1a

H(position=left)

= -7/9\*log2(7/9)-2/9\*log2(2/9)

= 0.28199895063+0.48220555587

= 0.7642045065

H(background = blue|position=left)

= -4/4\*log2(4/4)

= 0

H(background = red|position=left)

= 3/5\*log2(3/5)-2/5\*log2(2/5)

= 0.4421793565+0.52877123795

= 0.97095059445

H(background|position=left)

= 4/9\*0+5/9\*0.97095059445

= 0.53941699691

IG(position=left, background)

=H(position=left)-H(background|position=left)

=0.7642045065-0.53941699691=0.22478750959

1. Size. Selecting this gives the highest information gain.

1b

p(xt|y=apple) = 1/5\*(0.07+0.26+0.12+0.11+0.14) = 0.14

p(xt|y=pear) = 1/5\*(0.16+0.10+0.06+0.12+0.01) = 0.09

ii)

p(xt) = 0.14\*0.35+0.09\*0.65 = 0.1075

p(y=apple|xt) = 0.14\*0.35/0.1075 = 0.45581395348

p(y=pear|xt) = 1-0.45581395348 = 0.54418604652

xt should be classified as pear.

2a

z1 = -0.9\*0.1+0.7\*-0.8 = -0.65

x3 = max(0, -0.65) = 0

z2 = 0.1\*0.1+-0.2\*-0.8 = 0.17

x4 = max(0, 0.17) = 0.17

z3 = -0.1\*0+-0.4\*0.17+0.2=-0.48

y\_hat = 1/(1+e^0.48) = 0.38225212523

ii)

d Loss/d y\_hat = 2 \* (y\_hat - y) = 2 \* (0.38225212523 - 0.2) = 0.36450425046

dLoss/dz3=dLoss/dy\_hat\*d y\_hat/dz3=0.36450425046\*0.38225212523\* (1- 0.38225212523)

=0.08607237083

d Loss / d w1 = d Loss/d z3 \* d z3 / d w1 = 0.08607237083 \* 0 = 0

d Loss/d w2 = d Loss/d z3 \* d z3 / d w2 = 0.08607237083 \* 0.17 = 0.01463230304

w1\_new = w1 - dLoss/dw1 \* 0.7 = -0.1

w2\_new = w2 - dLoss/dw2 \* 0.7 = -0.4 - 0.01463230304 \* 0.7 = -0.41024261212

2b

i)

3 neurons, activation function: softmax, loss function: categorical crossentropy

ii)

First make the confusion matrix:

|  |  |  |  |
| --- | --- | --- | --- |
| Predicted values  Actual values | Name | Location | Neither |
| Name | 12 | 1 | 2 |
| Location | 0 | 4 | 3 |
| Neither | 2 | 0 | 87 |

1. Precison = True positive/False positive = 4/(4+3) = 0.57142857142
2. Precision = True positive/False positive = 12/(12+1+2)=0.8

Recall = True positive/True negative = 12/(12+0+2) = 0.85714285714

F1 = 2\*Precision\*Recall/(Precision+Recall) =0.82758620689

1. Accuracy = (12+4+87)/111 = 0.92792792792

3a

Coverage = 8/16 = 0.5

Max fitness = 1.2

QD score = 0.4+1.1+1.2+1.0+1.2+0.9+0.6+0.5 = 6.9