UTM

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SECJ3563-06 COMPUTATIONAL INTELLIGENCE (KEPINTARAN KOMPUTER)

Lab Exercise 6 Deep Learning

LECTURER: DR SHAFAATUNNUR HASAN

NAME	MATRIC NO
GAN HENG LAI	A21EC0176
NG KAI ZHENG	A21EC0101
LEW CHIN HONG	A21EC0044
YEO CHUN TECK	A21EC0148

Introduction

The goal of this lab is to develop a deep learning algorithm to classify Pokemon images from generation 1 to generation 7 based on their primary types. The dataset used consists of Pokemon images and a CSV file containing the Pokemon's name, primary type (Type1), secondary type (Type2), and evolution stage.

Dataset Preparation

The Pokemon dataset was downloaded from Kaggle, including a set of images and an Excel file. To prepare the dataset for deep learning, the following steps were taken:

1. Add .png to each name grid in the CSV file.
2. The Excel file was converted to an ARFF file using the online converter tool: https://ilyakuzovkin.com/csv2arff/
3. Modify the type of attribute of the “Name” from ‘Nominal’ to ‘string’.
4. The imported data in the ARFF file was checked for accuracy and completeness, and any necessary fixes or filtering were performed.

The ARFF file contains the following attributes (Only taken Name and Type1 attributes):

1. Name (Name of the Pokemon)
2. Type1 (primary type)
3. Type2 (secondary type)
4. Evolution

The number of classes in the dataset is 18:

Grass	Fire	Water	Bug	Normal
Poison	Electric	Ground	Fairy	Fighting
Psychic	Rock	Ghost	Ice	Dragon
Dark	Steel	Flying		

Experiment Setup

The classification was performed using the Dl4jMlpClassifier from the Deeplearning4j library. The ImageInstanceIterator was used with the following parameters:

- Size of mini-batch: 16
- Desired width: 120
- Desired height: 120
- Desired number of channels: 3

The dataset was split into 70% for training and 30% for testing.

Three different types of layer configurations were evaluated:

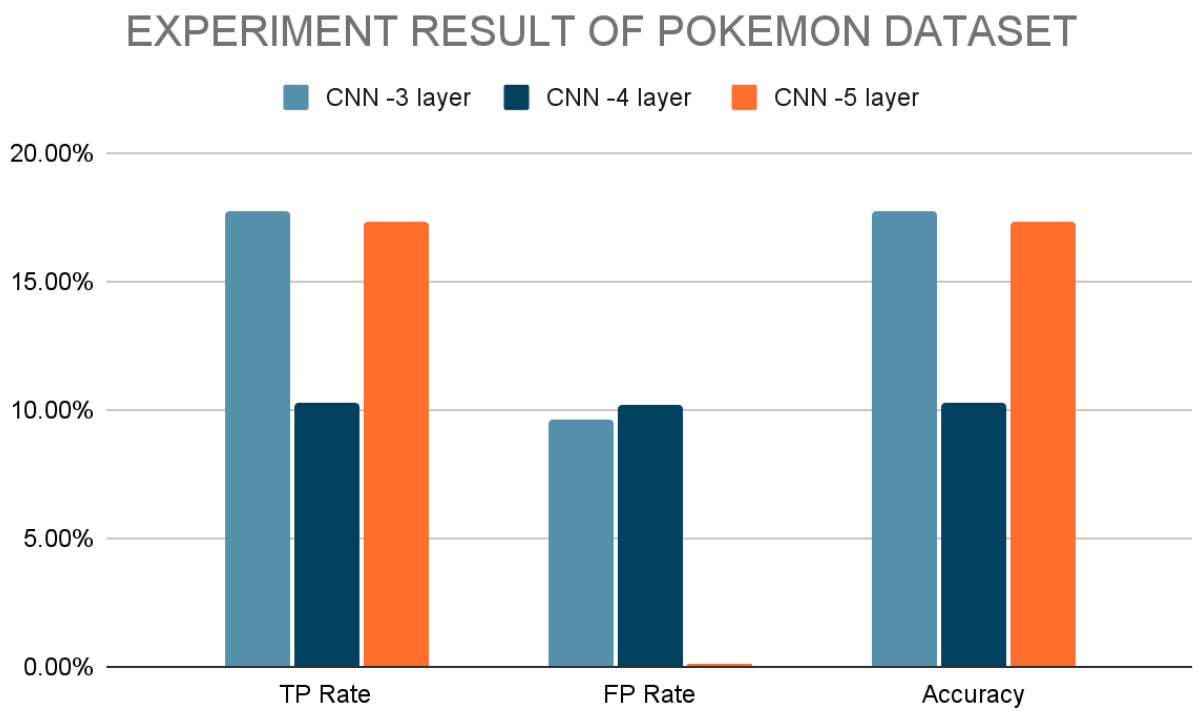
Type of Layer	**Layer Detail**
CNN 3-Layer	Convolutional Layer (number of filters: 18) Subsampling Layer Output Layer (number of outputs: 18)
CNN 4-Layer	Convolutional Layer (number of filters: 18) Subsampling Layer Dense Layer (number of outputs: 18) Output Layer (number of outputs: 18)
CNN 5-Layer	Convolutional Layer (number of filters: 18) Subsampling Layer Convolutional Layer (number of filters: 18) Subsampling Layer Output Layer (number of outputs: 18)

Result of Experiments

The results of the experiments are summarized in the following table:

	CNN -3 layer	**CNN -4 layer**	**CNN -5 layer**
TP Rate	17.7%	10.30%	17.30%
FP Rate	9.6%	10.20%	0.097%
Accuracy	17.70%	10.29%	17.28%

Experimental Result Graph



CNN 3 Layer

Use Training Set

Detailed Accuracy by Class:

```
=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Bug
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Dark
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Dragon
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Electric
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Fairy
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Fighting
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Fire
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Flying
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Ghost
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Grass
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Ground
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Ice
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Normal
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Poison
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Psychic
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Rock
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Steel
                 1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000     Water
Weighted Avg.    1.000    0.000    1.000      1.000    1.000      1.000    1.000     1.000
```

Confusion Matrix:

```
=== Confusion Matrix ===

   a   b   c   d   e   f   g   h   i   j   k   l   m   n   o   p   q   r   <-- classified as
  72   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 |   a = Bug
   0  29   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 |   b = Dark
   0   0  27   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 |   c = Dragon
   0   0   0  40   0   0   0   0   0   0   0   0   0   0   0   0   0   0 |   d = Electric
   0   0   0   0  18   0   0   0   0   0   0   0   0   0   0   0   0   0 |   e = Fairy
   0   0   0   0   0  29   0   0   0   0   0   0   0   0   0   0   0   0 |   f = Fighting
   0   0   0   0   0   0  53   0   0   0   0   0   0   0   0   0   0   0 |   g = Fire
   0   0   0   0   0   0   0   3   0   0   0   0   0   0   0   0   0   0 |   h = Flying
   0   0   0   0   0   0   0   0  27   0   0   0   0   0   0   0   0   0 |   i = Ghost
   0   0   0   0   0   0   0   0   0  78   0   0   0   0   0   0   0   0 |   j = Grass
   0   0   0   0   0   0   0   0   0   0  32   0   0   0   0   0   0   0 |   k = Ground
   0   0   0   0   0   0   0   0   0   0   0  23   0   0   0   0   0   0 |   l = Ice
   0   0   0   0   0   0   0   0   0   0   0   0 105   0   0   0   0   0 |   m = Normal
   0   0   0   0   0   0   0   0   0   0   0   0   0  34   0   0   0   0 |   n = Poison
   0   0   0   0   0   0   0   0   0   0   0   0   0   0  53   0   0   0 |   o = Psychic
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0  46   0   0 |   p = Rock
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0  26   0 |   q = Steel
   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0 114 |   r = Water
```

Result: CNN 3 Layer

70% Training 30% Testing

```
=== Summary ===

Correctly Classified Instances          25               10.2881 %
Incorrectly Classified Instances       218               89.7119 %
Kappa statistic                          0.0007
Mean absolute error                      0.1049
Root mean squared error                  0.2291
Relative absolute error                102.2949 %
Root relative squared error            101.1349 %
Total Number of Instances              243
```

```
=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0.208    0.087    0.208      0.208    0.208      0.122    0.702     0.218     Bug
                 0.091    0.004    0.500      0.091    0.154      0.199    0.704     0.216     Dark
                 0.000    0.000    ?          0.000    ?          ?        0.613     0.187     Dragon
                 0.000    0.022    0.000      0.000    0.000      -0.033   0.457     0.052     Electric
                 0.000    0.004    0.000      0.000    0.000      -0.006   0.824     0.047     Fairy
                 0.222    0.021    0.286      0.222    0.250      0.227    0.667     0.124     Fighting
                 0.214    0.044    0.231      0.214    0.222      0.177    0.878     0.417     Fire
                 ?        0.000    ?          ?        ?          ?        ?         ?         Flying
                 0.000    0.004    0.000      0.000    0.000      -0.014   0.732     0.127     Ghost
                 0.143    0.098    0.160      0.143    0.151      0.047    0.614     0.182     Grass
                 0.125    0.026    0.143      0.125    0.133      0.106    0.477     0.056     Ground
                 0.000    0.004    0.000      0.000    0.000      -0.011   0.556     0.068     Ice
                 0.280    0.170    0.159      0.280    0.203      0.087    0.578     0.141     Normal
                 0.000    0.021    0.000      0.000    0.000      -0.028   0.809     0.112     Poison
                 0.000    0.062    0.000      0.000    0.000      -0.070   0.417     0.064     Psychic
                 0.000    0.047    0.000      0.000    0.000      -0.043   0.461     0.035     Rock
                 0.000    0.009    0.000      0.000    0.000      -0.018   0.802     0.157     Steel
                 0.541    0.296    0.247      0.541    0.339      0.186    0.612     0.255     Water
Weighted Avg.    0.177    0.096    ?          0.177    ?          ?        0.627     0.170
```

```
=== Confusion Matrix ===

  a  b  c  d  e  f  g  h  i  j  k  l  m  n  o  p  q  r   <-- classified as
  5  1  0  2  0  1  2  0  0  3  0  0  5  0  0  1  0  4 |  a = Bug
  1  1  0  1  0  0  0  0  0  1  0  0  4  1  0  0  1  1 |  b = Dark
  0  0  0  0  0  0  0  0  0  1  0  0  1  1  1  0  0  6 |  c = Dragon
  1  0  0  0  1  0  1  0  0  1  0  0  1  0  1  2  1  3 |  d = Electric
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2 |  e = Fairy
  0  0  0  0  0  2  0  0  0  0  0  0  4  1  0  0  0  2 |  f = Fighting
  2  0  0  0  0  0  3  0  0  1  2  0  2  0  1  1  0  2 |  g = Fire
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 |  h = Flying
  2  0  0  0  0  2  0  0  0  0  1  1  1  0  0  0  0  4 |  i = Ghost
  3  0  0  1  0  1  1  0  0  4  0  0  2  0  4  0  0 12 |  j = Grass
  2  0  0  0  0  0  1  0  0  1  1  0  1  0  0  1  0  1 |  k = Ground
  0  0  0  1  0  0  0  0  0  0  0  0  2  0  2  0  0  2 |  l = Ice
  5  0  0  0  0  0  3  0  0  1  0  0  7  1  2  2  0  4 |  m = Normal
  0  0  0  0  0  0  0  0  0  1  0  0  2  0  0  1  0  5 |  n = Poison
  0  0  0  0  0  1  0  0  0  5  1  0  2  1  0  3  0  5 |  o = Psychic
  0  0  0  0  0  0  0  0  0  4  0  0  1  0  1  0  0  3 |  p = Rock
  0  0  0  0  0  0  0  0  1  1  1  0  1  0  0  0  0  5 |  q = Steel
  3  0  0  0  0  0  2  0  0  1  1  0  8  0  2  0  0 20 |  r = Water
```

Result: CNN 4 Layer
70% Training 30% Testing

```
=== Summary ===

Correctly Classified Instances          25               10.2881 %
Incorrectly Classified Instances       218               89.7119 %
Kappa statistic                          0.0007
Mean absolute error                      0.1049
Root mean squared error                  0.2291
Relative absolute error                102.2949 %
Root relative squared error            101.1349 %
Total Number of Instances              243
```

```
=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0.000    0.000    ?          0.000    ?          ?        0.482     0.096     Bug
                 0.000    0.004    0.000      0.000    0.000      -0.014   0.500     0.045     Dark
                 0.000    0.000    ?          0.000    ?          ?        0.500     0.041     Dragon
                 0.000    0.000    ?          0.000    ?          ?        0.504     0.050     Electric
                 0.000    0.004    0.000      0.000    0.000      -0.006   0.496     0.008     Fairy
                 0.000    0.000    ?          0.000    ?          ?        0.504     0.037     Fighting
                 0.000    0.000    ?          0.000    ?          ?        0.500     0.058     Fire
                 ?        0.000    ?          ?        ?          ?        ?         ?         Flying
                 0.000    0.000    ?          0.000    ?          ?        0.500     0.045     Ghost
                 0.000    0.000    ?          0.000    ?          ?        0.500     0.116     Grass
                 0.000    0.000    ?          0.000    ?          ?        0.504     0.033     Ground
                 0.000    0.000    ?          0.000    ?          ?        0.504     0.029     Ice
                 1.000    0.991    0.104      1.000    0.188      0.031    0.505     0.104     Normal
                 0.000    0.000    ?          0.000    ?          ?        0.500     0.037     Poison
                 0.000    0.000    ?          0.000    ?          ?        0.470     0.070     Psychic
                 0.000    0.000    ?          0.000    ?          ?        0.504     0.037     Rock
                 0.000    0.000    ?          0.000    ?          ?        0.504     0.037     Steel
                 0.000    0.000    ?          0.000    ?          ?        0.500     0.153     Water
Weighted Avg.    0.103    0.102    ?          0.103    ?          ?        0.497     0.081
```

```
=== Confusion Matrix ===

  a  b  c  d  e  f  g  h  i  j  k  l  m  n  o  p  q  r   <-- classified as
  0  1  0  0  0  0  0  0  0  0  0  0 23  0  0  0  0  0 |  a = Bug
  0  0  0  0  0  0  0  0  0  0  0  0 11  0  0  0  0  0 |  b = Dark
  0  0  0  0  0  0  0  0  0  0  0  0 10  0  0  0  0  0 |  c = Dragon
  0  0  0  0  0  0  0  0  0  0  0  0 12  0  0  0  0  0 |  d = Electric
  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  0  0  0 |  e = Fairy
  0  0  0  0  0  0  0  0  0  0  0  0  9  0  0  0  0  0 |  f = Fighting
  0  0  0  0  0  0  0  0  0  0  0  0 14  0  0  0  0  0 |  g = Fire
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 |  h = Flying
  0  0  0  0  0  0  0  0  0  0  0  0 11  0  0  0  0  0 |  i = Ghost
  0  0  0  0  0  0  0  0  0  0  0  0 28  0  0  0  0  0 |  j = Grass
  0  0  0  0  0  0  0  0  0  0  0  0  8  0  0  0  0  0 |  k = Ground
  0  0  0  0  0  0  0  0  0  0  0  0  7  0  0  0  0  0 |  l = Ice
  0  0  0  0  0  0  0  0  0  0  0  0 25  0  0  0  0  0 |  m = Normal
  0  0  0  0  0  0  0  0  0  0  0  0  9  0  0  0  0  0 |  n = Poison
  0  0  0  0  1  0  0  0  0  0  0  0 17  0  0  0  0  0 |  o = Psychic
  0  0  0  0  0  0  0  0  0  0  0  0  9  0  0  0  0  0 |  p = Rock
  0  0  0  0  0  0  0  0  0  0  0  0  9  0  0  0  0  0 |  q = Steel
  0  0  0  0  0  0  0  0  0  0  0  0 37  0  0  0  0  0 |  r = Water
```

Result: CNN 5 Layer
70% Training 30% Testing

```
=== Summary ===

Correctly Classified Instances          42               17.284  %
Incorrectly Classified Instances       201               82.716  %
Kappa statistic                          0.0755
Mean absolute error                      0.0927
Root mean squared error                  0.2502
Relative absolute error                 90.4207 %
Root relative squared error            110.4658 %
Total Number of Instances              243
```

```
=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure  MCC      ROC Area  PRC Area  Class
               0.125     0.059     0.188       0.125   0.150      0.079    0.726     0.223     Bug
               0.000     0.004     0.000       0.000   0.000      -0.014   0.696     0.140     Dark
               0.100     0.017     0.200       0.100   0.133      0.116    0.680     0.175     Dragon
               0.000     0.043     0.000       0.000   0.000      -0.047   0.534     0.065     Electric
               0.000     0.008     0.000       0.000   0.000      -0.008   0.805     0.042     Fairy
               0.111     0.013     0.250       0.111   0.154      0.146    0.583     0.147     Fighting
               0.429     0.066     0.286       0.429   0.343      0.301    0.889     0.461     Fire
               ?         0.000     ?           ?       ?          ?        ?         ?         Flying
               0.000     0.004     0.000       0.000   0.000      -0.014   0.669     0.163     Ghost
               0.143     0.107     0.148       0.143   0.145      0.036    0.623     0.169     Grass
               0.125     0.009     0.333       0.125   0.182      0.188    0.482     0.094     Ground
               0.000     0.004     0.000       0.000   0.000      -0.011   0.608     0.112     Ice
               0.200     0.183     0.111       0.200   0.143      0.013    0.600     0.129     Normal
               0.000     0.021     0.000       0.000   0.000      -0.028   0.800     0.104     Poison
               0.000     0.040     0.000       0.000   0.000      -0.055   0.372     0.058     Psychic
               0.000     0.034     0.000       0.000   0.000      -0.036   0.422     0.035     Rock
               0.111     0.000     1.000       0.111   0.200      0.328    0.693     0.219     Steel
               0.541     0.311     0.238       0.541   0.331      0.174    0.640     0.280     Water
Weighted Avg.  0.173     0.097     0.165       0.173   0.141      0.075    0.630     0.178
```

```
=== Confusion Matrix ===

  a  b  c  d  e  f  g  h  i  j  k  l  m  n  o  p  q  r   <-- classified as
  3  0  0  1  0  0  2  0  0  4  0  0  6  0  1  0  0  7 |  a = Bug
  0  0  1  1  0  0  0  0  1  1  0  0  5  0  0  0  0  2 |  b = Dark
  0  0  1  1  0  0  0  0  0  0  0  0  2  0  1  1  0  4 |  c = Dragon
  0  0  0  0  0  0  2  0  0  1  0  0  1  0  1  0  0  7 |  d = Electric
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  2 |  e = Fairy
  0  0  0  0  0  1  1  0  0  1  0  0  4  0  0  0  0  2 |  f = Fighting
  1  0  0  2  0  0  6  0  0  1  0  0  1  0  0  0  0  3 |  g = Fire
  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0 |  h = Flying
  1  0  0  0  1  1  1  0  0  0  1  0  2  1  0  0  0  3 |  i = Ghost
  5  0  0  2  0  1  0  0  0  4  0  0  2  0  2  1  0 11 |  j = Grass
  1  0  0  1  0  1  2  0  0  0  1  0  1  0  0  0  0  1 |  k = Ground
  0  0  0  2  0  0  0  0  0  0  0  0  2  0  1  0  0  2 |  l = Ice
  4  1  0  0  1  0  3  0  0  4  0  0  5  0  1  2  0  4 |  m = Normal
  0  0  0  0  0  0  0  0  0  0  0  0  2  0  0  2  0  5 |  n = Poison
  0  0  1  0  0  0  1  0  0  5  1  1  3  1  0  2  0  3 |  o = Psychic
  0  0  0  0  0  0  0  0  0  3  0  0  2  0  1  0  0  3 |  p = Rock
  0  0  1  0  0  0  1  0  0  1  0  0  0  0  0  0  1  5 |  q = Steel
  1  0  1  0  0  0  2  0  0  2  0  0  7  3  1  0  0 20 |  r = Water
```

Conclusion

In this lab, a deep learning algorithm was developed to classify Pokemon images based on their primary types. The dataset was prepared by converting an Excel file to an ARFF file, and three different layer configurations were evaluated. The CNN 3-Layer configuration achieved the best performance, with an accuracy of 17.70%.