Statistical Theories for Brain and Parallel Computing -- Assignment1

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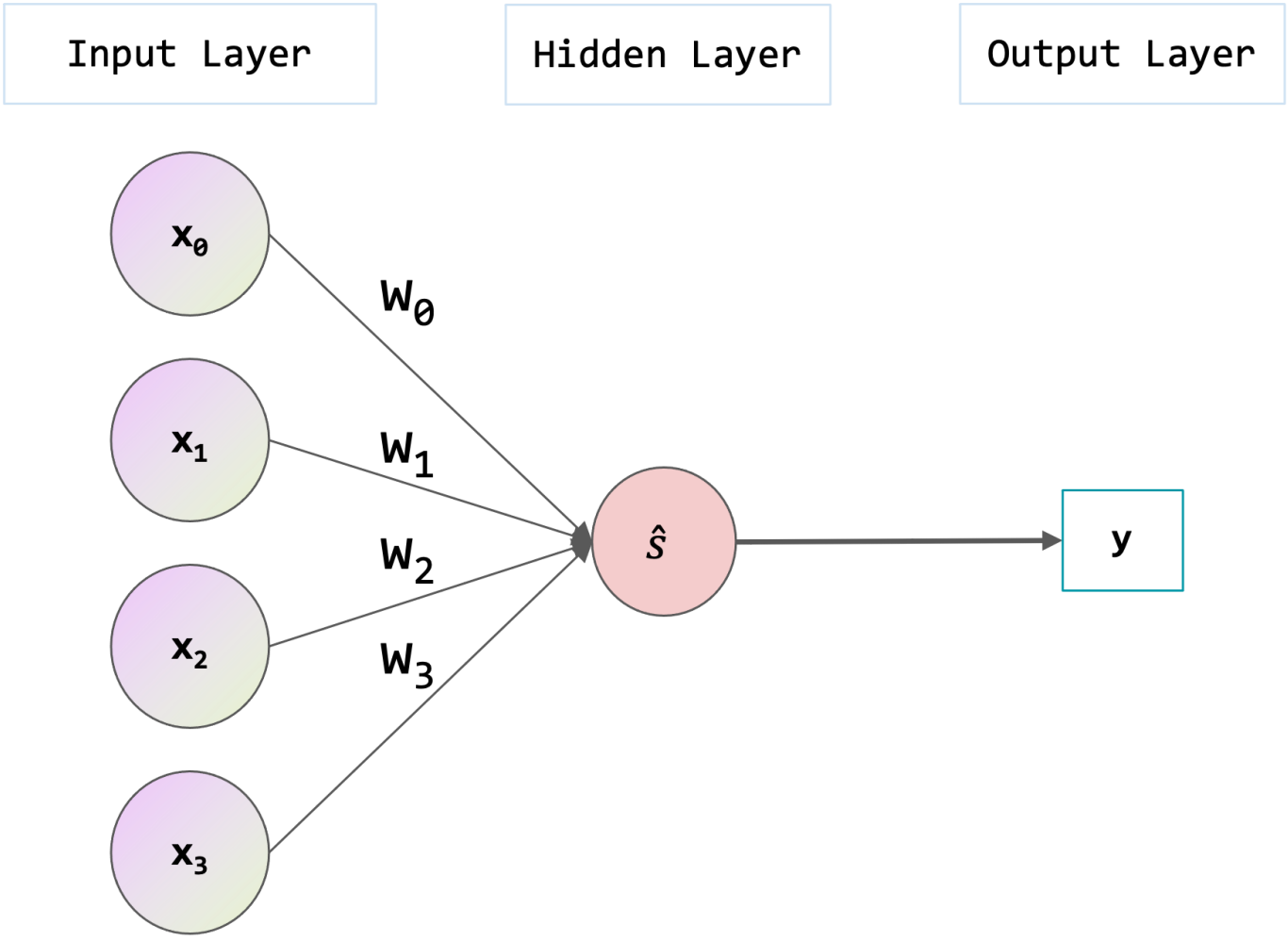
Data and Methods

Network

I constructed a network as shown in the figure.



value name	variable	description
input	x_n	$x_n \in \{0, 1\}$
weight	w_n	$w_n \in U(-1, 1)$
output	y	$y_n \in \{0, 1\}$
gain	α	$\alpha > 0$

Fomula

$$\hat{s} = \sum_{n=0}^{N} w_n x_n \quad (N = 3)$$
$$p = sigmoid(\hat{s}) = \frac{a}{1 + e^{-\alpha \hat{s}}}$$
$$y = \begin{cases} 0 & P(0) = 1 - p \\ 1 & P(1) = p \end{cases}$$

Results

Randomly determine and fix x_n and w_n in given conditions.At this time, observe how the output frequency of $y = 0, 1$ changes by changing $\alpha = 0.1, 1, 2, 5$. Also, change $trial = 100, 1000, 10000$ for each α and check the ratio of outputting $y = 1$. The results are as follows.

$\hat{s} > 0 \quad (p > 0.5)$

```
gain: 0.1, trial: 100, probability: 0.5053458175979504, ratio of the value
1 : 0.48
gain: 0.1, trial: 1000, probability: 0.5053458175979504, ratio of the
value 1 : 0.509
gain: 0.1, trial: 10000, probability: 0.5053458175979504, ratio of the
value 1 : 0.5055
gain: 1, trial: 100, probability: 0.5532574216935245, ratio of the value 1
: 0.55
gain: 1, trial: 1000, probability: 0.5532574216935245, ratio of the value
1 : 0.576
gain: 1, trial: 10000, probability: 0.5532574216935245, ratio of the value
1 : 0.5522
gain: 2, trial: 100, probability: 0.6053199452311429, ratio of the value 1
: 0.7
gain: 2, trial: 1000, probability: 0.6053199452311429, ratio of the value
1 : 0.609
gain: 2, trial: 10000, probability: 0.6053199452311429, ratio of the value
1 : 0.5967
gain: 5, trial: 100, probability: 0.7444455589084145, ratio of the value 1
: 0.63
gain: 5, trial: 1000, probability: 0.7444455589084145, ratio of the value
1 : 0.737
gain: 5, trial: 10000, probability: 0.7444455589084145, ratio of the value
1 : 0.7405
```

$\hat{s} < 0 \quad (p < 0.5)$

```
gain: 0.1, trial: 100, probability: 0.47326028052325025, ratio of the
value 1 : 0.4
gain: 0.1, trial: 1000, probability: 0.47326028052325025, ratio of the
value 1 : 0.48
gain: 0.1, trial: 10000, probability: 0.47326028052325025, ratio of the
value 1 : 0.4767
```

```
gain: 1, trial: 100, probability: 0.2552870535584264, ratio of the value 1
: 0.24
gain: 1, trial: 1000, probability: 0.2552870535584264, ratio of the value
1 : 0.245
gain: 1, trial: 10000, probability: 0.2552870535584264, ratio of the value
1 : 0.2583
gain: 2, trial: 100, probability: 0.10515449343961247, ratio of the value
1 : 0.08
gain: 2, trial: 1000, probability: 0.10515449343961247, ratio of the value
1 : 0.103
gain: 2, trial: 10000, probability: 0.10515449343961247, ratio of the
value 1 : 0.1036
gain: 5, trial: 100, probability: 0.004711383663726527, ratio of the value
1 : 0.0
gain: 5, trial: 1000, probability: 0.004711383663726527, ratio of the
value 1 : 0.002
gain: 5, trial: 10000, probability: 0.004711383663726527, ratio of the
value 1 : 0.004
```

Disuccusion

- When $\hat{s} > 0$, p increased as α increased. Also, as $trial$ increased, the rate at which y output 1 asymptotically approached p.
- When $\hat{s} < 0$, p decreased as α increased. Also, as $trial$ increased, the rate at which y output 1 asymptotically approached p.