.36	43.7369	32.5572	93.86	0.006932	0.007534	0.034063
Sep-90	48614	4975.4	86.95	43.0618	32.3116	94.05	0.007257	0.00785	0.033652
Oct-90	56100	4967.8	87.54	46.3691	34.4926	94.8	0.007731	0.008372	0.036401
Nov-90	43388	4977.3	87.74	44.9518	33.5811	95.08	0.007499	0.008126	0.035353
Dec-90	37184	4999.3	88.07	41.6122	33.8003	95.45	0.00744	0.008063	0.033948
Jan-91	34652	4987.9	88.4	43.0091	34.29	96.2	0.007622	0.008295	0.03497
Feb-91	27343	4999.4	88.46	40.7014	33.6372	96.2	0.007576	0.008239	0.03363
Mar-91	43514	5012.3	88.46	40.2305	34.4117	96.39	0.007092	0.007728	0.033768
Apr-91	44823	5038.6	88.66	41.5738	35.3026	96.3	0.007278	0.007905	0.034585
May-91	50330	5059	88.99	41.7745	35.1097	96.48	0.007252	0.007862	0.034588
Jun-91	50940	5094.6	89.25	41.0919	34.9262	96.58	0.007252	0.007848	0.034199
Jul-91	51725	5089.8	89.38	42.6081	34.8705	96.86	0.007257	0.007864	0.03477
Aug-91	45434	5105.3	89.64	42.8401	34.8563	97.05	0.007291	0.007894	0.034868
Sep-91	48047	5135.3	89.9	43.5885	35.1586	96.67	0.007527	0.008094	0.03534
Oct-91	57681	5135.4	90.04	44.4658	36.6555	97.23	0.007639	0.008249	0.03621
Nov-91	48464	5156.5	90.43	43.114	37.0853	97.98	0.007689	0.008331	0.035798
Dec-91	40122	5210.2	90.69	43.437	35.6193	97.98	0.007987	0.008629	0.035288
Jan-92	42149	5241.1	90.76	43.3649	35.404	97.89	0.007952	0.008577	0.034837
Feb-92	35013	5284.5	90.95	42.6563	37.702	97.98	0.007735	0.008333	0.035539
Mar-92	49222	5304.8	91.28	44.493	37.208	98.27	0.007508	0.008083	0.036133
Apr-92	49423	5330	91.48	45.1796	36.558	98.55	0.007491	0.00807	0.035814
May-92	52616	5355.3	91.68	45.3598	36.012	98.45	0.007797	0.008373	0.035654
Jun-92	50904	5371.3	91.94	46.6377	38.356	98.83	0.007968	0.008565	0.037241
Jul-92	51813	5383.5	92.2	46.7211	37.502	98.55	0.007862	0.008403	0.03662
Aug-92	44745	5373.4	92.4	46.8278	36.445	98.73	0.008137	0.008694	0.036207
Sep-92	44631	5415.2	92.6	47.787	37.469	98.73	0.008389	0.008944	0.037069
Oct-92	56772	5464	92.99	47.9354	38.932	98.45	0.008117	0.008594	0.037279
Nov-92	45982	5484.3	93.25	47.4437	37.744	98.64	0.008019	0.008483	0.036558
Dec-92	37670	5677.1	93.38	47.9463	38.831	99.02	0.008016	0.0085	0.03724
Jan-93	41946	5461.7	93.71	47.4149	37.616	99.02	0.008026	0.008481	0.036501
Feb-93	32726	5470.9	93.91	46.5922	37.064	99.39	0.008496	0.008992	0.035911
Mar-93	44798	5464.8	94.04	50.8302	39.027	99.39	0.008595	0.009084	0.038572
Apr-93	48365	5575	94.37	50.4188	38.717	99.39	0.008997	0.009476	0.038032
May-93	50196	5607.5	94.63	49.6707	39.592	99.39	0.00939	0.009862	0.038086
Jun-93	47015	5603.2	94.7	51.2353	37.932	99.67	0.009368	0.00986	0.038045
Jul-93	48547	5609.2	94.83	49.904	37.422	100.42	0.009443	0.01	0.037097
Aug-93	44119	5640.1	95.02	50.0828	37.833	100.61	0.009597	0.010162	0.037347
Sep-93	42286	5641.6	95.15	51.1881	38.413	100.23	0.00951	0.010018	0.038063
Oct-93	53166	5669	95.55	52.8619	40.006	99.95	0.009242	0.009668	0.038864
Nov-93	44936	5693.2	95.81	51.9875	40.049	99.58	0.009179	0.00954	0.038516
Dec-93	35301	5883.4	96.01	51.3962	41.42	99.95	0.008941	0.009308	0.038842
Jan-94	41013	5656.4	96.01	51.8062	39.843	100.33	0.009099	0.009508	0.038032
Feb-94	32293	5725.4	96.27	52.2415	38.293	100.42	0.009602	0.010016	0.037569
Mar-94	47270	5759.4	96.53	54.5308	42.487	100.61	0.009695	0.010105	0.04026
Apr-94	48386	5832.1	96.6	55.2358	41.251	100.23	0.009756	0.010123	0.039489
May-94	46497	5870.6	96.8	56.0057	41.379	100.33	0.009572	0.009921	0.039856