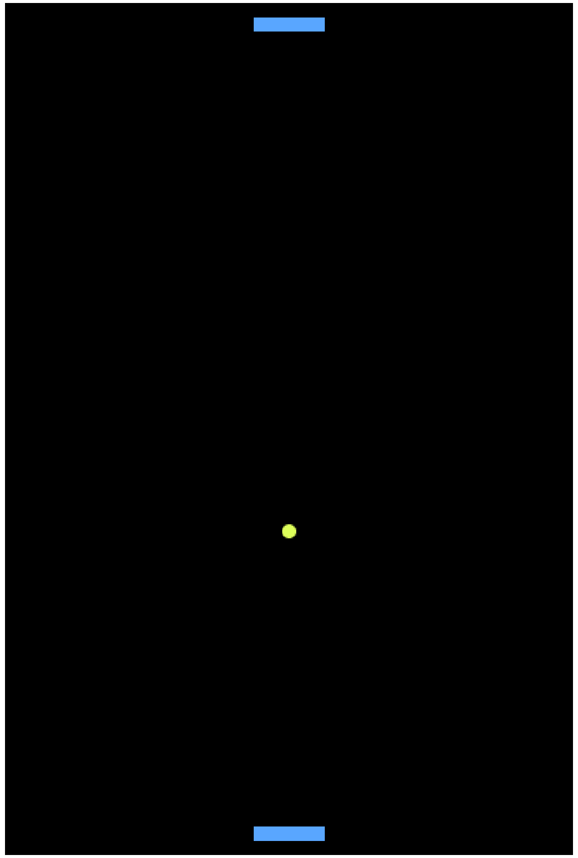
物聯網實務

11_30

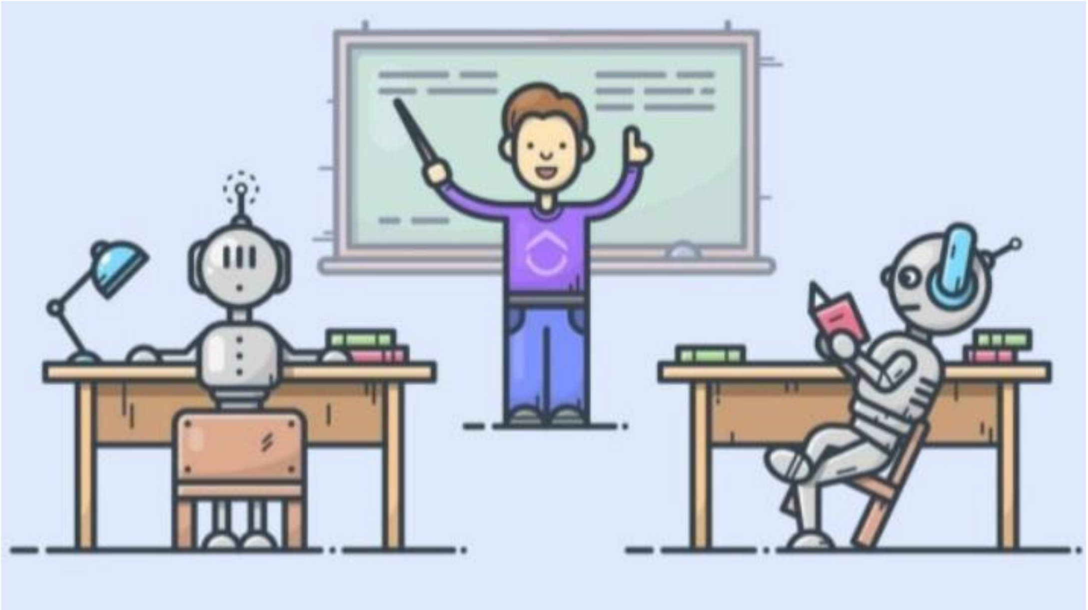
廖裕評

AI game

Yu-Ping Liao Ping Pong Game



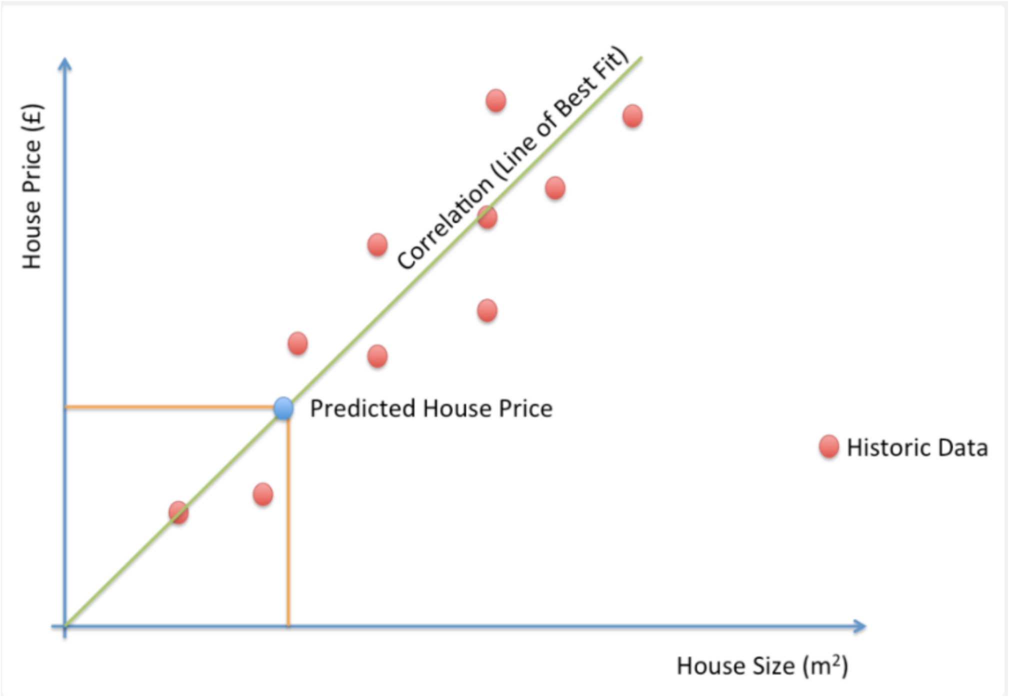
Teaching AI to Understand Our World



https://www.slideshare.net/sakhaglobal/unsupervised-learning-teaching-ai-to-understand-our-world

Regression

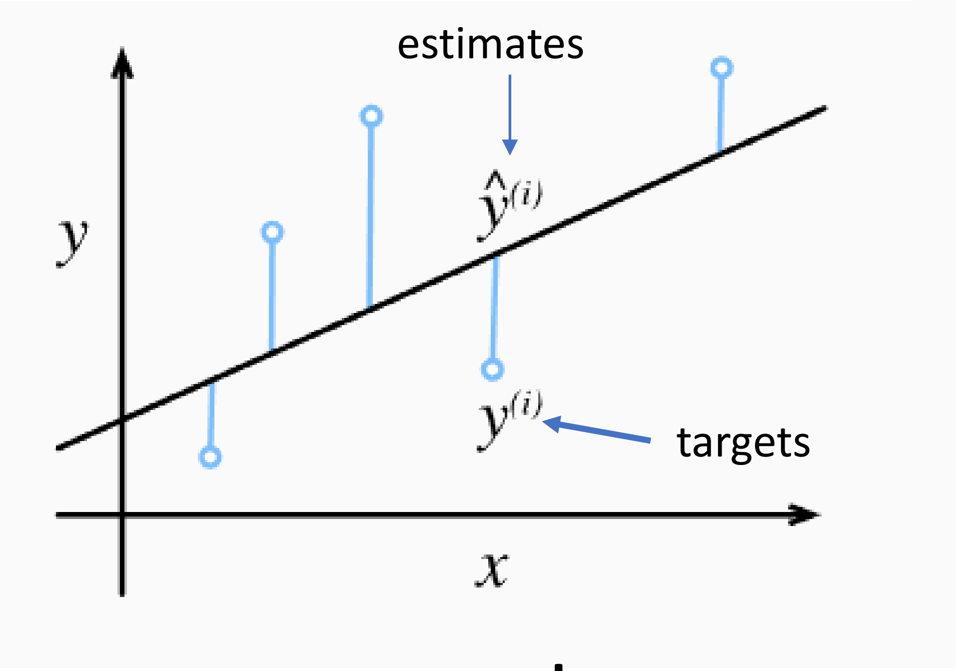
- *Regression* refers to a set of methods for modeling the relationship between one or more independent variables and a dependent variable.
- *Prediction:*predicting prices (of homes, stocks, etc.), predicting length of stay (for patients in the hospital), demand forecasting (for retail sales)



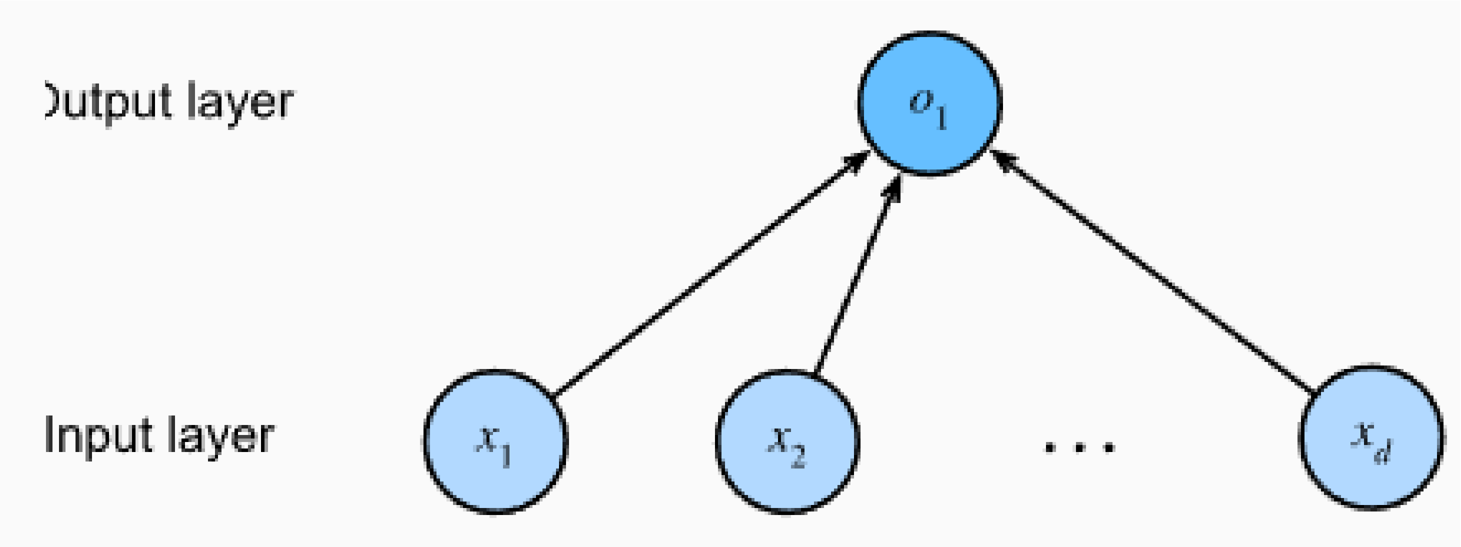
http://davidgildeh.com/2013/09/16/the-future-of-enterprise-machine-learning/

https://d2l.ai/chapter_linear-networks/linear-regression.html

Linear regression



y=wx+b

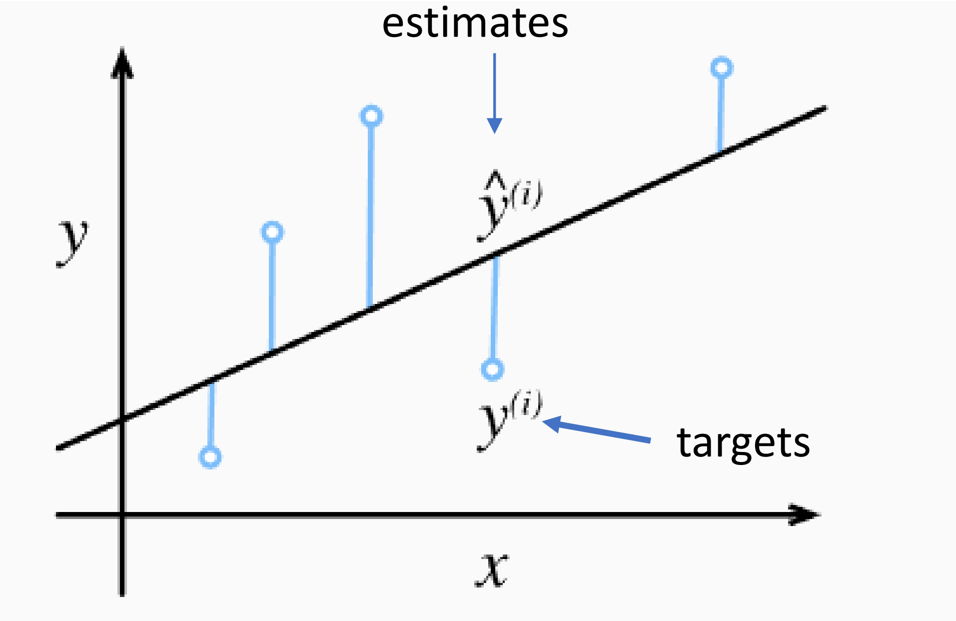


$$\hat{y} = w_1 x_1 + \ldots + w_d x_d + b$$

single-layer neural network

https://d2l.ai/chapter_linear-regression/linear-regression.html

Loss Function



y=w*x*+b

squared error $l^{(i)}(\mathbf{w}, b) = \frac{1}{2}\left(\hat{y}^{(i)} - y^{(i)}\right)^2.$

the losses on the training set $L(\mathbf{w}, b) = \frac{1}{n}\sum_{i=1}^{n} l^{(i)}(\mathbf{w}, b)$

training the model $\mathbf{w}^*, b^* = \underset{\mathbf{w}, b}{\operatorname{argmin}}\ L(\mathbf{w}, b).$

our prediction for an example i is $\hat{y}^{(i)}$ and the corresponding true label is $y^{(i)}$

https://d2l.ai/chapter_linear-regression/linear-regression.html

Regression

- Typically, we will use n to denote the number of examples in our dataset. We index the data examples by i, denoting each input as $x^{(i)}=[x_1^{(i)}, x_2^{(i)}]^{\mathrm{T}}$ and the corresponding label as $y^{(i)}$.

$y \qquad x_1 \qquad x_2$

$$\text{price} = w_{\text{area}} \cdot \text{area} + w_{\text{age}} \cdot \text{age} + b.$$

weights

bias

$$y^{(i)} = w_{area} \cdot x_1^{(i)} + w_{age} \cdot x_2^{(i)} + b$$
$$y^{(i)} = w_1 \cdot x_1^{(i)} + w_2 \cdot x_2^{(i)} + b$$

https://d2l.ai/chapter_linear-networks/linear-regression.html

Regression

- When our inputs consist of dd features, we express our prediction$\hat{y}$ (in general the "hat" symbol denotes estimates) as

$$\hat{y} = w_1 x_1 + \ldots + w_d x_d + b.$$

$$\hat{y} = \mathbf{w}^\top \mathbf{x} + b.$$

a vector $\mathbf{w} \in \mathbb{R}^d$

a vector $\mathbf{x} \in \mathbb{R}^d$

$$x = [x_1, x_2, \ldots, x_d]^T = \begin{bmatrix} x_1 \\ x_2 \\ \cdots \\ x_d \end{bmatrix}$$

$$w = [w_1, w_2, \ldots, w_d]^T = \begin{bmatrix} w_1 \\ w_2 \\ \cdots \\ w_d \end{bmatrix}$$

$$w^T = [w_1, w_2, \ldots, w_d]$$

$$\hat{y} = [w_1, w_2, \ldots, w_d] \begin{bmatrix} x_1 \\ x_2 \\ \cdots \\ x_d \end{bmatrix}$$

Regression

$\hat{\mathbf{y}} \in \mathbb{R}^{n}$ $\quad$ $\mathbf{X} \in \mathbb{R}^{n \times d}$.

$$\hat{\mathbf{y}} = \mathbf{X}\mathbf{w} + b,$$

$$x^{(i)}=[x_1{}^{(i)}, x_2{}^{(i)}, \dots, x_d{}^{(i)}]^{\mathrm{T}} = \begin{bmatrix} x_1{}^{(i)} \\ x_2{}^{(i)} \\ \cdots \\ x_d{}^{(i)} \end{bmatrix}$$

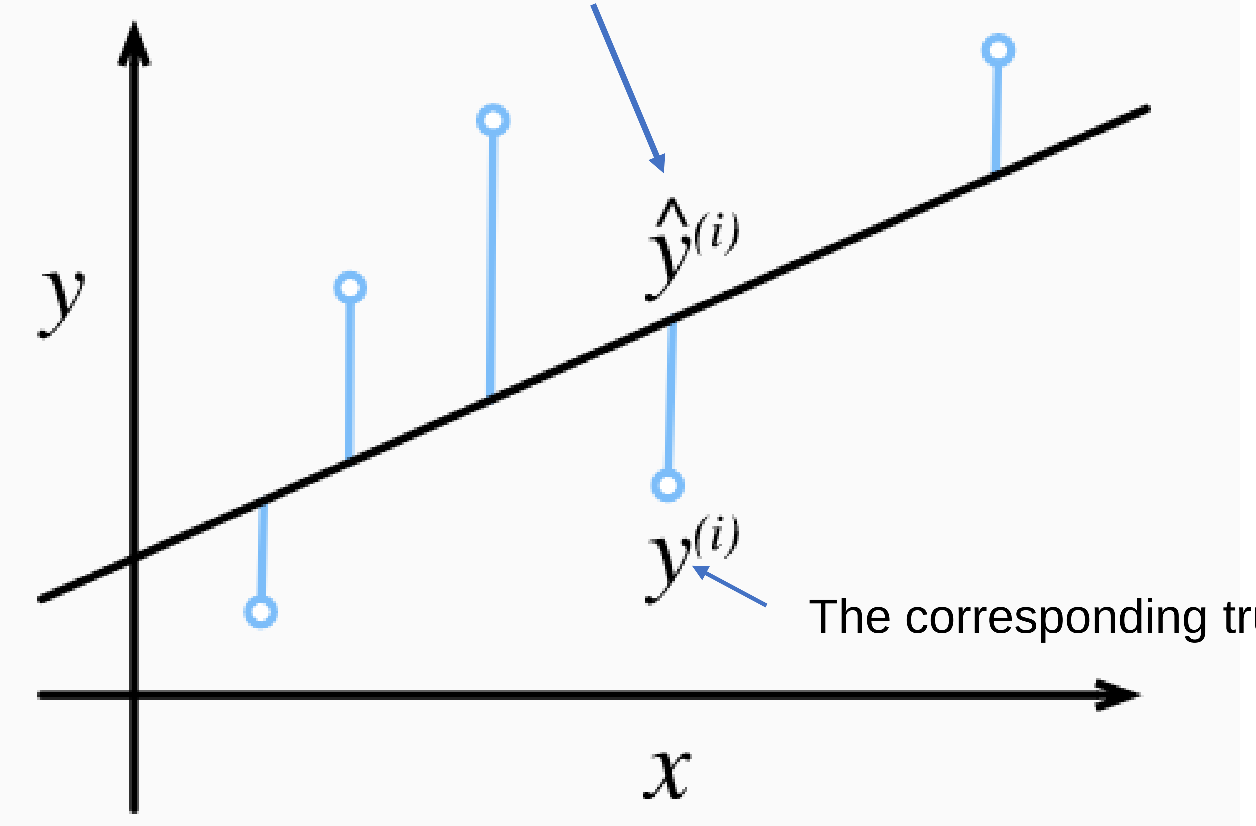
$$X= \begin{bmatrix} x_1{}^{(1)} & x_2{}^{(1)} & & x_d{}^{(1)} \\ x_1{}^{(2)} & x_2{}^{(2)} & & x_d{}^{(2)} \\ & , & , \dots , & \\ x_1{}^{(n)} & x_2{}^{(n)} & & x_d{}^{(n)} \end{bmatrix}$$

$$w = \begin{bmatrix} w_1 \\ w_2 \\ \cdots \\ w_d \end{bmatrix}$$

$$\begin{bmatrix} \hat{y}_1 \\ \hat{y}_2 \\ \cdots \\ \hat{y}_n \end{bmatrix} = \begin{bmatrix} x_1{}^{(1)} & x_2{}^{(1)} & & x_d{}^{(1)} \\ x_1{}^{(2)} & x_2{}^{(2)} & & x_d{}^{(2)} \\ & , & , \dots , & \\ x_1{}^{(n)} & x_2{}^{(n)} & & x_d{}^{(n)} \end{bmatrix} \begin{bmatrix} w_1 \\ w_2 \\ \cdots \\ w_d \end{bmatrix} + b$$

Loss Function

The prediction for an example i is $\hat{y}_1{}^{(i)}$



The corresponding true label is $y^{(i)}$

Fig. 3.1.1 Fit data with a linear model.¶

The loss function for an example i is:

$$l^{(i)}(\mathbf{w}, b) = \frac{1}{2}\left(\hat{y}^{(i)} - y^{(i)}\right)^2.$$

average loss

$$L(\mathbf{w}, b) = \frac{1}{n}\sum_{i=1}^{n} l^{(i)}(\mathbf{w}, b) = \frac{1}{n}\sum_{i=1}^{n} \frac{1}{2}\left(\mathbf{w}^\top \mathbf{x}^{(i)} + b - y^{(i)}\right)^2. \tag{3.1.6}$$

When training the model, we want to find parameters ($\mathbf{w}^*, b^*$) that minimize the total loss across all training examples:

$$\mathbf{w}^*, b^* = \operatorname*{argmin}_{\mathbf{w}, b}\ L(\mathbf{w}, b). \tag{3.1.7}$$

Making Predictions with the Learned Model

- Given the learned linear regression model $\hat{w}^T\mathrm{x} + \hat{b}$, we can now estimate the price of a new house (not contained in the training data)

- given its area x_1 and age x_2. Estimating targets given features is commonly called *prediction* or *inference*.

From Linear Regression to Deep Networks

- Neural Network Diagram

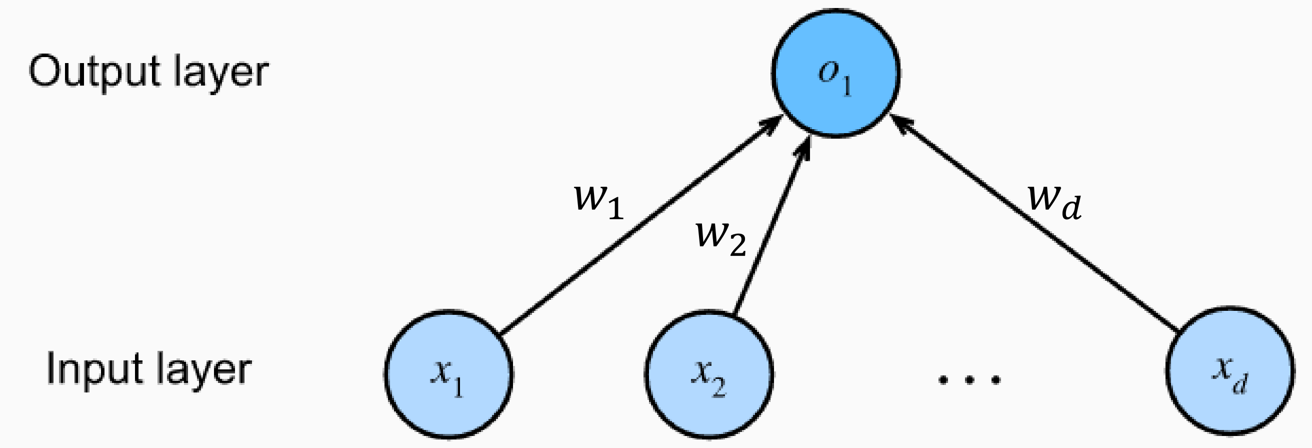
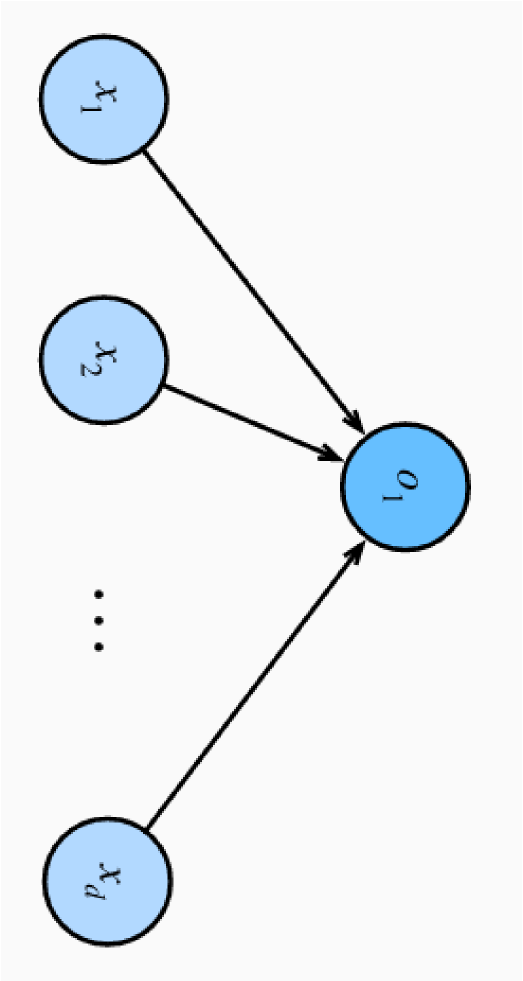
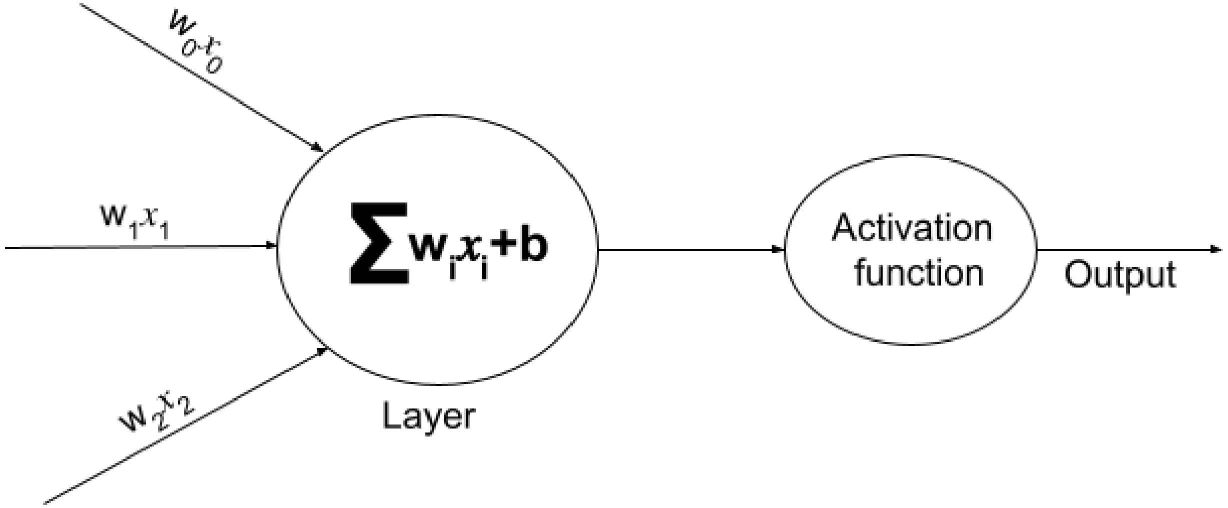


Fig. 3.1.2 Linear regression is a single-layer neural network.

Since for linear regression, every input is connected to every output (in this case there is only one output), we can regard this transformation (the output layer in Fig. 3.1.2) as a *fully-connected layer* or *dense layer*.

Activation function

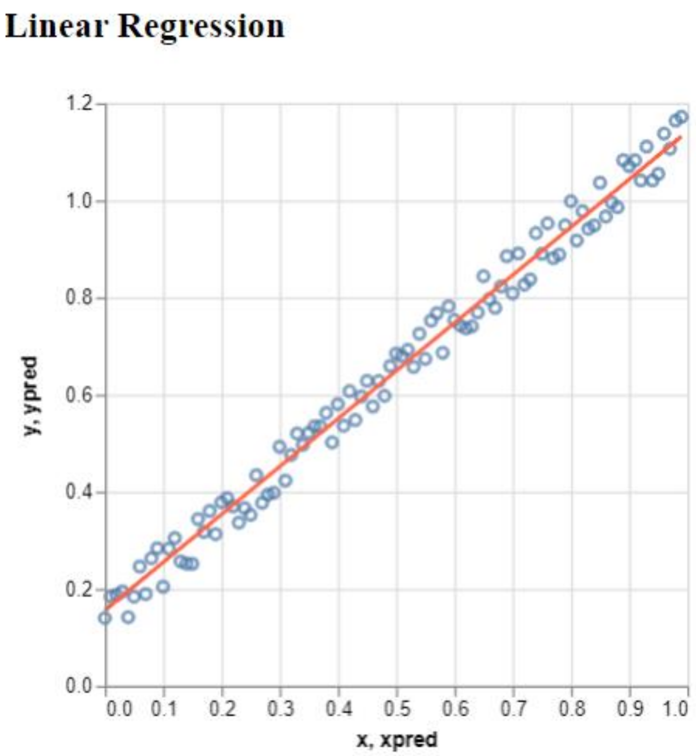


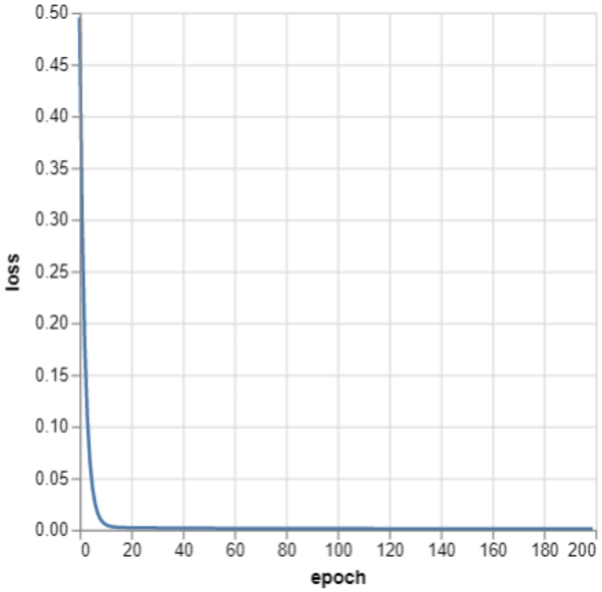


https://androidkt.com/advantages-relu-tanh-sigmoid-activation-function-deep-neural-networks/

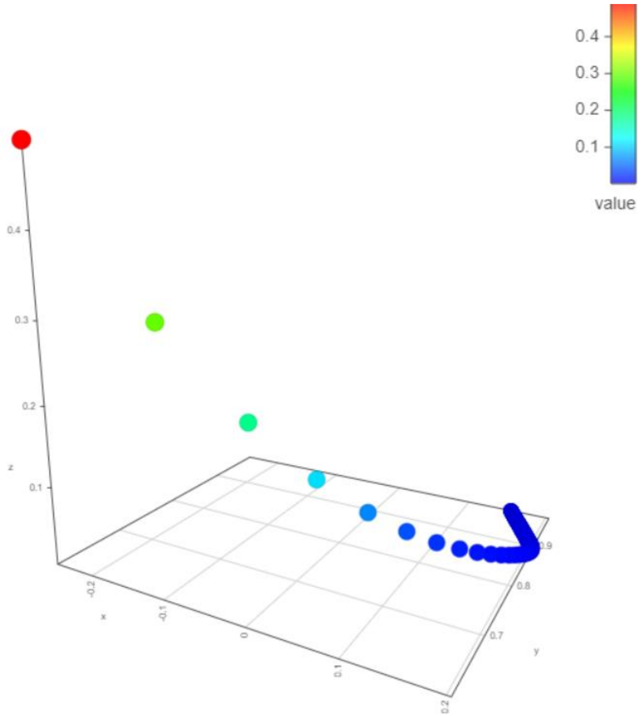
Exercise 11-1

- ex1130_1.html (copy from ex1130_1.txt)

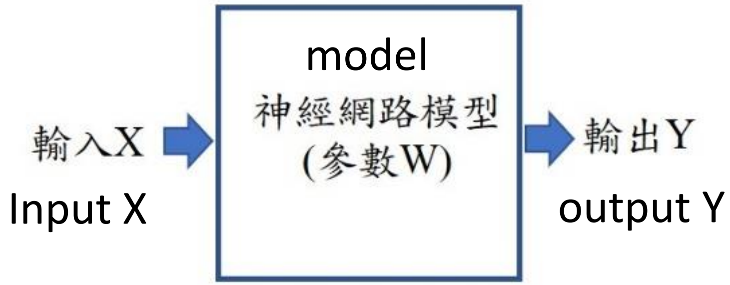


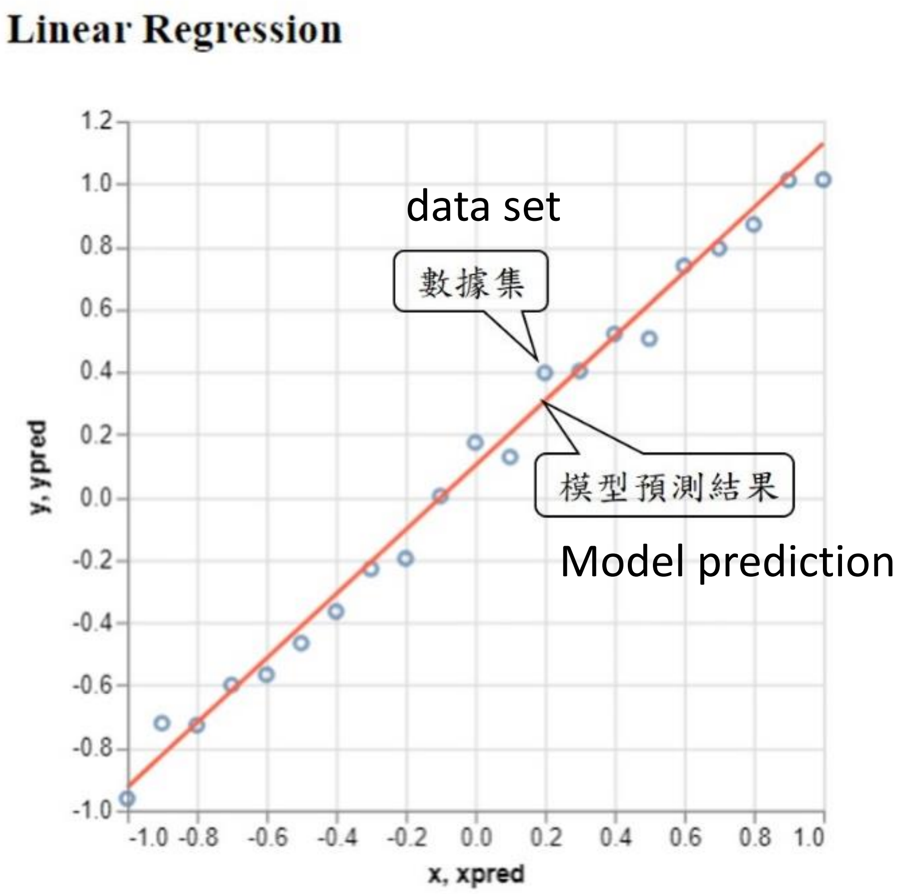


Save as SVGSave as PNGView SourceOpen in Vega Editor



Linear Regression

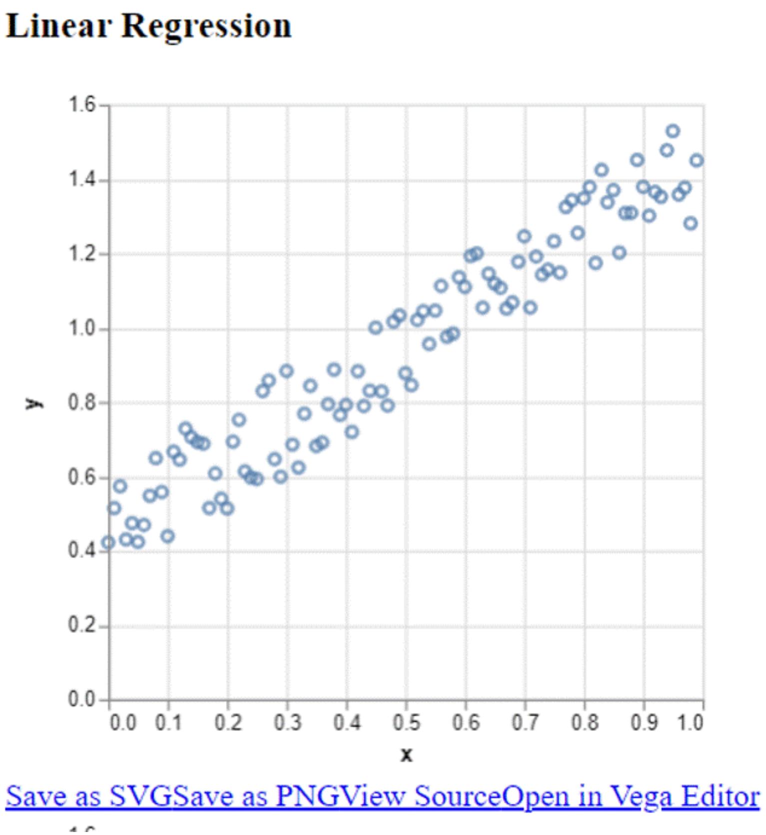




Data set

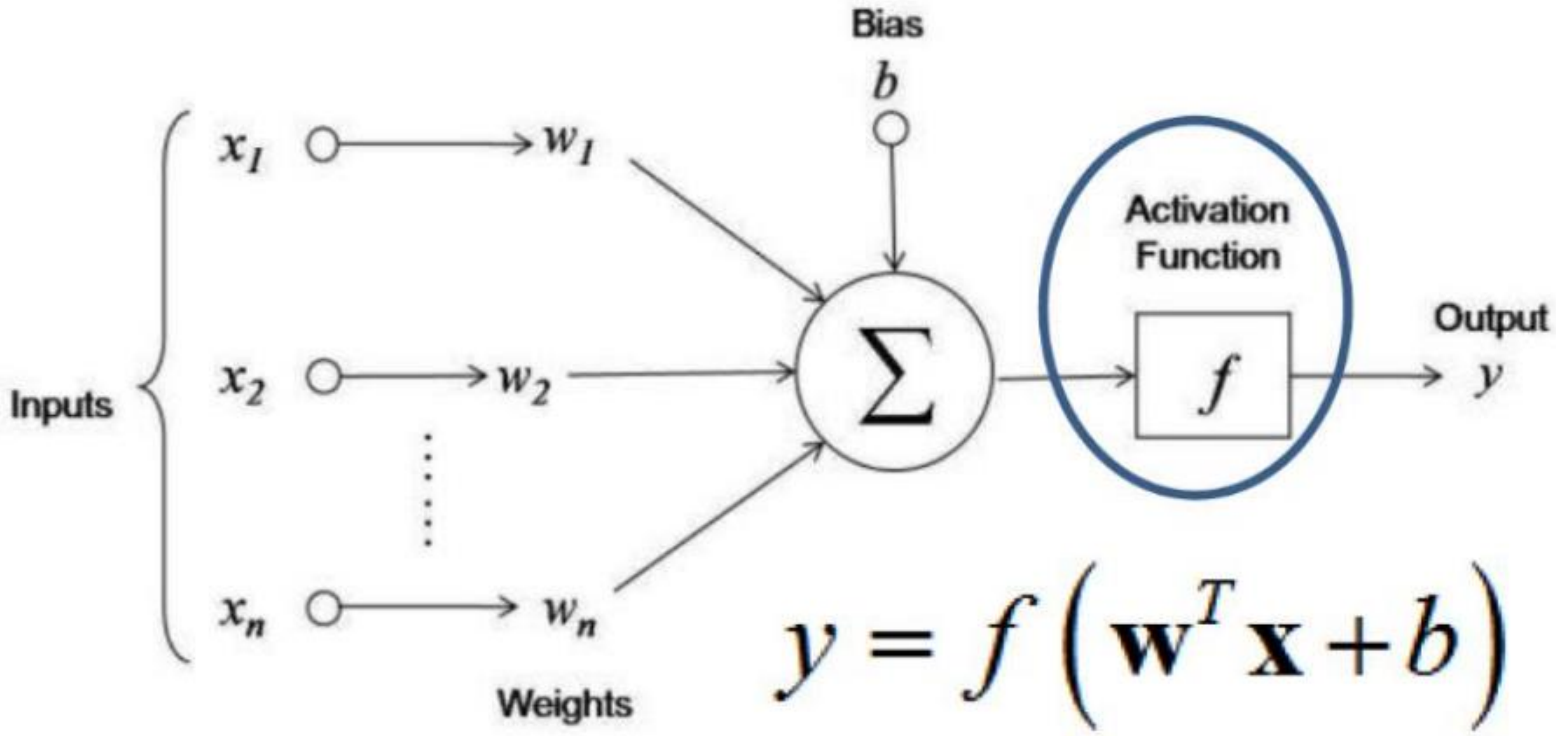
coeffs = [1, 0.1];

```
let y= coeffs[0] * x + coeffs[1]*(1+Math.random());
```



Tensorflow.js

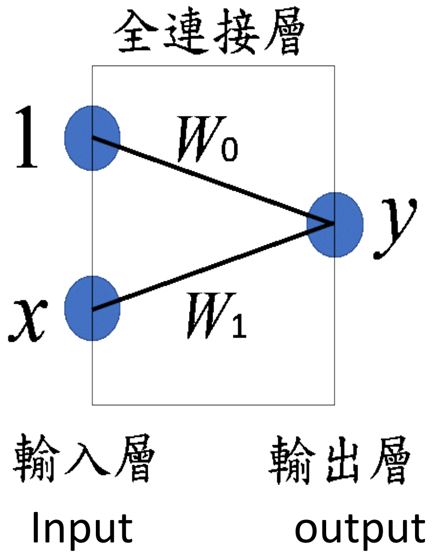
tf.layers.dense



model

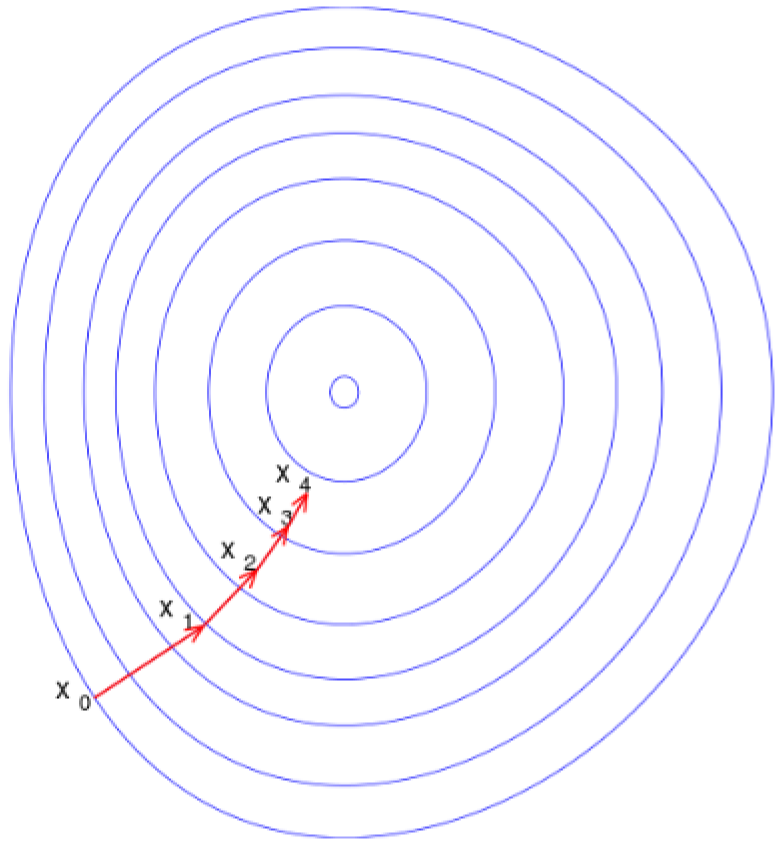
```
model = tf.sequential();//

model.add(tf.layers.dense({units: 1, inputShape: [2],
    useBias: false}));
```

tf.layers.dense



$y=1*W_0+x*W_1$

Optimization algorithms



Gradient descent

- Gradient method

B

- Biconjugate gradient method
- Biconjugate gradient stabilized method

C

- Conjugate gradient method
- Contour currents
- Coordinate descent

D

- Derivation of the conjugate gradient method

F

- *Gradient flow*
- Frank–Wolfe algorithm

G

- Gradient descent

L

- Landweber iteration

M

- Mirror descent

N

- Nonlinear conjugate gradient method

P

- Proximal gradient method

R

- Random coordinate descent

S

- Stochastic gradient descent
- Stochastic gradient Langevin dynamics
- Stochastic variance reduction

https://en.wikipedia.org/wiki/Gradient_descent

https://en.wikipedia.org/wiki/Category:Gradient_methods

最佳化的演算法

- 梯度下降（gradient descent, GD ）法，梯度下降法是一個一階找最佳解的一種方法，是希望用梯度下降法找到損失函數的最小值，如3-6圖的某模型參數座標點對應到曲面上梯度的方向是走向最大的方向，所以在梯度下降法中是往梯度的反方向走，變化模型參數往讓損失函數最小值方向移動，如式子(9)所示。
-
    - $W(t+1)= W(t)-\gamma\nabla(f)$ (9)

其中f為損失函數，$\nabla(f)$為函數f的梯度，γ為學習率(learning rate)，W(t)為在某時間點模型參數座標值，W(t+1)為調整後的模型參數座標。

Loss function

- 均方誤差**(mean-square error, MSE)函數，是各測量值誤差的平方和取平均值，以有n個量測值**y_i**與模型計算出的結果**$y_i{}^p$之均方誤差表示**如(8)所示:**
-
    - **MSE =** $\frac{1}{n}\sum_{i=1}^{n}(y_i - y_i{}^p)^2$ **(8)**
- **其中**$y_i{}^p = 1 * W_0 + x_i * W_1$，$x_i$**為第*i*筆測試資料的*x*值，根據第i筆測試資料的x值帶入**W_0與W_1計算出的y值就是$y_i{}^p$

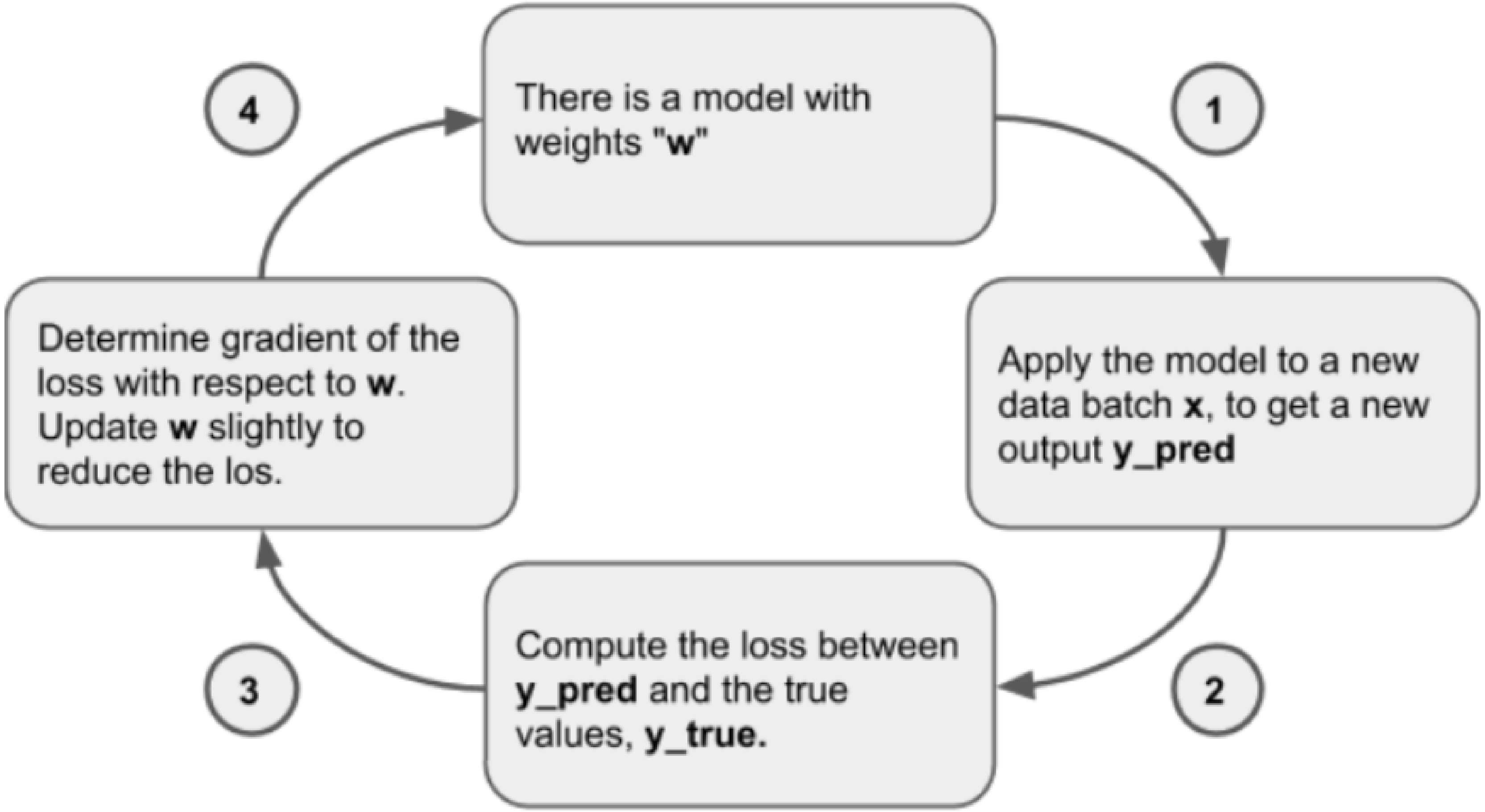
Setting Optimization algorithm & loss function

```
    const learningRate = 0.01;
    const sgd = tf.train.sgd(learningRate);
    //'meanSquaredError
    model.compile({optimizer: sgd, loss: 'meanSquaredError'});
```

Optimization algorithm

loss function

Training process



Training

```
const batchSize = 10;
 const epochs   = 200;
await model.fit( xtensor,ytensor, {
 batchSize: batchSize,
 epochs: epochs,
 callbacks: {
 onEpochEnd: async (epoch, log) => { console.log(epoch),
 console.log(log.loss); Prediction(x);
  plotloss("#vis2", log.loss, epoch);
  var W= Array.from(model.trainableWeights[0].read().dataSync());
  var style = log.loss;
  data3d.add({x:W[0],y:W[1],z:log.loss,style:style});
  drawVisualizationdot("vis3",data3d);
 }}
 });
```

Prediction

```
const xtensor = tf.tensor2d(xArrayData, [nVx.length, 2]);

xtensor.print();//xtensor

const predictOut = await model.predict(xtensor);

Ysfinal = predictOut.dataSync();
console.log('Ysfinal =', Ysfinal);

predictOut.dispose();//release GPU memory
xtensor.dispose();//release GPU memory
plotData2("#vis1", xyData[0], xyData[1], xyData[0],Ysfinal);
```

Plot

- function drawVisualizationdot(containerid,datadot) {

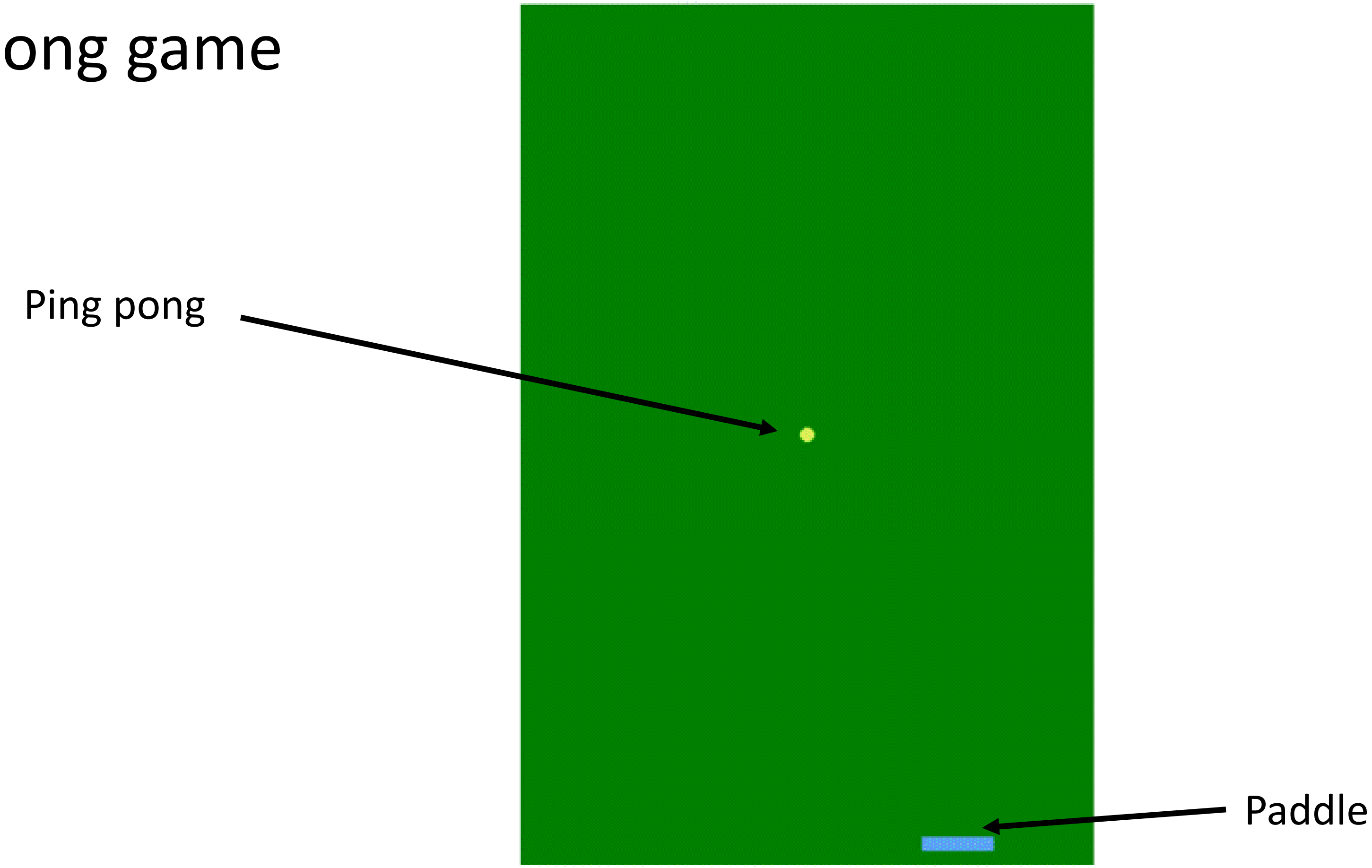
  }
- function plotloss(container, loss, epoch) {

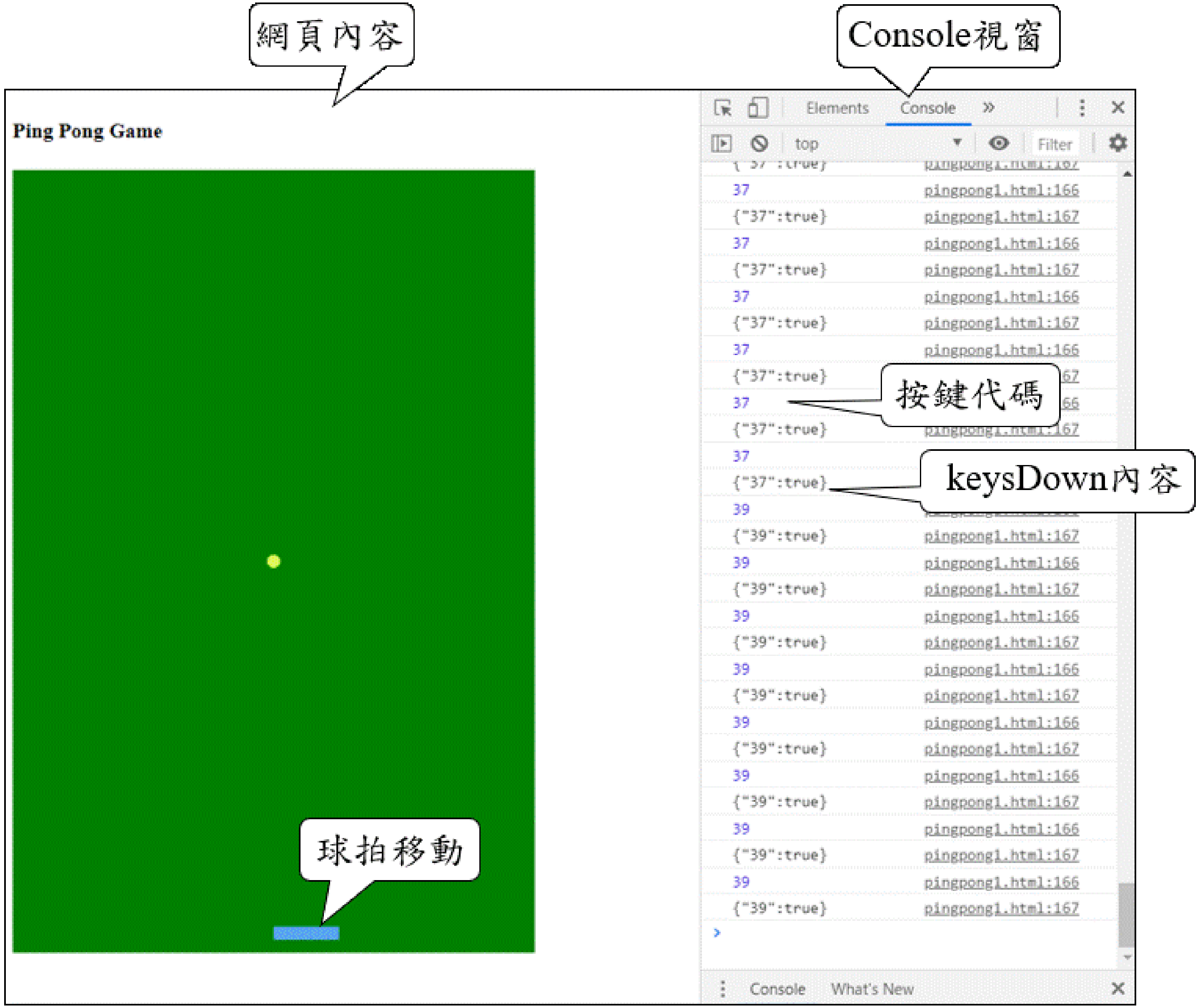
  }
- function plotData2(container, xs, ys, xspreds, yspreds) {

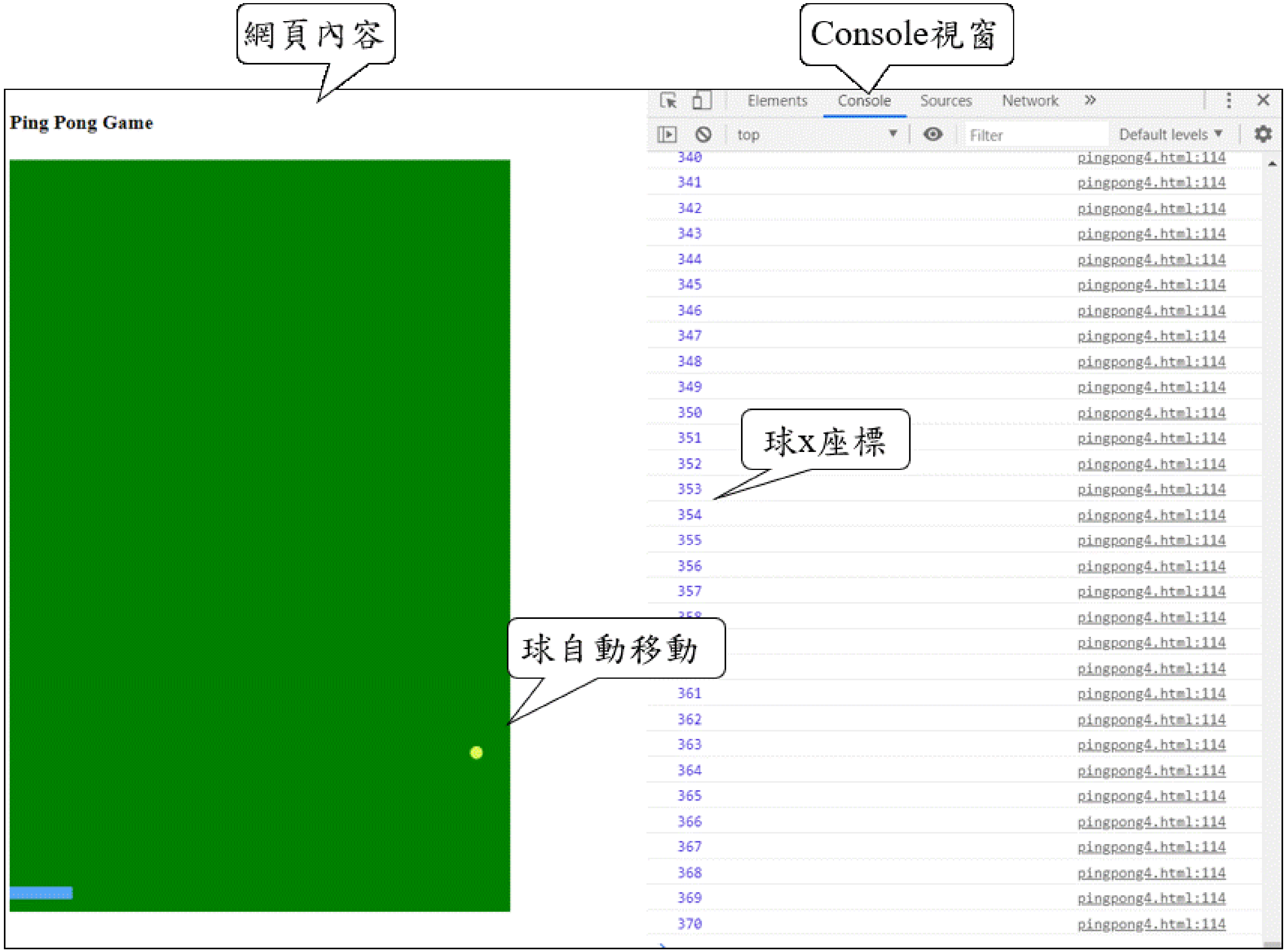
  }

Exercise 11-2

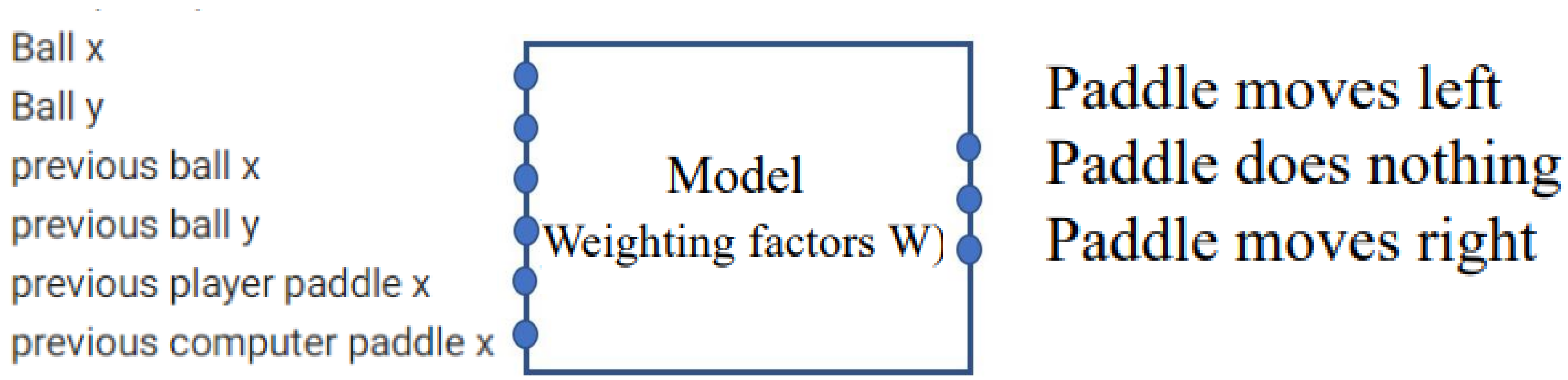
- ex1130_2.html (copy from ex1130_2.txt)
- Ping pong game




網頁內容
Console視窗
Ping Pong Game
Elements
Console
top
Filter
37
{"37":true}
pingpong1.html:166
pingpong1.html:167
39
{"39":true}
按鍵代碼
keysDown內容
球拍移動
Console
What's New


網頁內容
Console視窗
Ping Pong Game
Elements
Console
Sources
Network
top
Filter
Default levels
340
341
342
343
344
345
346
347
348
349
350
351
352
353
354
355
356
357
361
362
363
364
365
366
367
368
369
370
pingpong4.html:114
球x座標
球自動移動

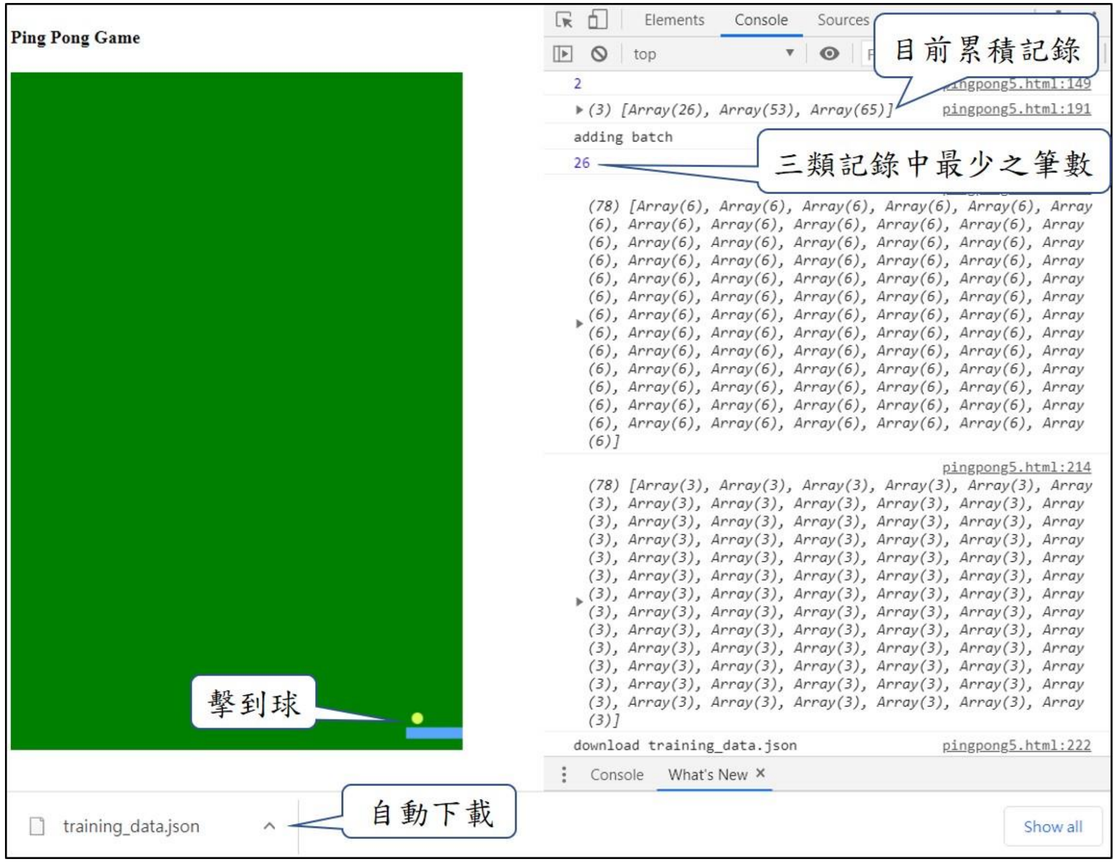
Model



Ball x
Ball y
previous ball x
previous ball y
previous player paddle x
previous computer paddle x
Model
Weighting factors W)
Paddle moves left
Paddle does nothing
Paddle moves right

Exercise 11-3

- ex1130_3.html (copy from ex1130_3.txt)
- Record playing data



training_data.json

{"xs":[[272,328,188,264,320,180],[264,320,180,256,312,172],[256,312,172,248,30
4,164],[248,304,164,240,296,156],[240,296,156,232,288,148],[232,288,148,224,28
0,140],[224,280,140,216,272,132],[216,272,132,208,264,124],[208,264,124,200,25
6,116],[200,256,116,192,248,108],[192,248,108,184,240,100],[184,240,100,176,23
2,92],[176,232,92,168,224,84],[168,224,84,160,216,76],[160,216,76,152,208,68],[1
52,208,68,144,200,60],[144,200,60,136,192,52],[136,192,52,128,184,44],[128,184,
44,120,176,36],[120,176,36,112,168,28],[112,168,28,104,160,20],[104,160,20,96,1
52,12],[96,152,12,88,144,4],[88,144,4,80,136,12],[80,136,12,72,128,20],[72,128,20
,64,120,28],[40,88,572,40,96,564],[40,96,564,40,104,556],[40,104,556,40,112,548]
,[40,112,548,40,120,540],[40,120,540,40,128,532],[40,128,532,40,136,524],[40,13
6,524,40,144,516],[40,144,516,40,152,508],[40,152,508,40,160,500],[40,160,500,4
0,168,492],[40,168,492,40,176,484],[40,176,484,40,184,476],[272,384,244,272,37
6,236],[272,376,236,272,368,228],[272,368,228,272,360,220],[272,360,220,272,35
2,212],[272,352,212,272,344,204],[272,344,204,272,336,196],[272,336,196,272,32
8,188],[64,120,28,64,112,36],[64,112,36,64,104,44],[64,104,44,64,96,52],[64,96,52
,64,88,60],[64,88,60,64,80,68],[64,80,68,64,72,76],[64,72,76,64,64,84],[40,184,476
,48,192,468],[48,192,468,56,200,460],[56,200,460,64,208,452],[64,208,452,72,216
,444],[72,216,444,80,224,436],[80,224,436,88,232,428],[88,232,428,96,240,420],[9
6,240,420,104,248,412],[104,248,412,112,256,404],[112,256,404,120,264,396],[12
0,264,396,128,272,388],[128,272,388,136,280,380],[136,280,380,144,288,372],[14
4,288,372,152,296,364],[152,296,364,160,304,356],[160,304,356,168,312,348],[16
8,312,348,176,320,340],[176,320,340,184,328,332],[184,328,332,192,336,324],[19
2,336,324,200,344,316],[200,344,316,208,352,308],[208,352,308,216,360,300],[21
6,360,300,224,368,292],[224,368,292,232,376,284],[232,376,284,240,384,276],[24
0,384,276,248,392,268]],"ys":[[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[
1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,
0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[1,0,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[
0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,
0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,1,0],[0,0,1],[

```
console.log(len);
var data_xx=[];
var data_yy=[];

if (len > 10){
    for(i = 0; i < 3; i++){
     data_xx.push(...training_data[i].slice(0, len));
            // trims training data to 'len' length

     data_yy.push(...Array(len).fill([i==0?1:0, i==1?1:0
     , i==2?1:0]));    // creates 'len' number records
     of embedding data
```

Blob

```
var a = document.createElement("a");
// var a = document.getElementById("a");
var file = new Blob([JSON.stringify({xs: data_xx, ys
: data_yy})], {type: 'application/json'});
a.href = URL.createObjectURL(file);
a.download = 'training_data.json';
a.click();
console.log('download training_data.json');
//印出文字'download training_data.json'
```

Exercise 11-4

- change code: when the length of the record is larger than 3000, the json file will be downloaded automatically。

```
console.log(len);
var data_xx=[];
var data_yy=[];

if (len > 10){
   for(i = 0; i < 3; i++){
    data_xx.push(...training_data[i].slice(0, len));
          // trims training data to 'len' length

    data_yy.push(...Array(len).fill([i==0?1:0, i==1?1:0
    , i==2?1:0]));    // creates 'len' number records
```

Classification Problem

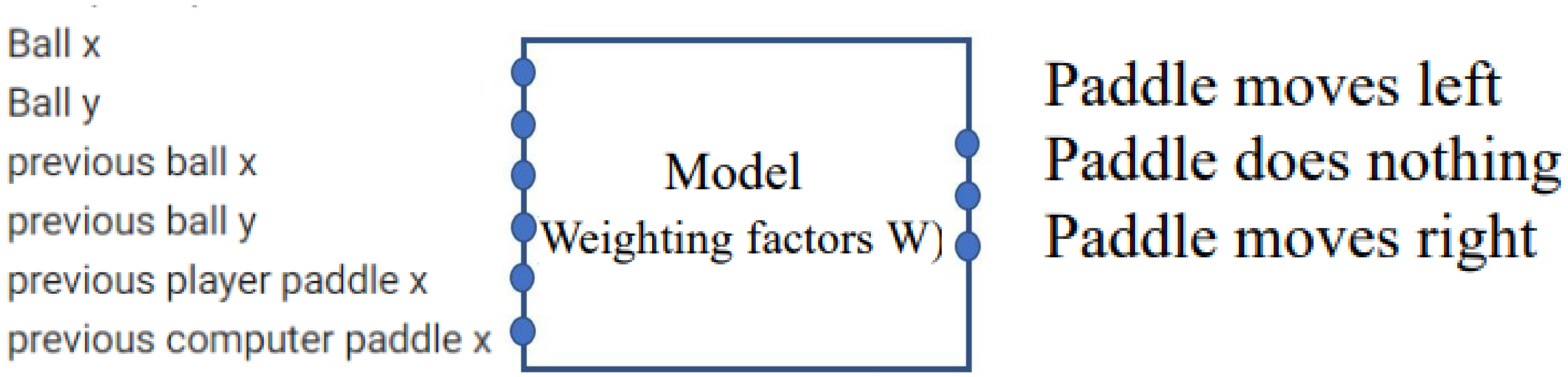
- y∈{dog,cat,chicken}   => y∈{1,2,3}   => y∈{(1,0,0),(0,1,0),(0,0,1)}
- In our case, a label yy would be a three-dimensional vector,
with (1,0,0)corresponding to “cat”, (0,1,0) to “chicken”, and (0,0,1) to “dog”:

- y∈{baby,toddler,adolescent,young adult,geriatric} => y∈{1,2,….?}   => y∈{????}

Classification

Classification	Label
Paddle move left	[1,0,0]
Paddle does nothing	[0,1,0]
Paddle move right	[0,0,1]

Model


Ball x
Ball y
previous ball x
previous ball y
previous player paddle x
previous computer paddle x
Model
Weighting factors W)
Paddle moves left
Paddle does nothing
Paddle moves right

Network Architecture

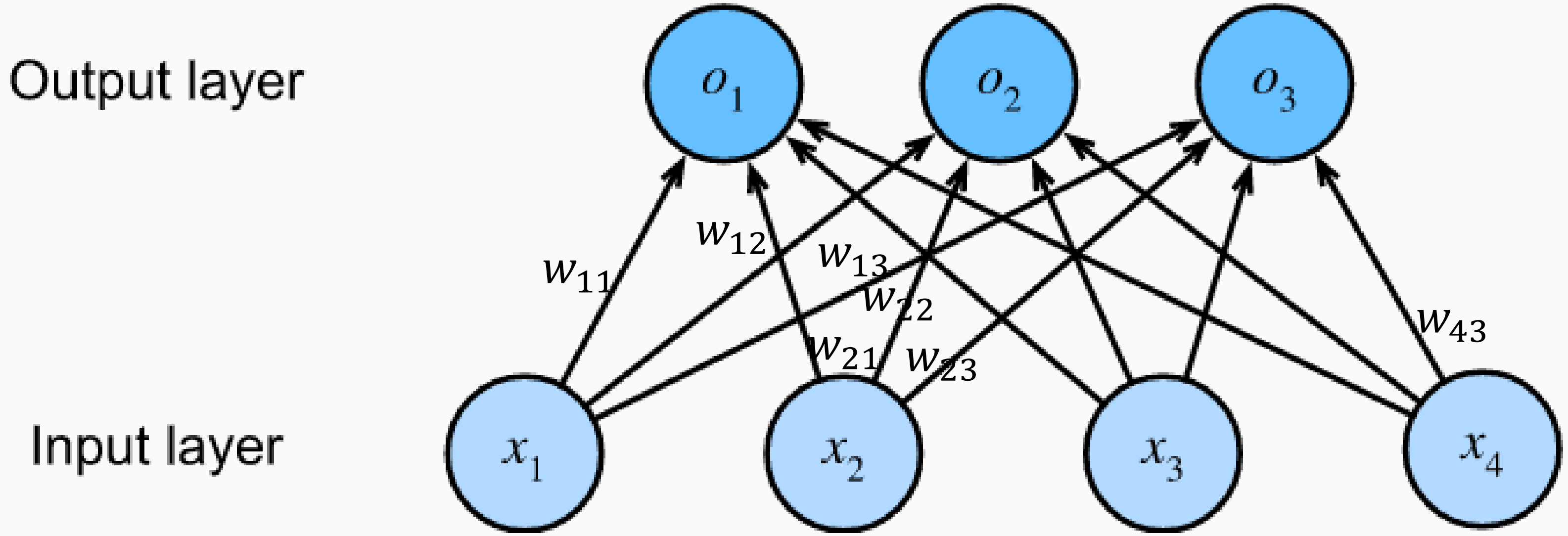


Fig. 3.4.1 Softmax regression is a single-layer neural network.

$$\mathbf{o} = \mathbf{W}\mathbf{x} + \mathbf{b},$$

Network Architecture

$$\mathbf{o} = \mathbf{W}\mathbf{x} + \mathbf{b},$$

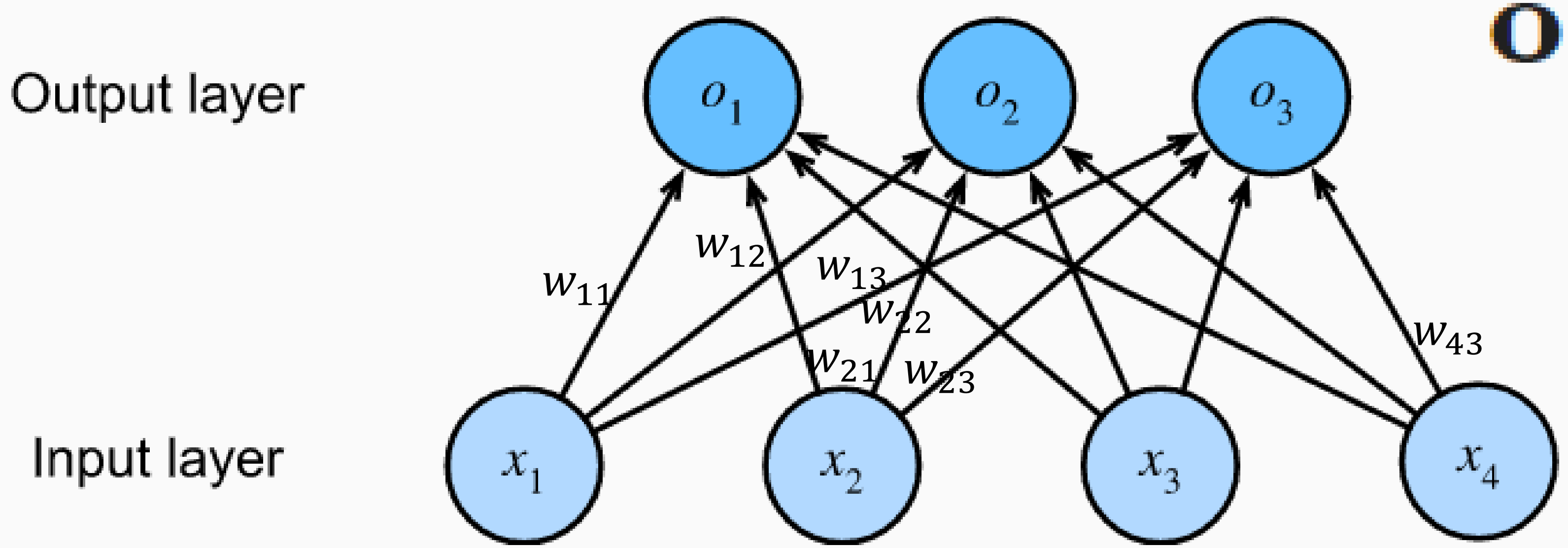


Fig. 3.4.1 Softmax regression is a single-layer neural network.

$$\begin{aligned} o_1 &= x_1 w_{11} + x_2 w_{12} + x_3 w_{13} + x_4 w_{14} + b_1, \\ o_2 &= x_1 w_{21} + x_2 w_{22} + x_3 w_{23} + x_4 w_{24} + b_2, \\ o_3 &= x_1 w_{31} + x_2 w_{32} + x_3 w_{33} + x_4 w_{34} + b_3. \end{aligned}$$

$o_1 = w_{11}x_1 + w_{12}x_2 + w_{13}\, x_3 + w_{14}x_4 + b_1$

$o_2 = ?$

$o_3 = ?$

Softmax Operation

$$\hat{\mathbf{y}} = \mathrm{softmax}(\mathbf{o}) \quad \text{where} \quad \hat{y}_j = \frac{\exp(o_j)}{\sum_k \exp(o_k)}. \tag{3.4.3}$$

It is easy to see $\hat{y}_1 + \hat{y}_2 + \hat{y}_3 = 1$ with $0 \leq \hat{y}_j \leq 1$ for all j. Thus, $\hat{\mathbf{y}}$ is a proper probability distribution whose element values can be interpreted accordingly.

we can still pick out the most likely class by

$$\operatorname*{argmax}_j \hat{y}_j = \operatorname*{argmax}_j o_j. \tag{3.4.4}$$

Although softmax is a nonlinear function, the outputs of softmax regression are still *determined* by an affine transformation of input features; thus, softmax regression is a linear model.

Vectorization for Minibatches

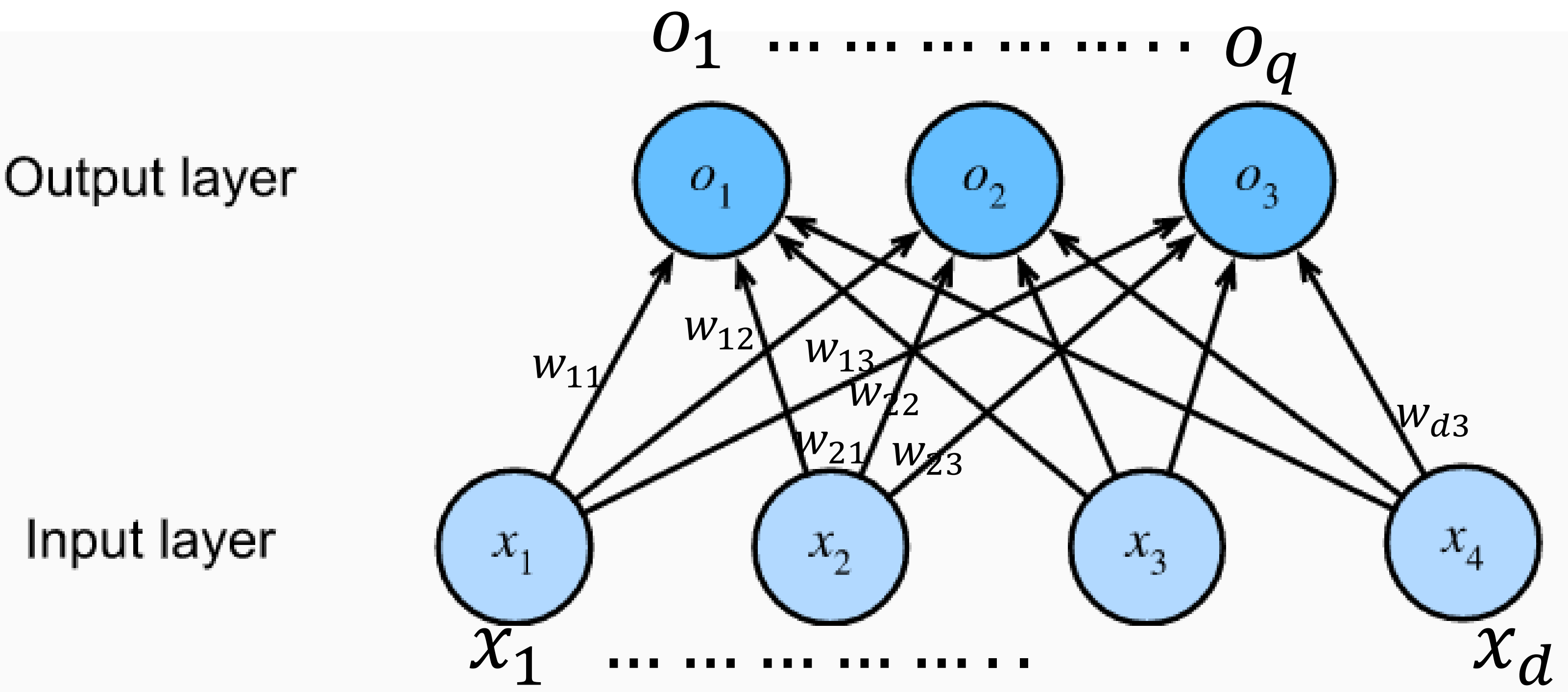


Fig. 3.4.1 Softmax regression is a single-layer neural network.

$\mathbf{X} \in \mathbb{R}^{n \times d}$.

$\mathbf{W} \in \mathbb{R}^{d \times q}$

$$\mathbf{O} = \mathbf{X}\mathbf{W} + \mathbf{b},$$
$$\hat{\mathbf{Y}} = \mathrm{softmax}(\mathbf{O}).$$

Multilayer Perceptrons

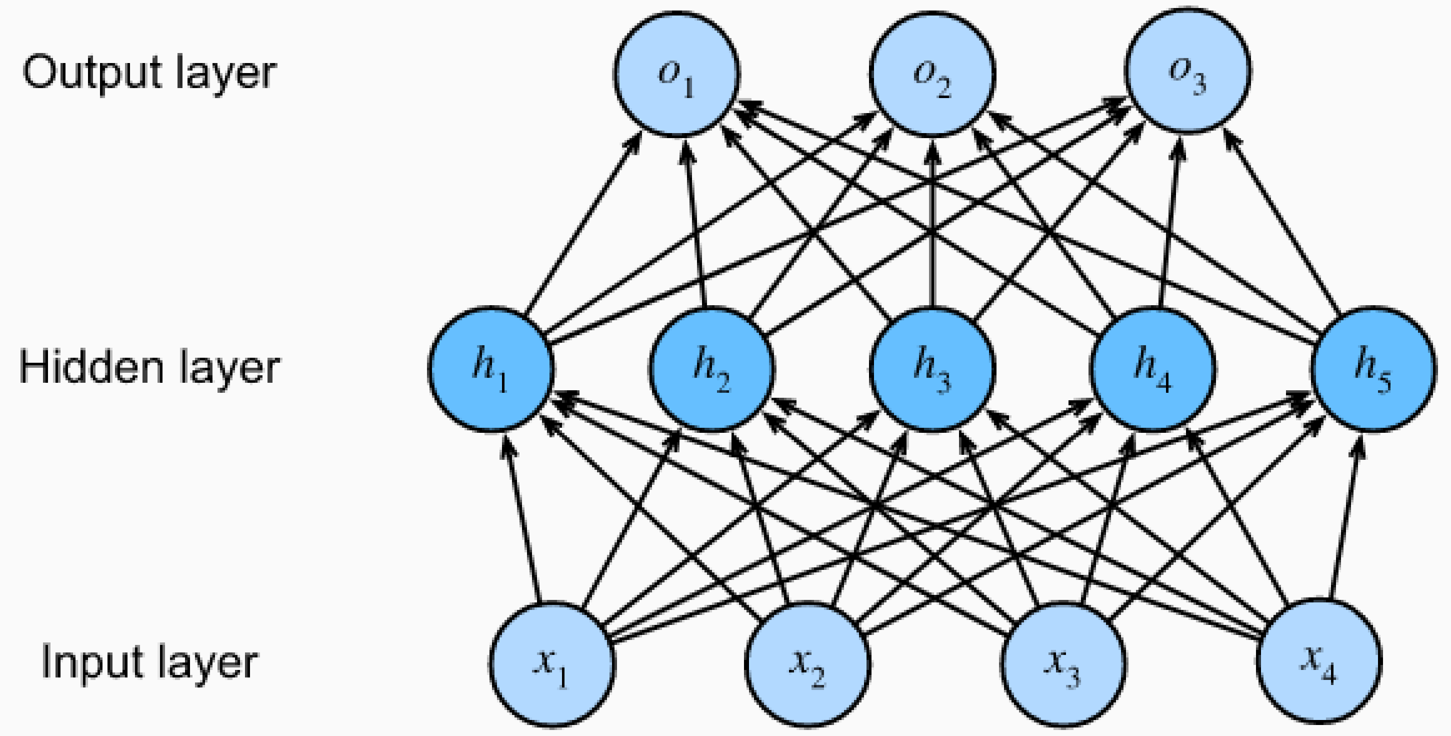


Fig. 4.1.1 An MLP with a hidden layer of 5 hidden units.

Multilayer Perceptrons

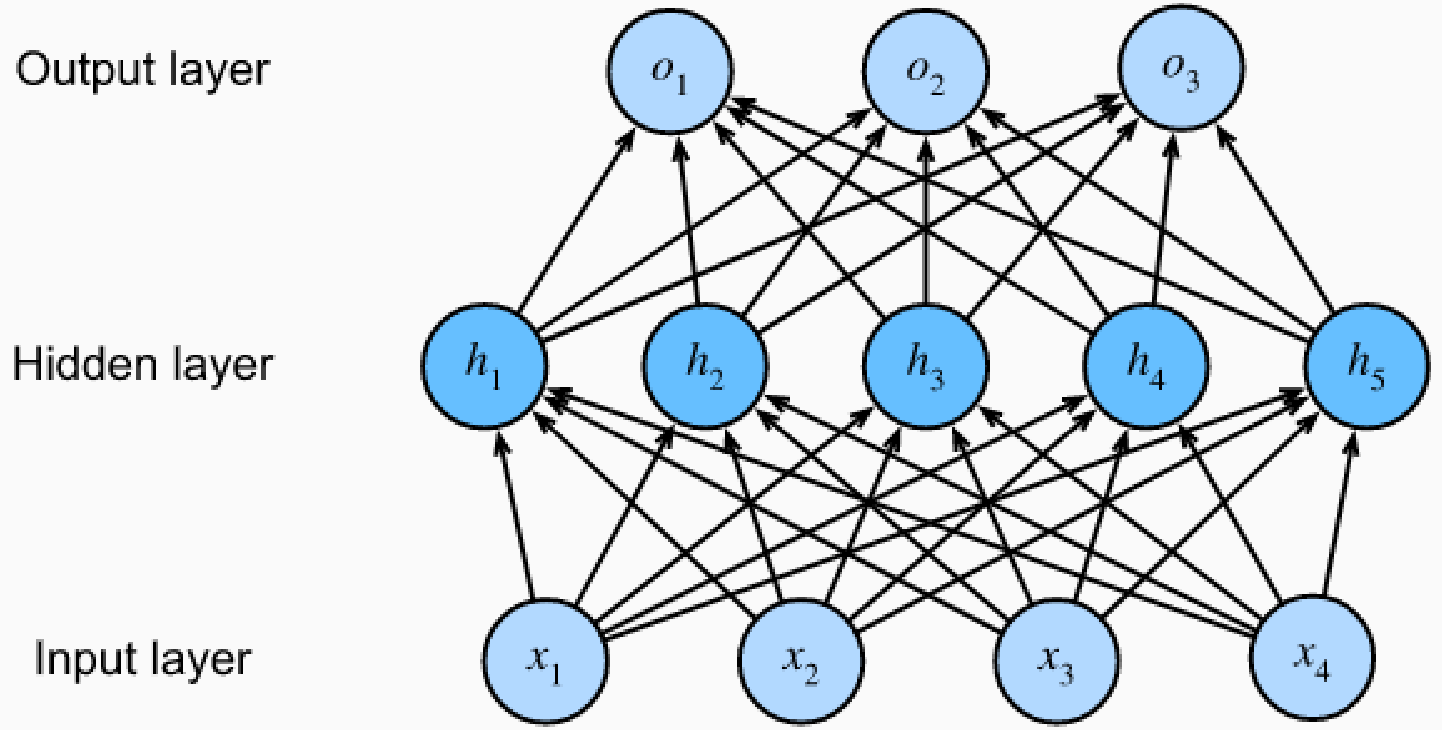


Fig. 4.1.1 An MLP with a hidden layer of 5 hidden units.

$$\mathbf{H} = \mathbf{X}\mathbf{W}^{(1)} + \mathbf{b}^{(1)},$$

Multilayer Perceptrons

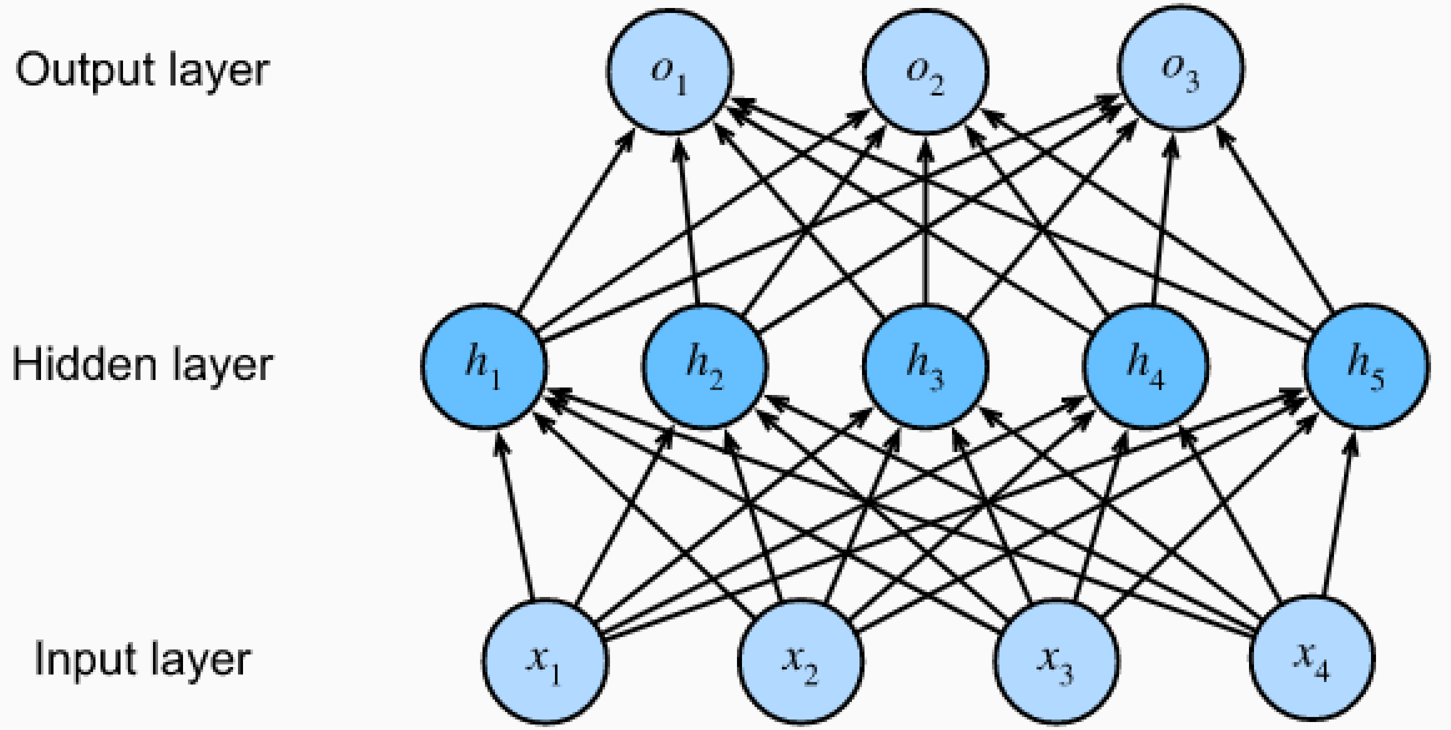


Fig. 4.1.1 An MLP with a hidden layer of 5 hidden units.

$$\mathbf{O} = \mathbf{H}\mathbf{W}^{(2)} + \mathbf{b}^{(2)}.$$

$$\mathbf{H} = \mathbf{X}\mathbf{W}^{(1)} + \mathbf{b}^{(1)},$$

From Linear to Nonlinear

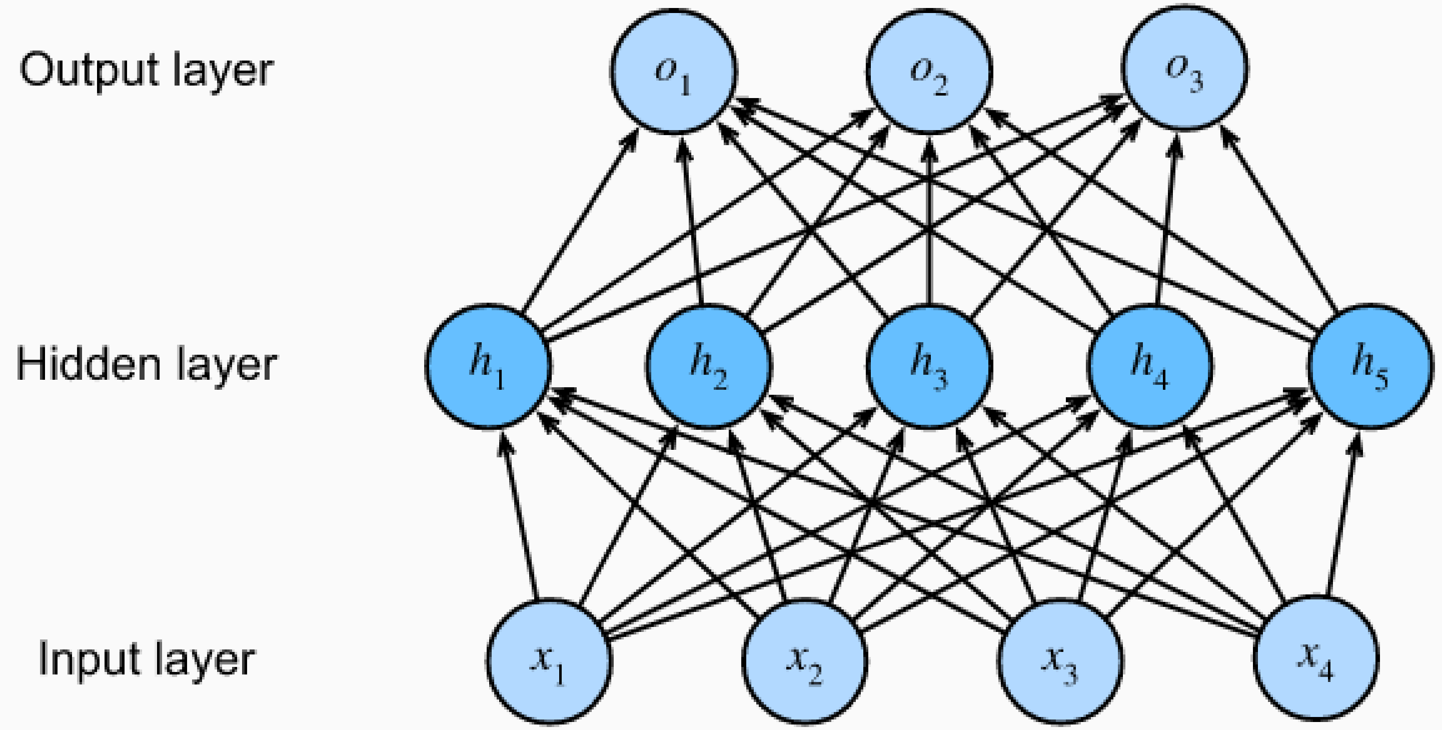


Fig. 4.1.1 An MLP with a hidden layer of 5 hidden units.

$$\mathbf{H} = \sigma(\mathbf{X}\mathbf{W}^{(1)} + \mathbf{b}^{(1)}),$$

From Linear to Nonlinear

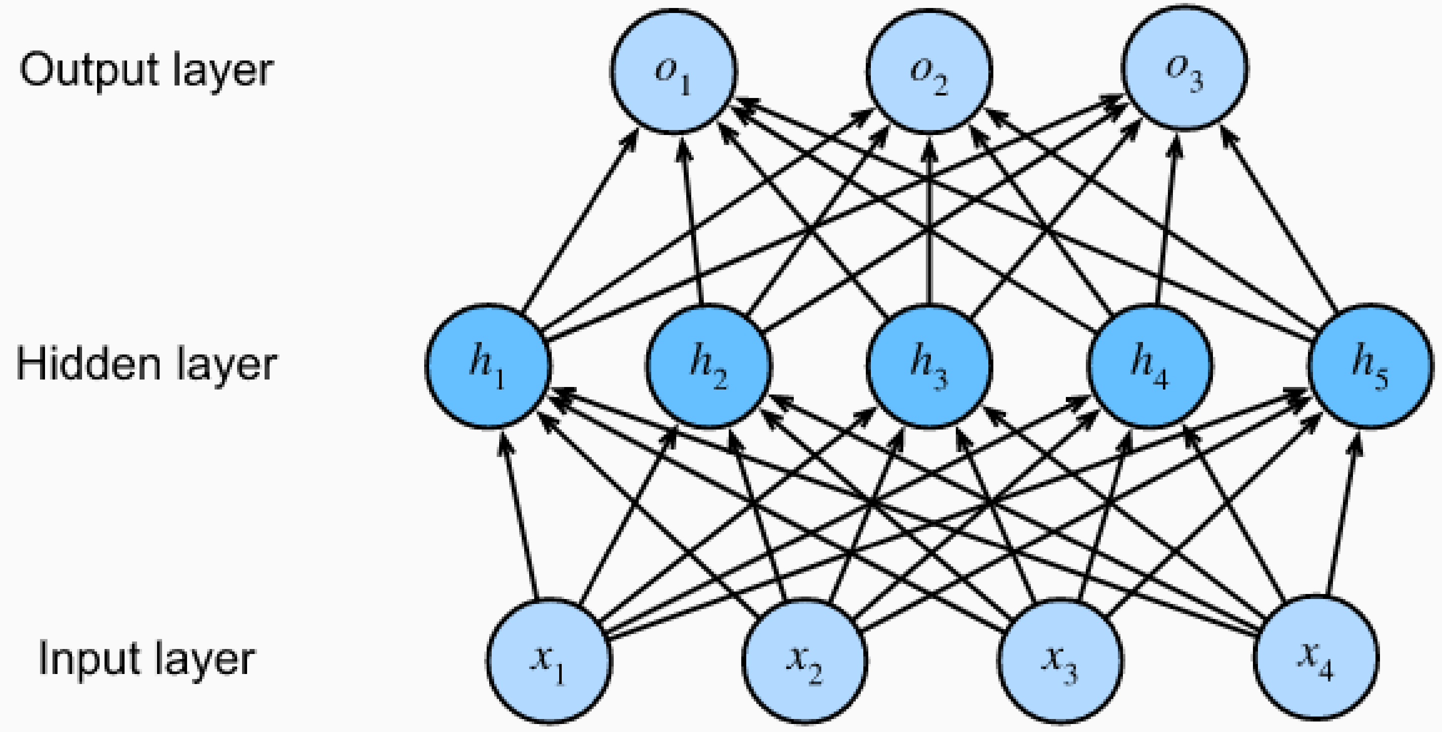


Fig. 4.1.1 An MLP with a hidden layer of 5 hidden units.

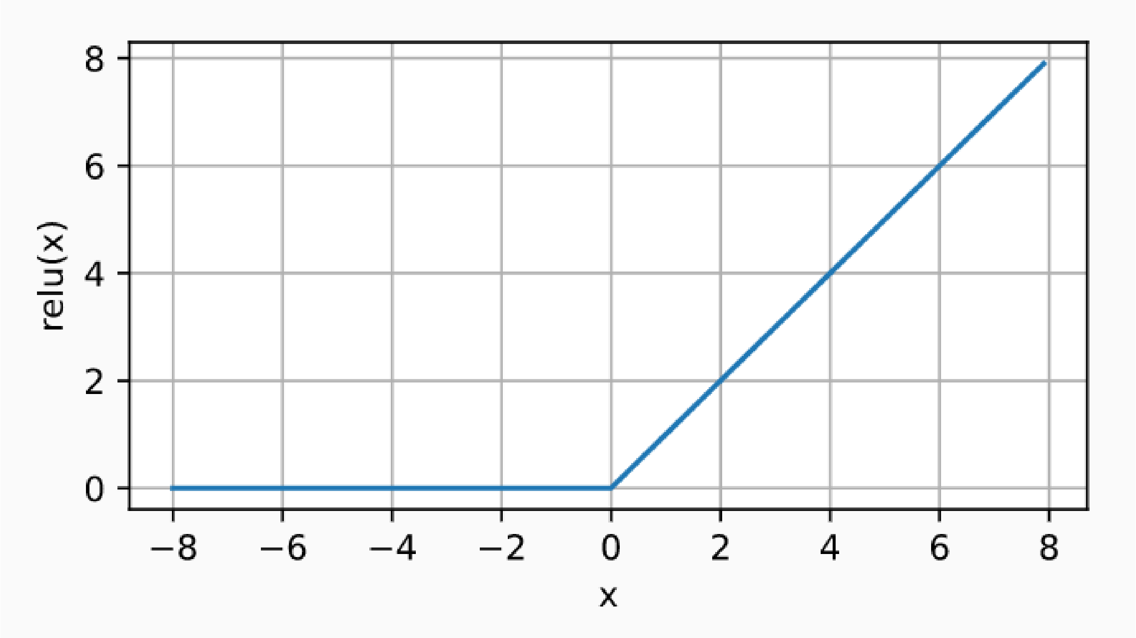
$$\mathbf{O} = \mathbf{H}\mathbf{W}^{(2)} + \mathbf{b}^{(2)}.$$

$$\mathbf{H} = \sigma(\mathbf{X}\mathbf{W}^{(1)} + \mathbf{b}^{(1)}),$$

Activation Functions

Activation Functions

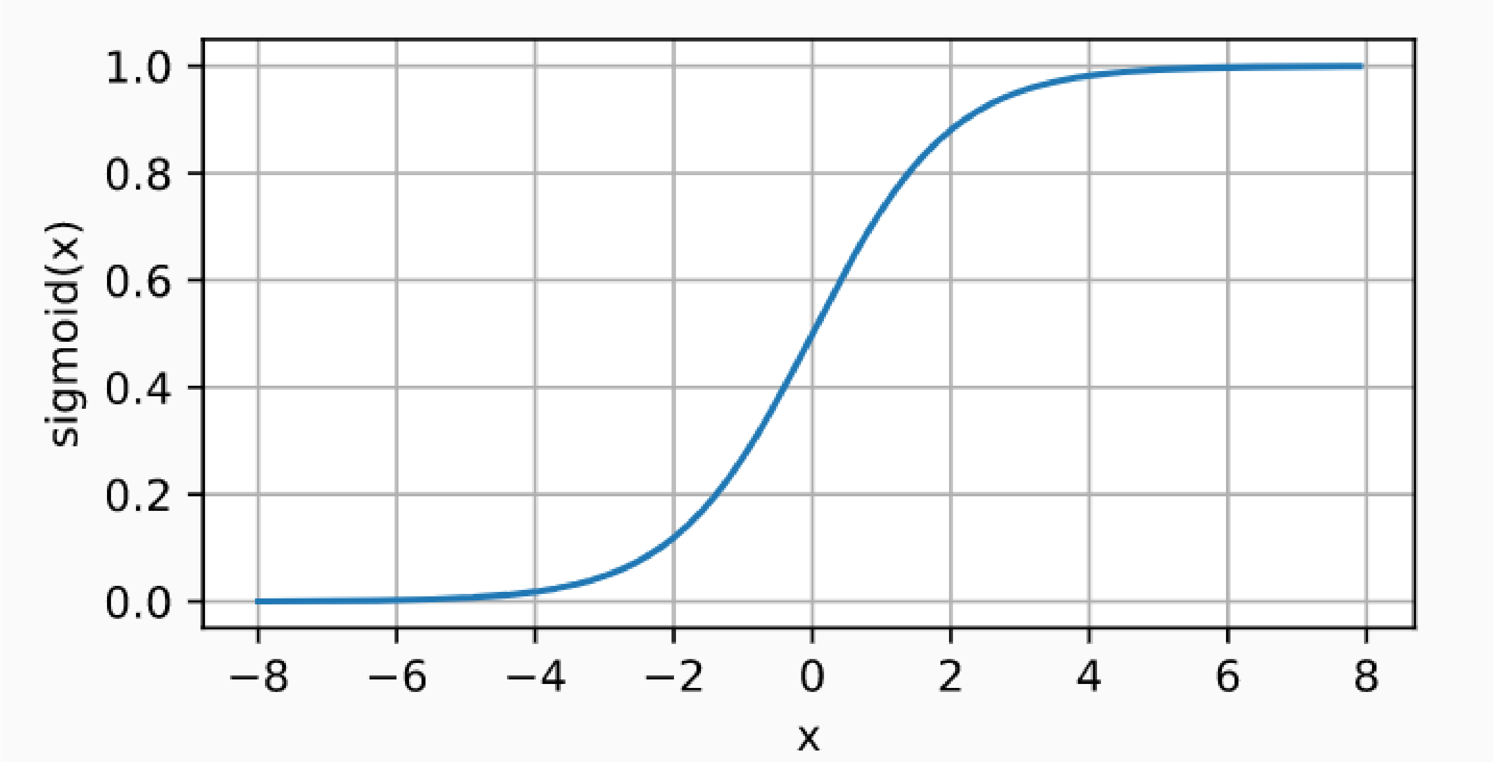
- ReLU Function



$$\mathrm{ReLU}(x) = \max(x, 0).$$

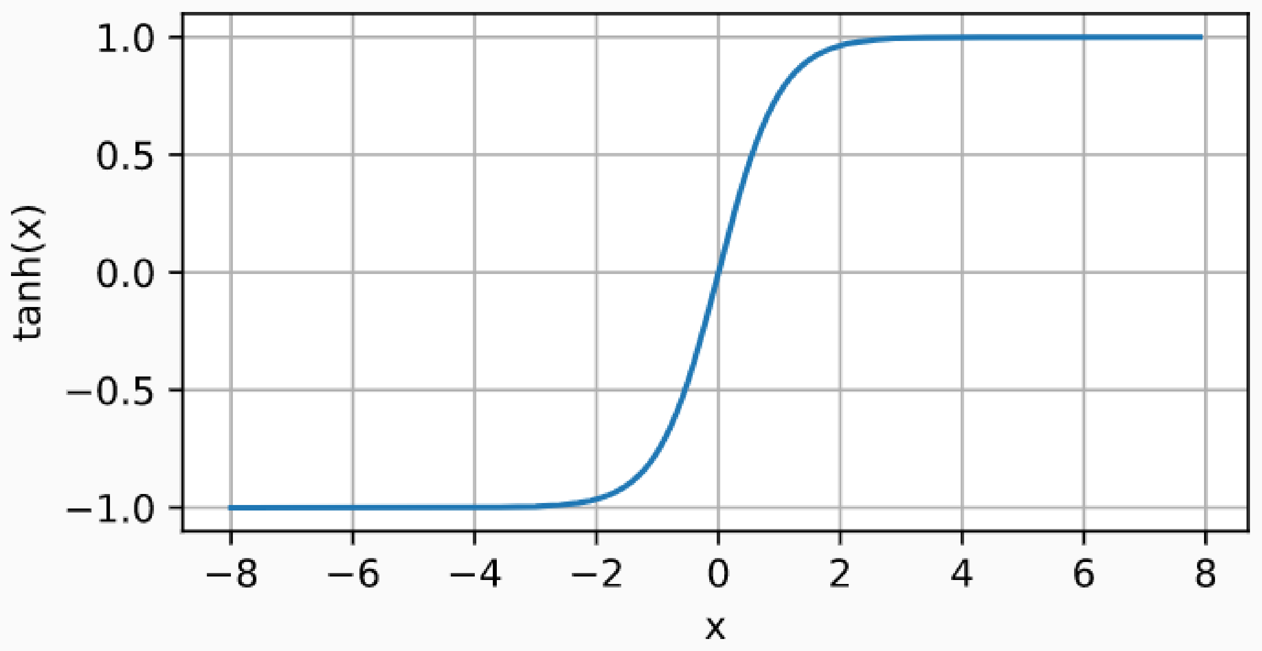
Sigmoid Function

$$\text{sigmoid}(x) = \frac{1}{1 + \exp(-x)}.$$

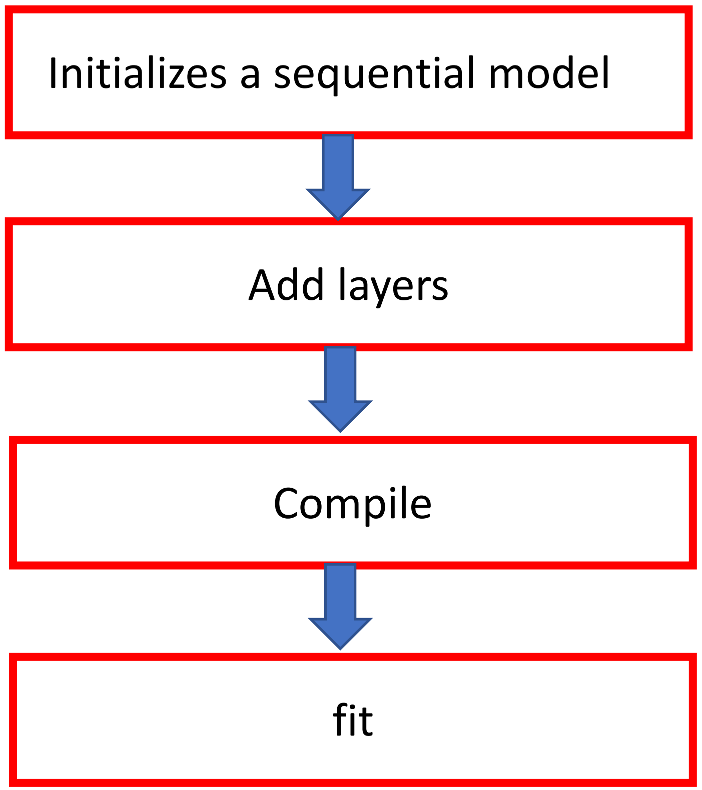


Tanh Function

$$\tanh(x) = \frac{1 - \exp(-2x)}{1 + \exp(-2x)}.$$

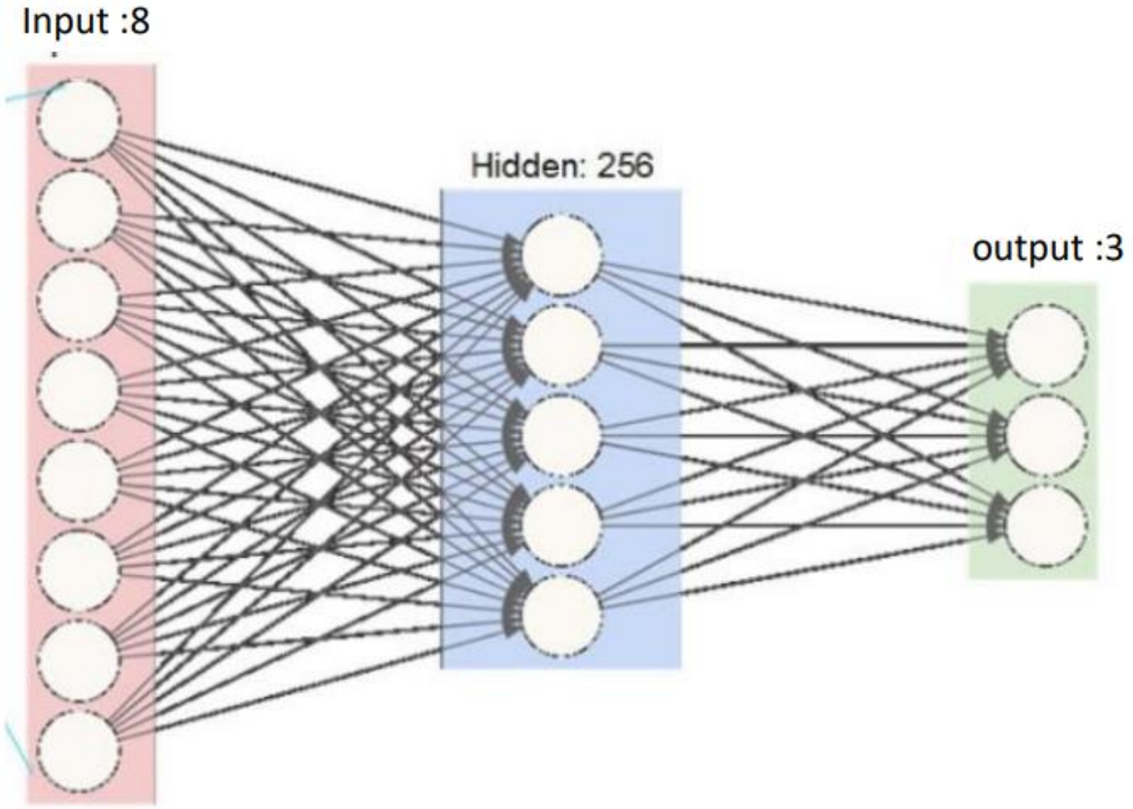


```
// Initializes a sequential model
const model = tf.sequential();
// The line below needs curly braced inputs (note the syntax similarity with TF K
// We are using 10 units and ReLU activation. The input shape is a 28 by 28 monoc
model.add(tf.layers.dense({units:64,inputShape:[28,28,1],activation:'relu'}));
// This line compiles the model quite similar to model.compile in TensorFlow, wit
model.compile({
  optimizer:'adam',
  loss:'categoricalCrossentropy'
});
// This line fits the model on the dataset, which is currently stored in a tensor
await model.fit(xs,ys,{
  epochs: 100,
  callbacks: { // The line below may look scary, but all it does it prints the lo
    onEpochEnd: async(epoch,logs) =>{
          console.log("Epoch :" + epoch + " Loss:" + logs.loss);
    }
  }
});
// Done!
```

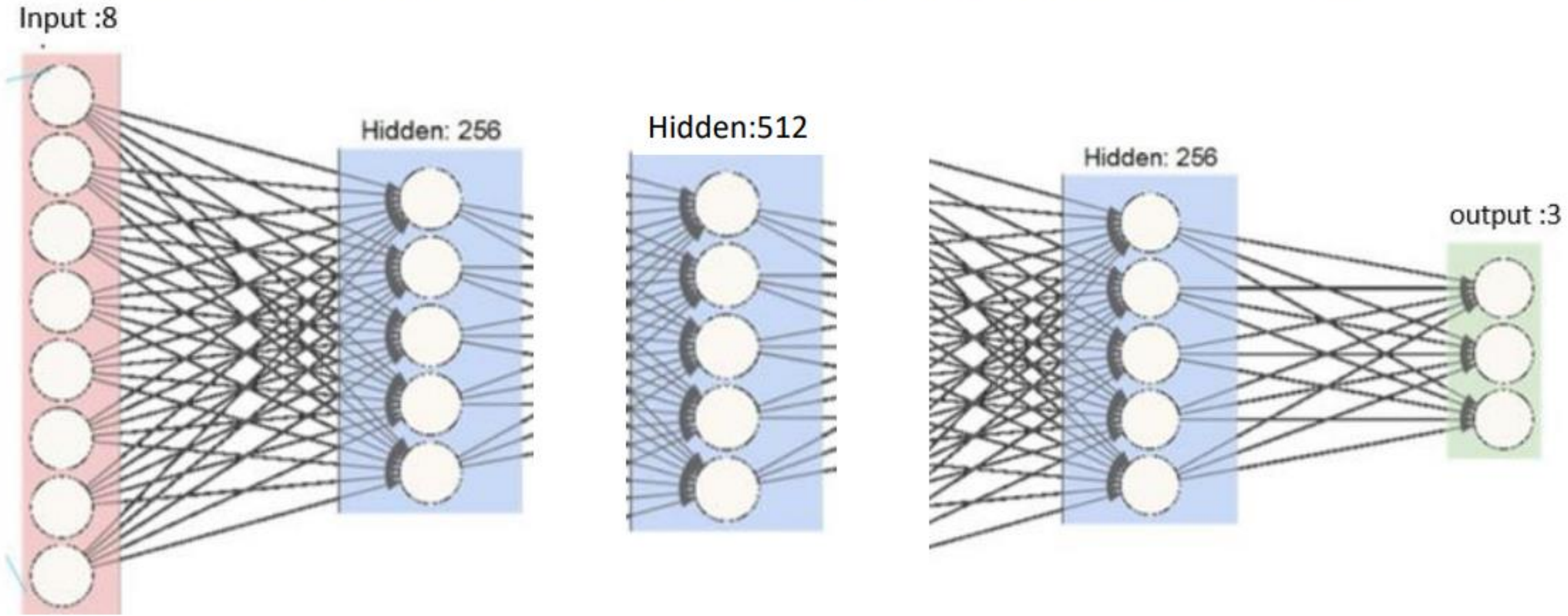


model

```
const model = tf.sequential();
model.add(tf.layers.dense({units: 256, inputShape: [8]}));
model.add(tf.layers.dense({units: 3, inputShape: [256]}));
//returns a 1x3
```

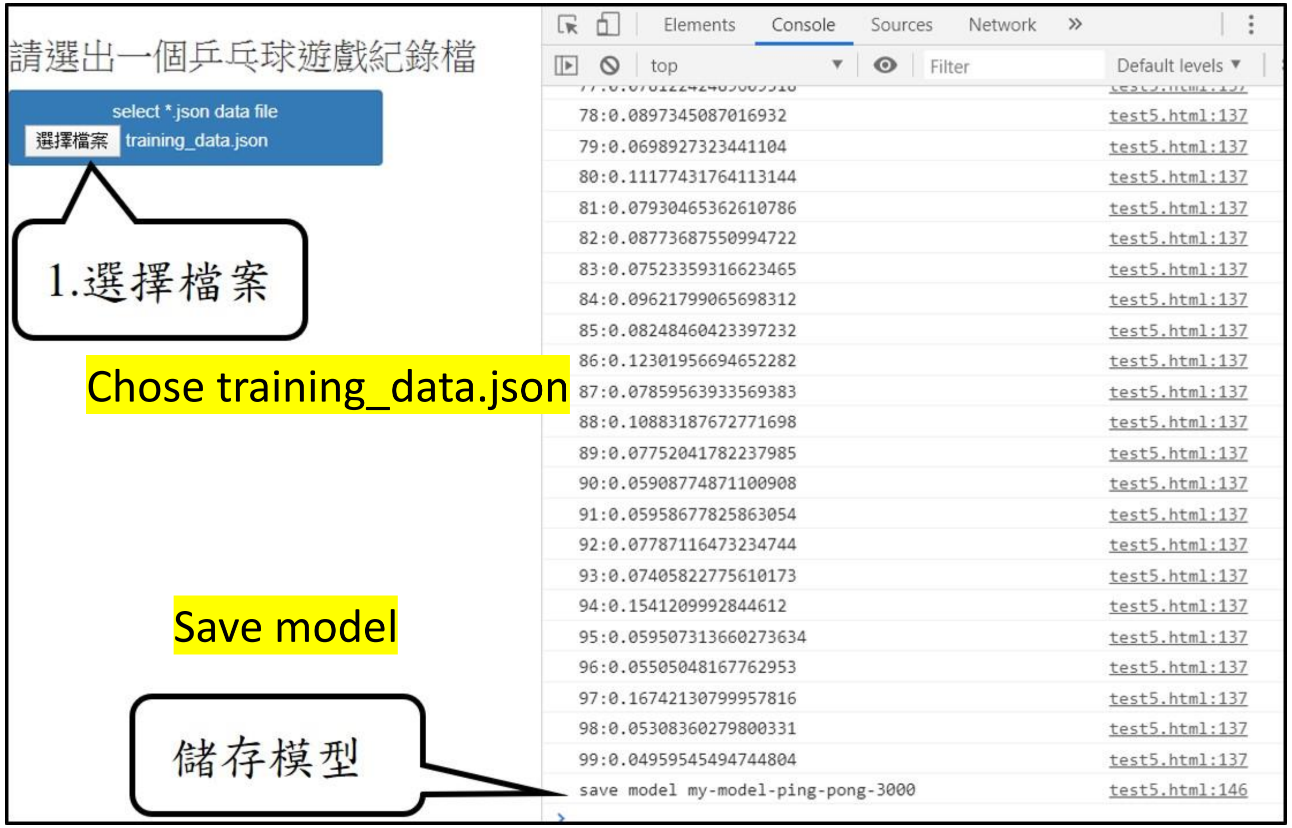


```
// initial model definition
const model = tf.sequential();
model.add(tf.layers.dense({units: 256, inputShape: [8]})); //input is a 1x8
model.add(tf.layers.dense({units: 512, inputShape: [256]}));
model.add(tf.layers.dense({units: 256, inputShape: [512]}));
model.add(tf.layers.dense({units: 3, inputShape: [256]})); //returns a 1x3
```



Exercise 11-5

- ex1130_5.html (copy from ex1130_5.txt)
- Train model



model

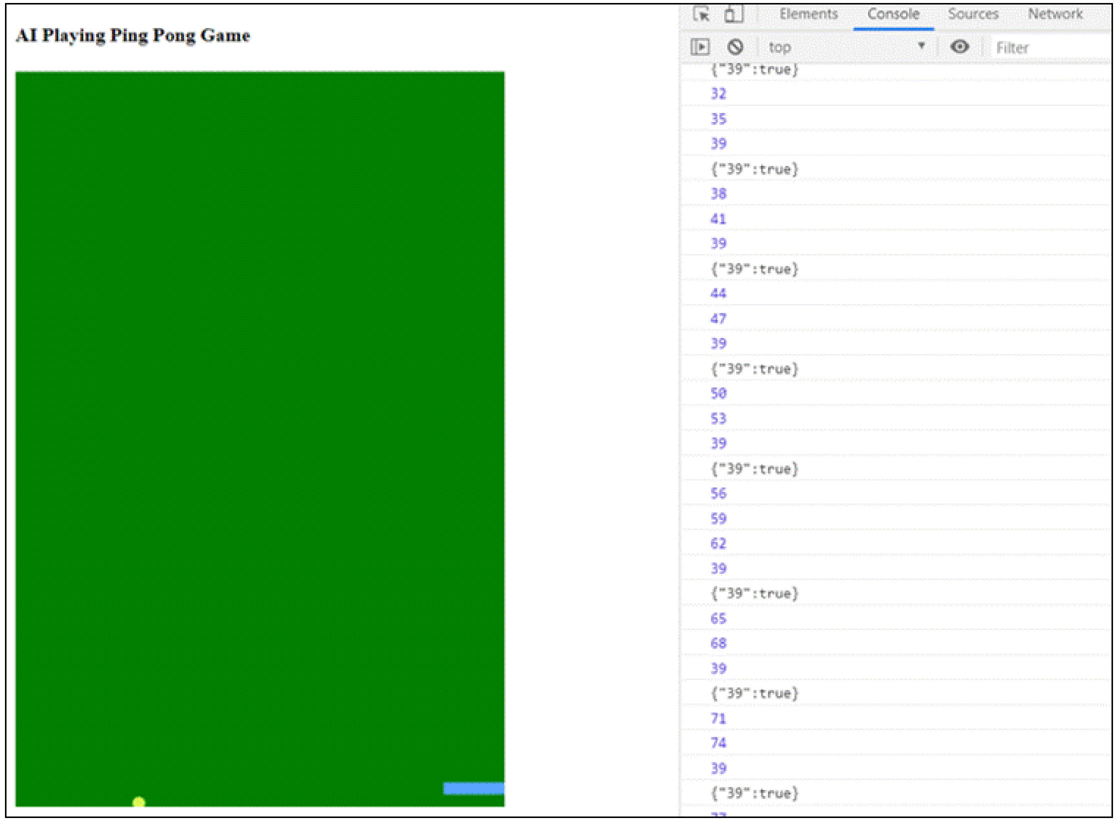
```
model = tf.sequential();
model.add(tf.layers.dense({units: 64,activation:'relu',
inputShape: [6]})); //input is a 1x8
model.add(tf.layers.dropout(0.5));
model.add(tf.layers.dense({units: 64,activation:'relu'}));
model.add(tf.layers.dropout(0.5));
model.add(tf.layers.dense({units: 3,activation:'softmax'}));
```

Setting Optimization algorithm & loss function

```
// set optimiser and compile model
const learningRate = 0.001;
const optimizer = tf.train.adam(learningRate);
model.compile({loss: 'categoricalCrossentropy', optimizer:
optimizer, metrics: ['accuracy']});
console.log( 'compile finished');
```

Exercise 11-6

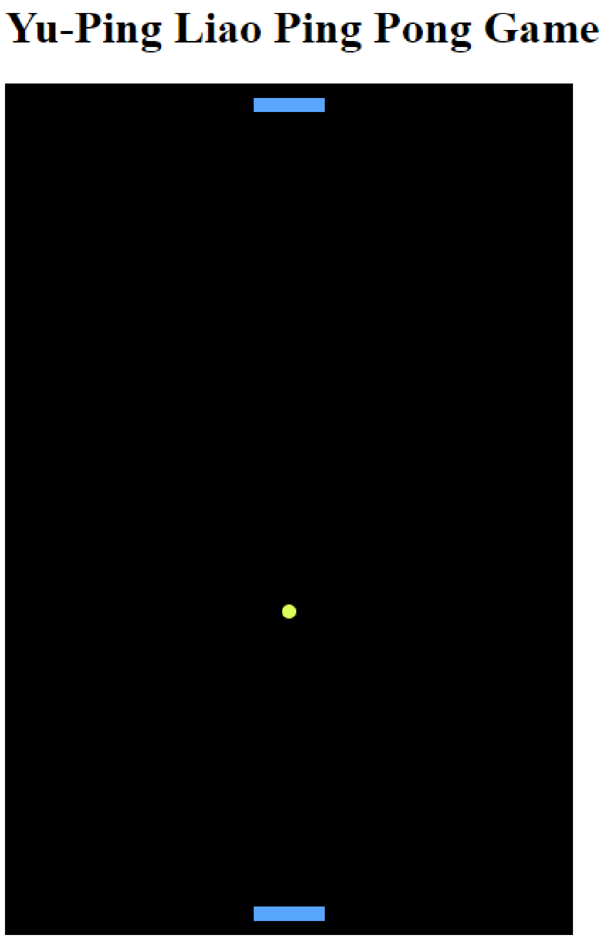
- ex1130_6.html (copy from ex1130_6.txt)
- AI play ping pong game



Model summary

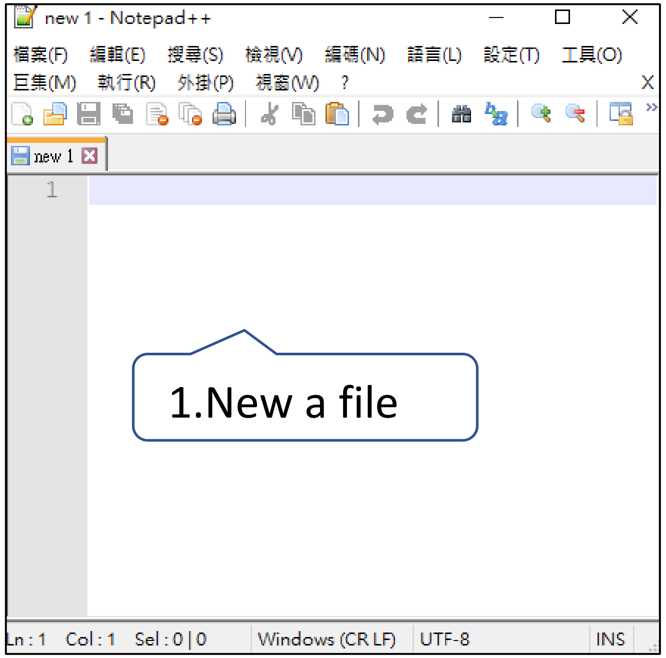
```
_________________________________________________________________
Layer (type)                 Output shape              Param #
=================================================================
dense_Dense1 (Dense)         [null,64]                 448
_________________________________________________________________
dropout_Dropout1 (Dropout)   [null,64]                 0
_________________________________________________________________
dense_Dense2 (Dense)         [null,64]                 4160
_________________________________________________________________
dropout_Dropout2 (Dropout)   [null,64]                 0
_________________________________________________________________
dense_Dense3 (Dense)         [null,3]                  195
=================================================================
Total params: 4803
Trainable params: 4803
Non-trainable params: 0
_________________________________________________________________
```

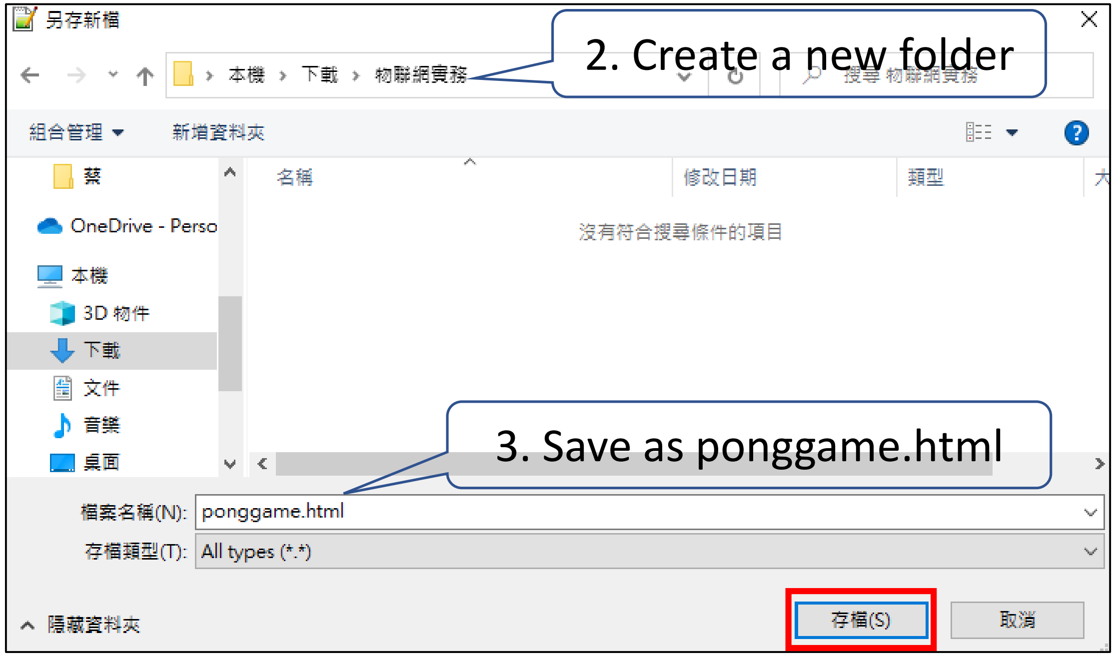
Pong Game AI using TensorFlow JS



Exercise 11-7

- **Pong Clone In JavaScript**
- • we will have just a simple HTML file that is:”ponggame.html”





ponggame.html

```html
<html>
<head>
<title> Ping Pong Game</title>
</head>
<body>
<h1> Your name's Ping Pong Game</h1>
<div id='mainContent'></div>
<script src="https://cdn.jsdelivr.net/npm/@tensorflow/tfjs@0.11.2"> </script>
<script src="ponggame.js"></script>
</body>
</html>
```

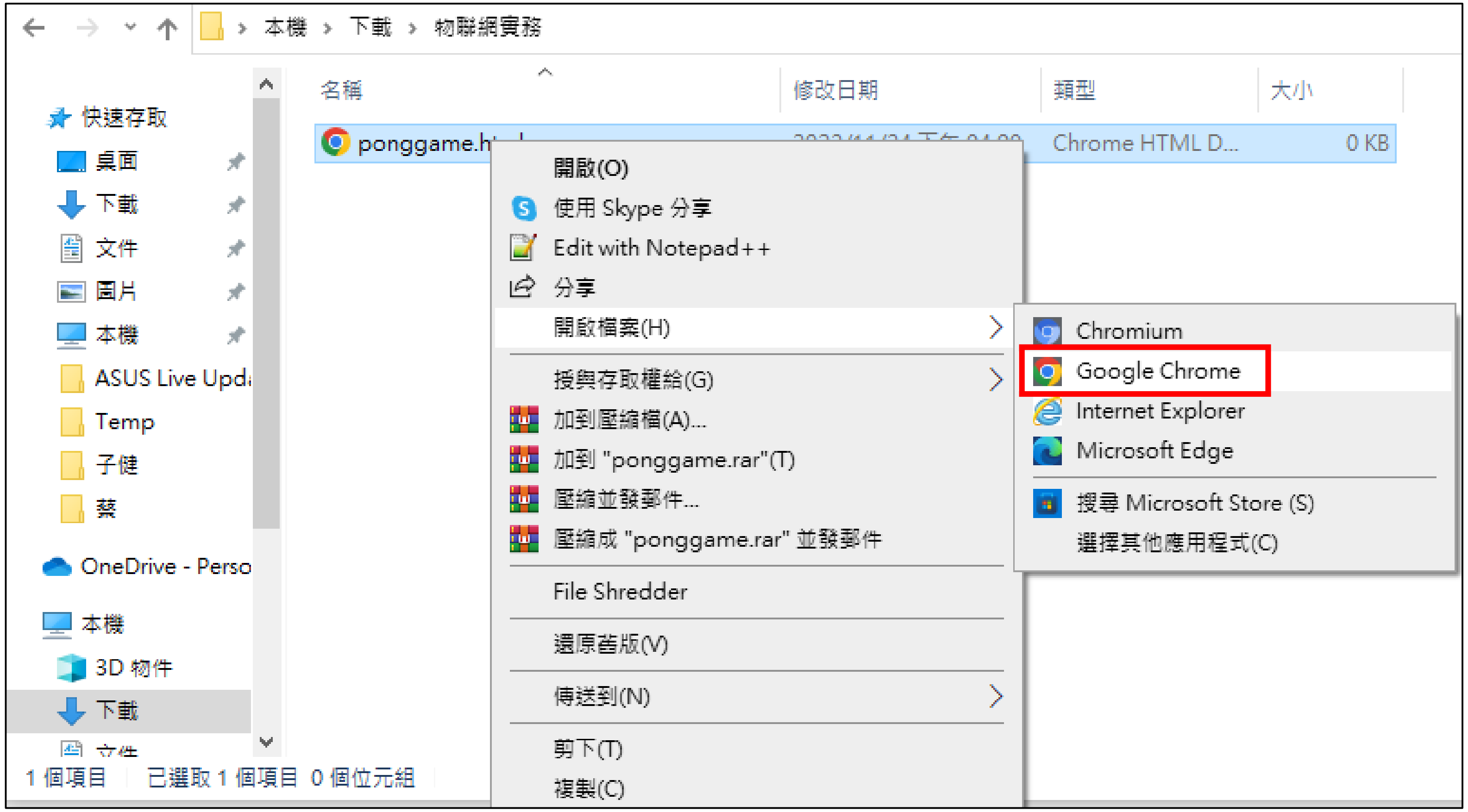
Copy

ponggame.html

```html
<html>
<head>
<title> Ping Pong Game</title>
</head>
<body>
<h1> Your name's Ping Pong Game</h1>
<div id='mainContent'></div>
<script
src="https://cdn.jsdelivr.net/npm/@tensorflow/tfjs@0.11.2"> </script>
<script src="ponggame.js"></script>
</body>
</html>
```

Paste & Save

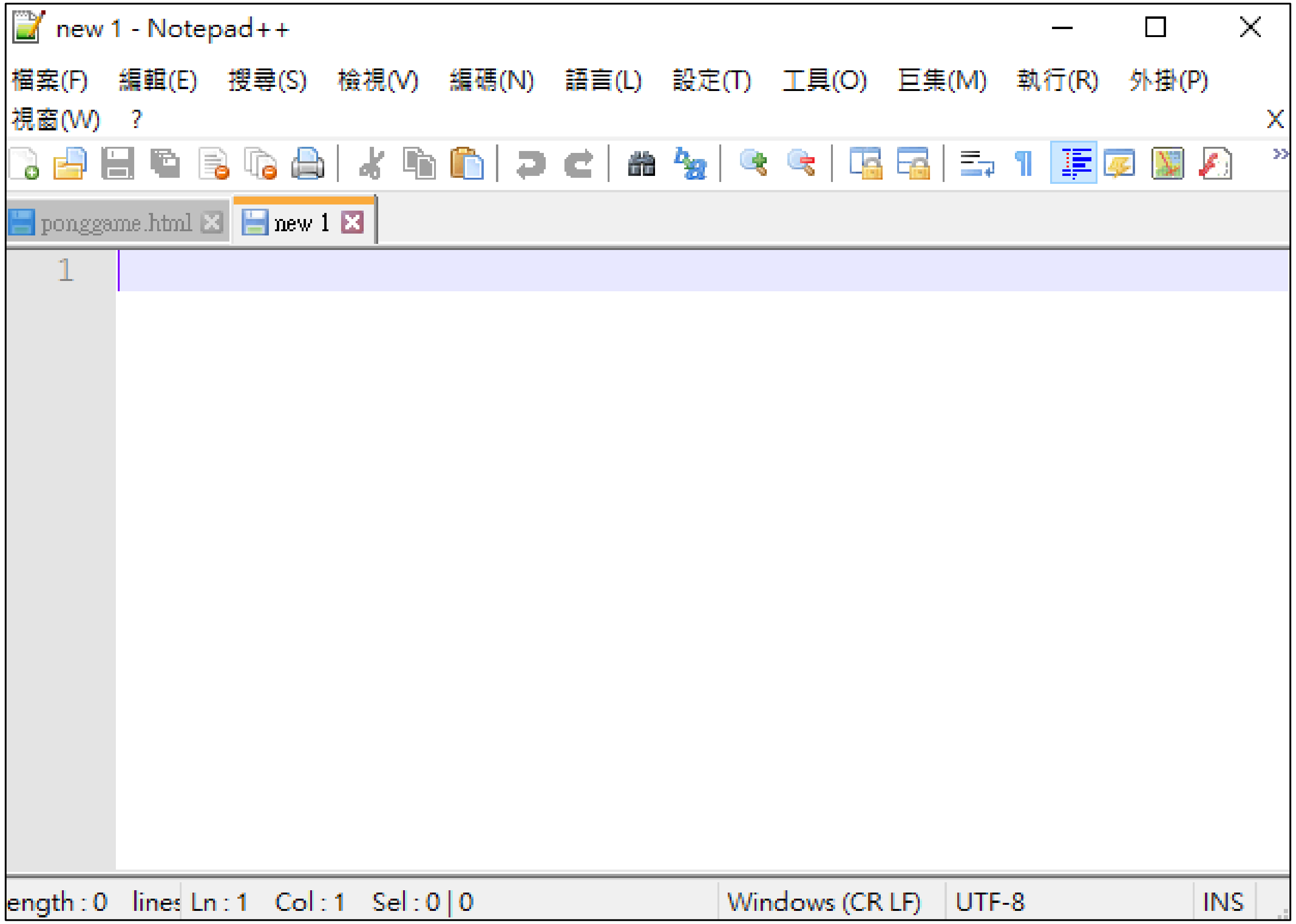
Open ponggame.html with Google Chrome



Ctrl+Shift+I

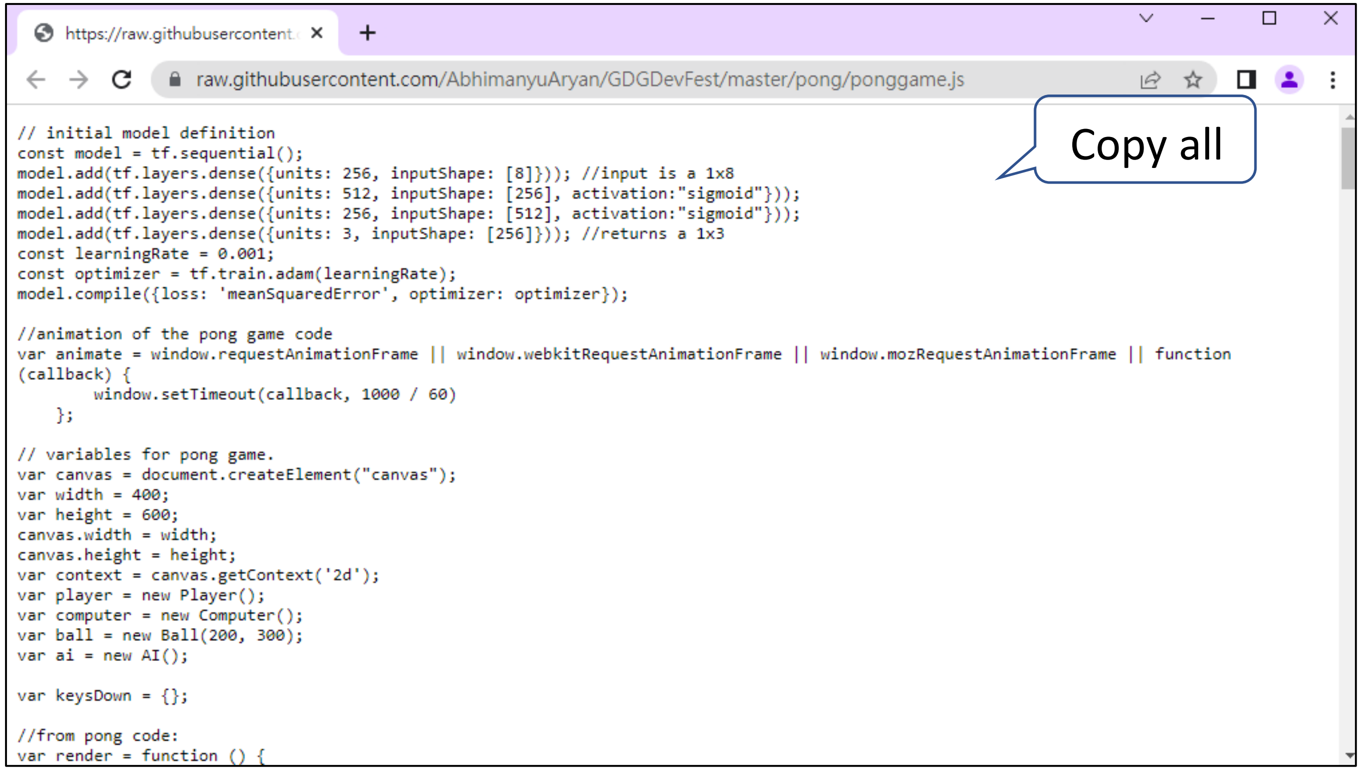

Ping Pong Game
File | C:/Users/jason/Downloads/物聯網實務/ponggame.html
Your name's Ping Pong Game
Elements
Console
Sources
top
Filter
Default levels
1 Issue: 1
GET file:///C:/Users/jason/Downloads/%E7%89%A9%E8%81%AF%E7%B6%B2%E5%AF%A6%E5%8B%99/ponggame.js
ponggame.html:10
net::ERR_FILE_NOT_FOUND
Error
Console
What's New
Highlights from the Chrome 107 update
Customize keyboard shortcuts
Customize keyboard shortcuts for your favourite commands in DevTools.
new

New a file


new 1 - Notepad++
檔案(F) 編輯(E) 搜尋(S) 檢視(V) 編碼(N) 語言(L) 設定(T) 工具(O) 巨集(M) 執行(R) 外掛(P)
視窗(W) ?
ponggame.html
new 1
1
ength : 0 lines Ln : 1 Col : 1 Sel : 0 | 0
Windows (CR LF)
UTF-8
INS

Copy

- https://raw.githubusercontent.com/AbhimanyuAryan/GDGDevFest/master/pong/ponggame.js



Save As ponggame.js

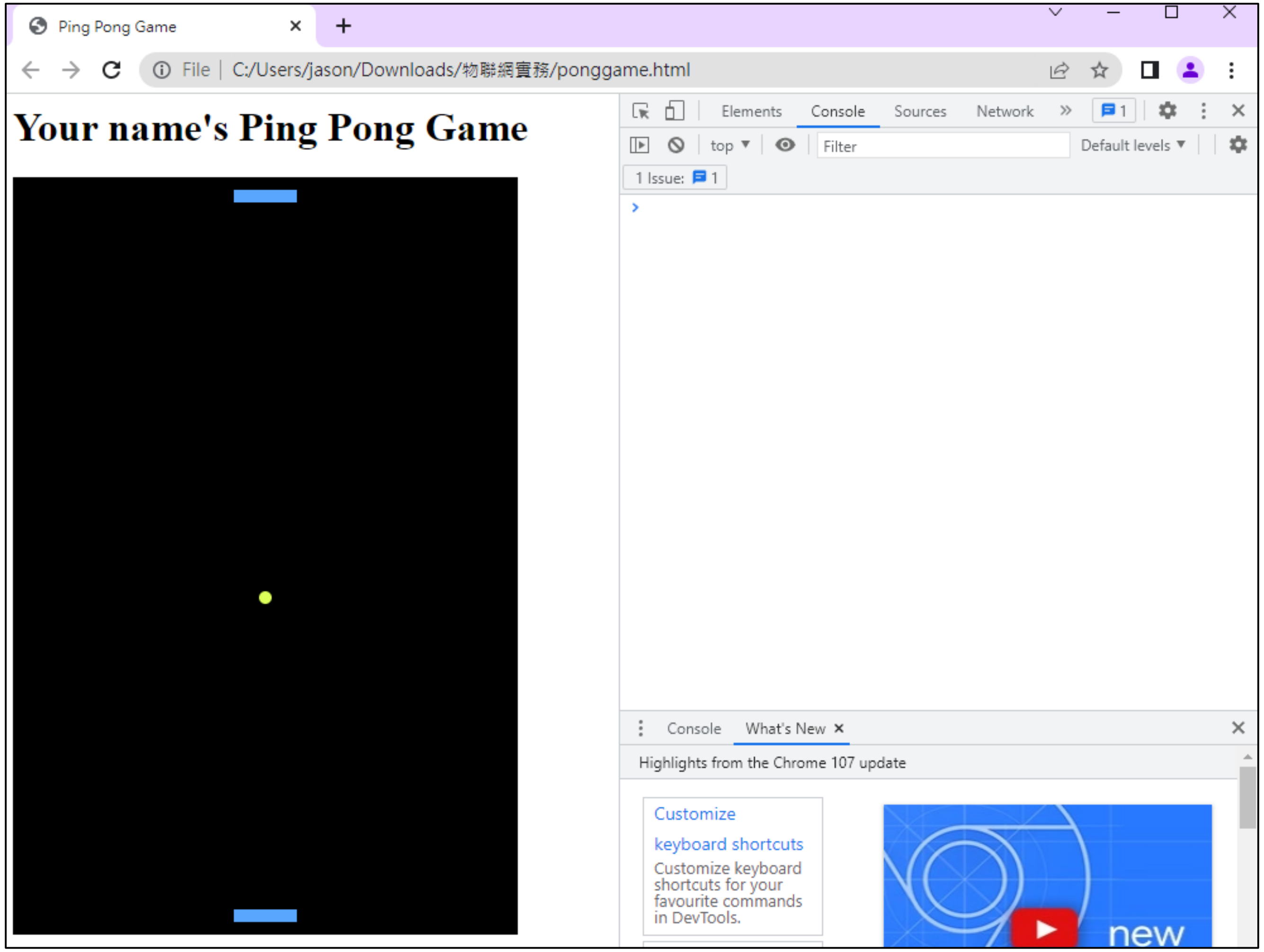
ponggame.html | ponggame.js

```
// initial model definition
const model = tf.sequential();
model.add(tf.layers.dense({units: 256, inputShape: [8]})); //input is
model.add(tf.layers.dense({units: 512, inputShape: [256], activation:
model.add(tf.layers.dense({units: 256, inputShape: [512], activation:
model.add(tf.layers.dense({units: 3, inputShape: [256]})); //returns
const learningRate = 0.001;
const optimizer = tf.train.adam(learningRate);
model.compile({loss: 'meanSquaredError', optimizer: optimizer});

//animation of the pong game code
var animate = window.requestAnimationFrame || window.webkitRequestAni
        window.setTimeout(callback, 1000 / 60)
    };

// variables for pong game.
var canvas = document.createElement("canvas");
var width = 400;
var height = 600;
canvas.width = width;
```

Paste

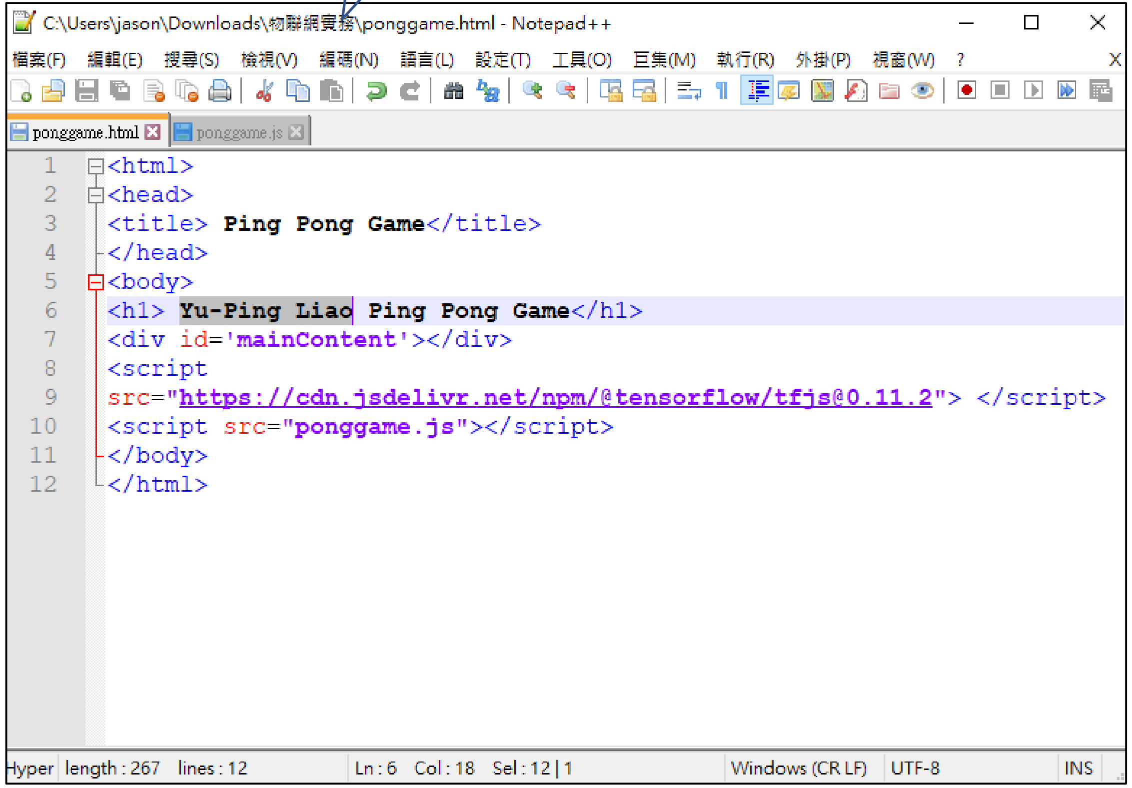
avaSc length : 8,834 lines : 323 | Ln : 323 Col : 4 Sel : 0 | 0 | Windows (CR LF) | UTF-8 | INS

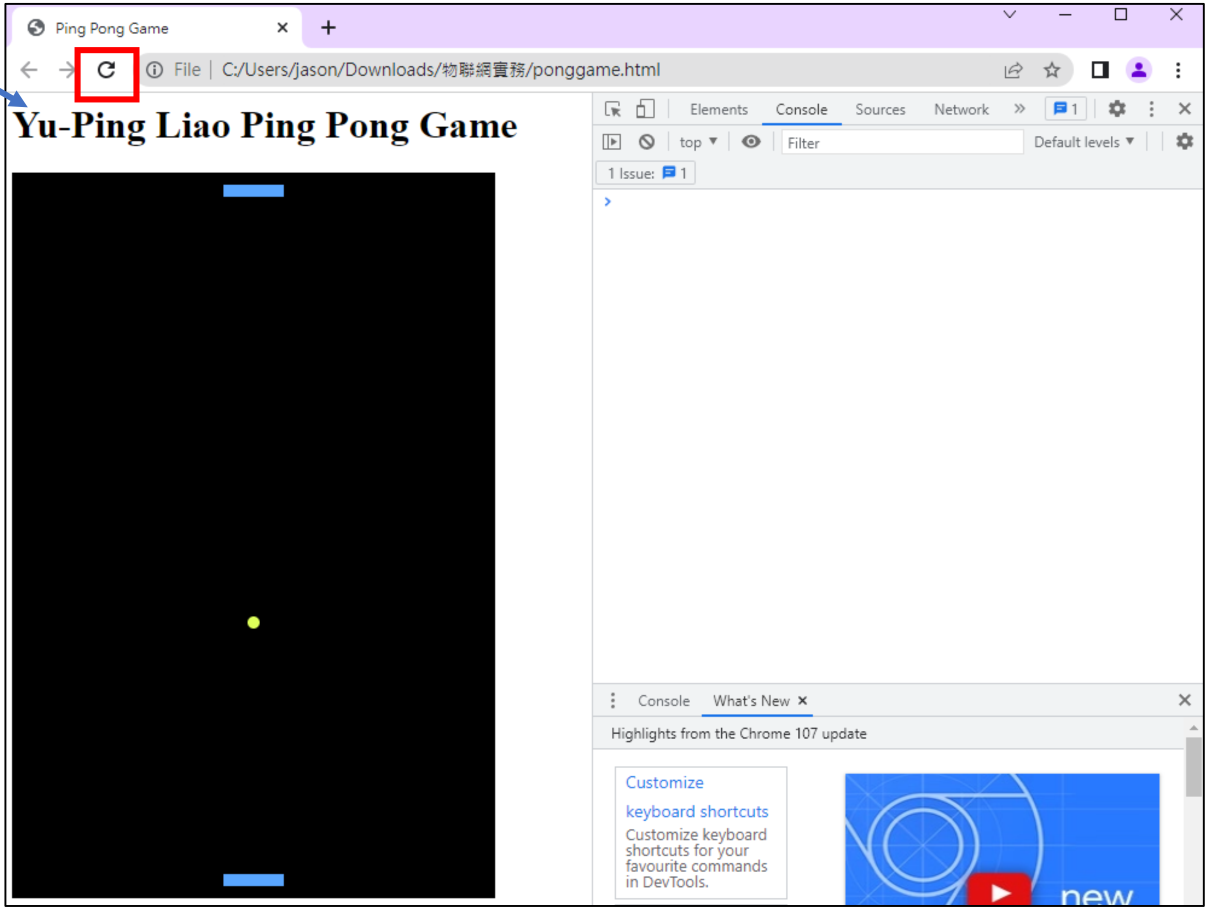
Reload ponggame.html (F5)



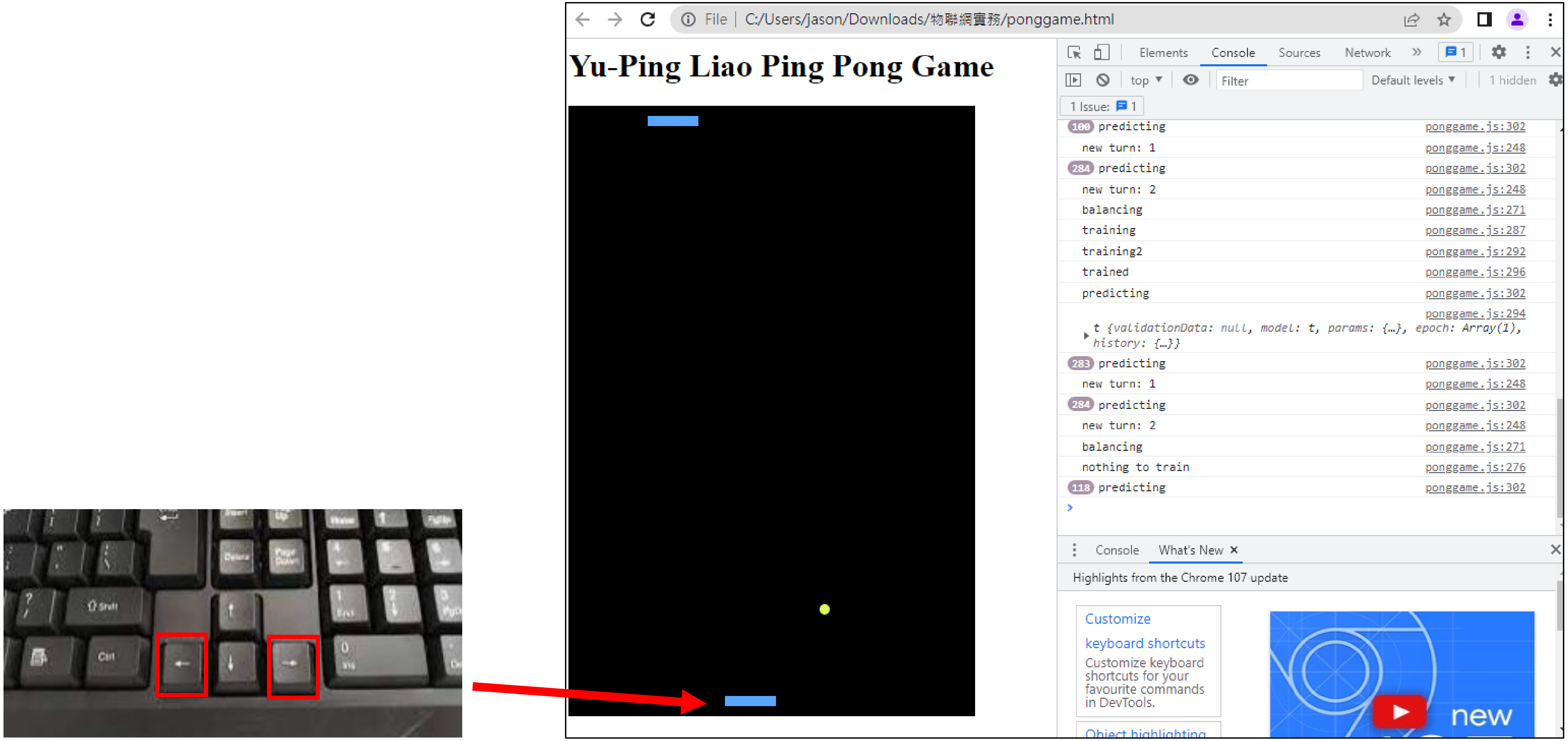
Edit name

Ponggame.html





Play with AI


C:/Users/jason/Downloads/物聯網實務/ponggame.html
Yu-Ping Liao Ping Pong Game
Elements
Console
Sources
Network
top
Filter
Default levels
1 hidden
1 Issue: 1
100 predicting ponggame.js:302
new turn: 1 ponggame.js:248
284 predicting ponggame.js:302
new turn: 2 ponggame.js:248
balancing ponggame.js:271
training ponggame.js:287
training2 ponggame.js:292
trained ponggame.js:296
predicting ponggame.js:302
ponggame.js:294
t {validationData: null, model: t, params: {…}, epoch: Array(1), history: {…}}
283 predicting ponggame.js:302
new turn: 1 ponggame.js:248
284 predicting ponggame.js:302
new turn: 2 ponggame.js:248
balancing ponggame.js:271
nothing to train ponggame.js:276
118 predicting ponggame.js:302
Console
What's New
Highlights from the Chrome 107 update
Customize keyboard shortcuts
Customize keyboard shortcuts for your favourite commands in DevTools.
new

Model

1. Player paddle x
2. Computer paddle x
3. Ball x
4. Ball y
5. previous ball x
6. previous ball y
7. previous player paddle x
8. previous computer paddle x