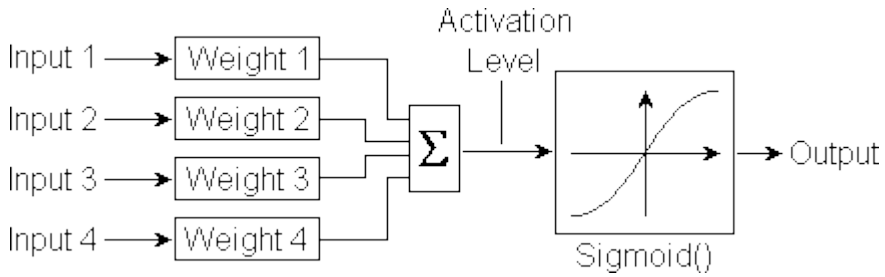
Web Site of Robert John Morton

Neural Networks: The Completed Neurone

Introduction, *input summation*, *sigmoid function*, *the complete neuron*, *testing*.

Introduction

The complete neurone comprises the weighted inputs summation function and the sigmoid transfer function as shown below:



Each input is multiplied by a corresponding weight. All the products are then added together and divided by the number of inputs to yield what is termed the 'activation level'. This is then fed in as input to the Sigmoid() function to produce the neurone's output.

Input Summation

In the document wsum.htm and associated source files, we developed the optimum 'C' code for computing a neurone's activation level from its inputs and their corresponding weights. This code is shown below:

```
int i, al, *pi, *pw;
long x, Hi, Lo;
for(pi = I, pw = W, Hi = 0, Lo = 0, i = 0; i < NI; i++) {
  x = (long)*(pi + i) * *(pw + i);
  Lo += x & 0xFFFF;
  Hi += x >> 16;
}
al = ((Hi << 1) + (Lo >> 15)) / NI;
```

Sigmoid Function

Then, in the document SIGMOID.HTM and associated source files, we developed the optimum 'C' source code for the Sigmoid() function as shown below:

```
int Sigmoid(int x) {
  int s, y, j;
  if((s = x) < 0) x = -x;
  y = *(SigTab + (j = x >> 5));
  y += ((*(SigTab + j + 1) - y) * (x & 0x1F)) >> 5;
  if (s < 0) y = -y;
  return(y);
}
```

The Complete Neurone

We will now combine these two separately developed and tested pieces of code to form a function to simulate a complete neurone:

```
int Neuron(int *pi, int *pw, int NI) {
  register i;       //input array index, sigmoid table index
  int a, o, s;      //activation level, neurone output, sign
  long P, Hi, Lo;   //long product, high & low accumulators

  for(Hi = 0, Lo = 0, i = 0; i < NI; i++) {
    P = (long)*(pi + i) * *(pw + i);
    Hi += P >> 16;
    Lo += P & 0xFFFF;
    }
  if((s = (a = ((Hi << 1) + (Lo >> 15)) / NI)) < 0) a = -a;
  o = *(SigTab + (i = a >> 5));
  o += ((*(SigTab + i + 1) - o) * (a & 0x1F)) >> 5;
  if (s < 0) o = -o;
  return(o);
}
```

Note that the names of some of the variables have been changed in order to rationalise them and help to identify better what they do. The comments adjacent to their declarations explain the new names. We have assigned the index variable i to a register in an attempt to increase speed further.

Testing

The following exerciser was then written and used to test the completed neurone function:

```
#include <stdio.h>
#define R  32767
#define RR 65556  //65534 + 22
#define NI    77  //number of inputs to the neurone
int AL;
short   SigTab[1025];

int I[] = {      //inputs
  11376, 13425, 17920, 30226, 28763, 18940, 15329,
  11376, 13425, 17920, 30226, 28763, 18940, 15329,
  11376, 13425, 17920, 30226, 28763, 18940, 15329,
  11376, 13425, 17920, 30226, 28763, 18940, 15329,
  11376, 13425, 17920, 30226, 28763, 18940, 15329,
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  11376, 13425, 17920, 30226, 28763, 18940, 15329,
  11376, 13425, 17920, 30226, 28763, 18940, 15329,
  11376, 13425, 17920, 30226, 28763, 18940, 15329,
  11376, 13425, 17920, 30226, 28763, 18940, 15329
};

int W[] = {      //weights
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557,
  12345, 21345, 31245, 16730, 31662, 25460, 13557
};

void SigGen(void) {
  int i;
  for(i = 0; i < 1024; i++)
    SigTab[i] = (double)(
      RR /(1 + exp(-((double)(((long)(i)) << 8))/R))- R
    );
  SigTab[1024] = R;
}

int Neuron(int *pi, int *pw, int ni) {
  register i;      //input array index, sigmoid table index
  int a, o, s;     //activation level, output, sign
  long P, Hi, Lo;  //long product, high & low accumulators

  for(Hi = 0, Lo = 0, i = 0; i < ni; i++) {
    P = (long)*(pi + i) * *(pw + i);
    Hi += P >> 16;
    Lo += P & 0xFFFF;
  }
  if((s = (a = ((Hi << 1) + (Lo >> 15)) / ni)) < 0) a = -a;
```

```
  o = *(SigTab + (i = a >> 5));
  o += ((*(SigTab + i + 1) - o) * (a & 0x1F)) >> 5;
  if (s < 0) o = -o;
  AL = a;          //extra line to check activation level
  return(o);
}

main() {
  int OP;
  SigGen();
  OP = Neuron(I, W, NI);
  printf("Activation Level = %6d\n", AL);
  printf("Neuron Output    = %6d\n", OP);
}
```

The results displayed by this exerciser are as follows:

```
  Activation Level = 13485
  Neuron Output    = 30439
```

The neurone function can now be used to build into a complete multi-layer perceptron. This we do in the document mlpc.htm.
