Statistics and Machine Learning

Week 3 — Linear regression
02/01 — 02/05

Dr. Chi-Ken Lu 2021 Spring

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- Three elements in ML: Data set, model, loss function

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	Data set	Model	Loss function
Training			
Deploying			

Data set | **Model** | **Loss function**

Training

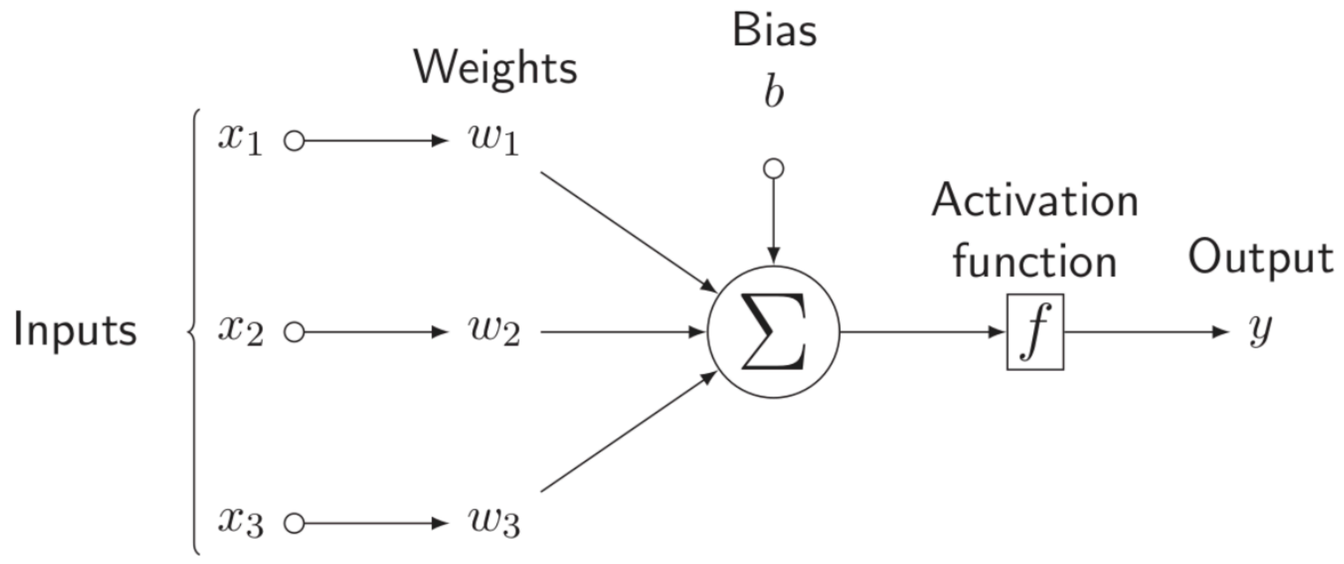
Deploying

Data set

Model

Loss function

Training



https://tex.stackexchange.com/questions/132444/diagram-of-an-artificial-neural-network

Deploying

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Loss function

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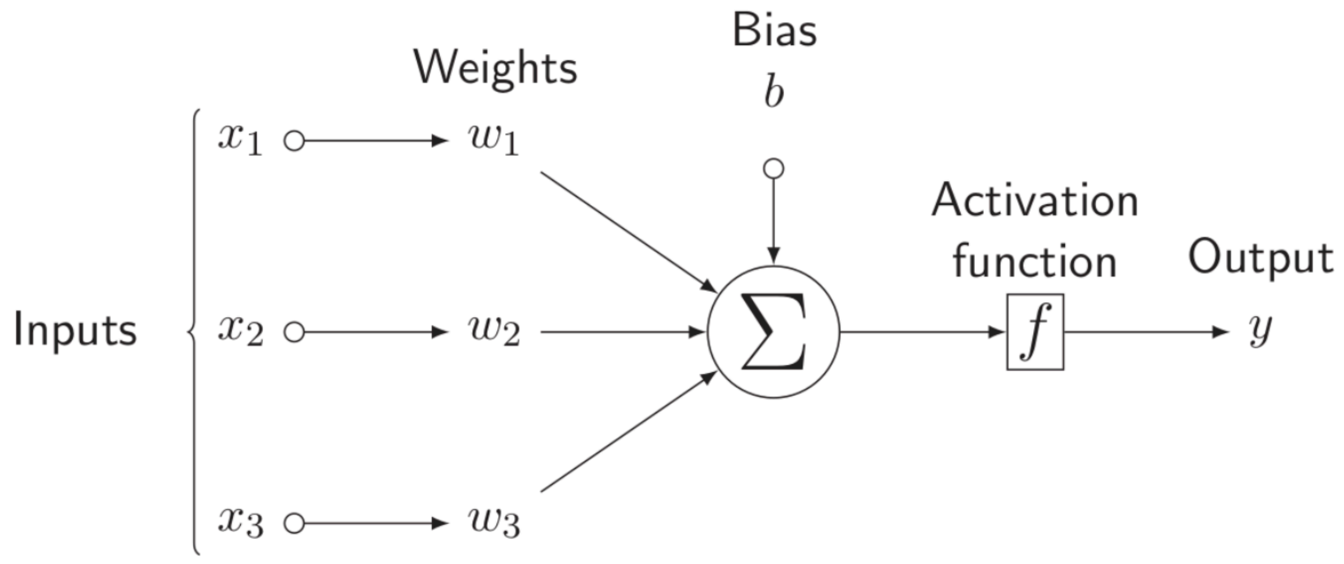

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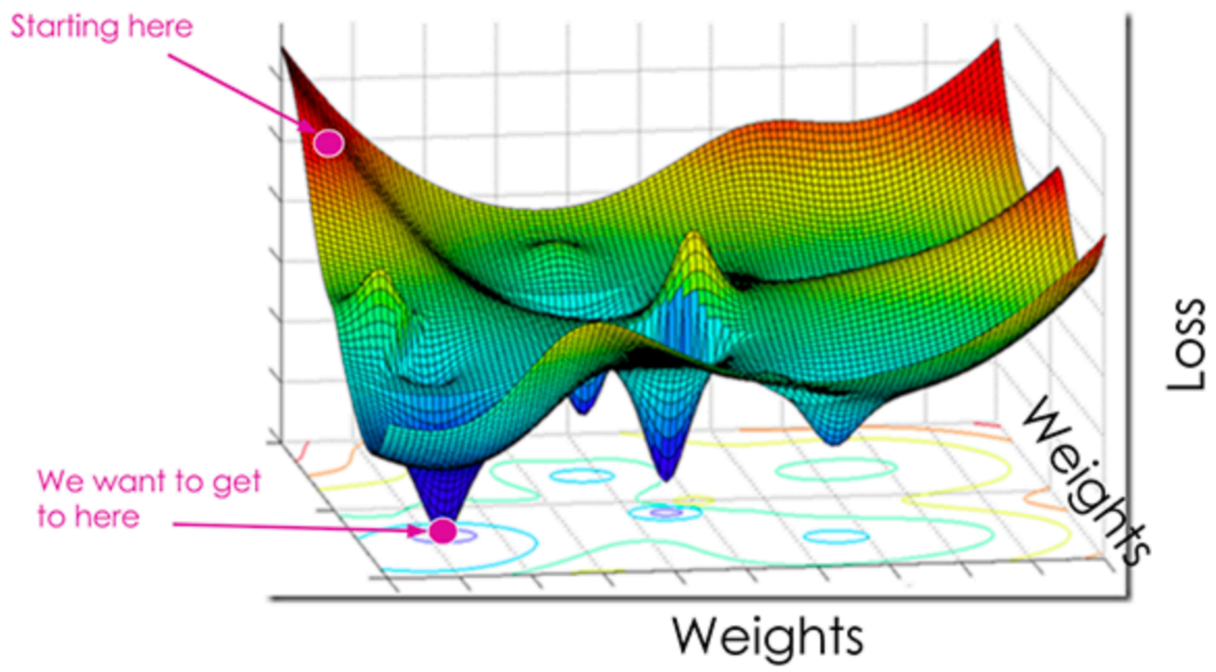

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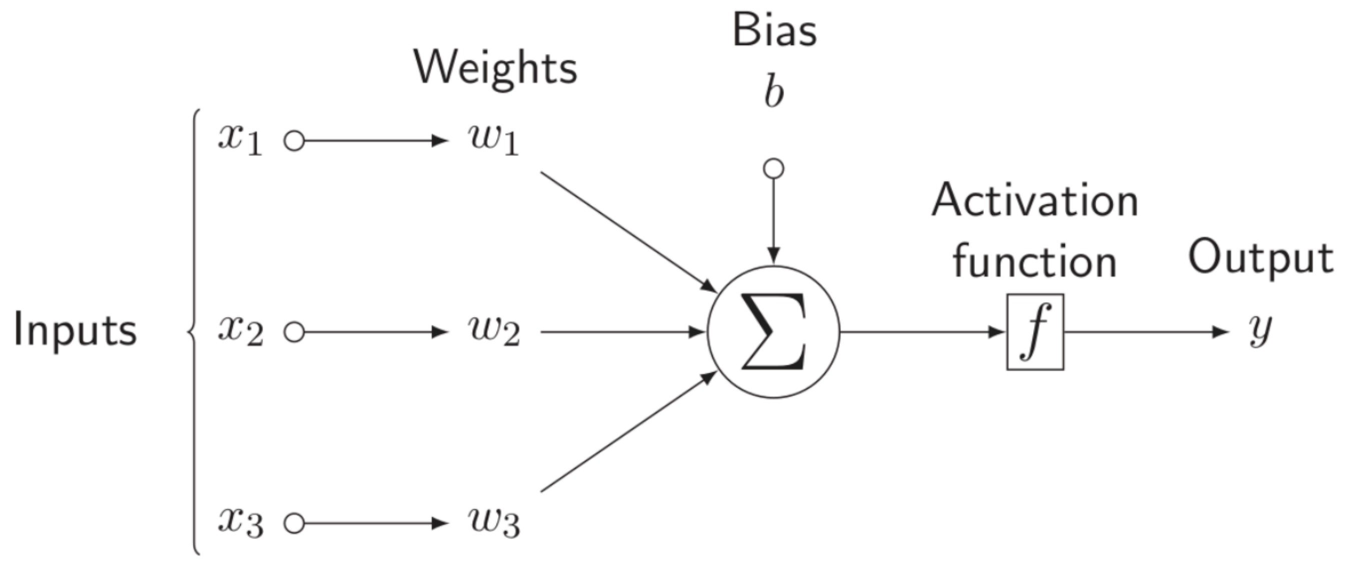

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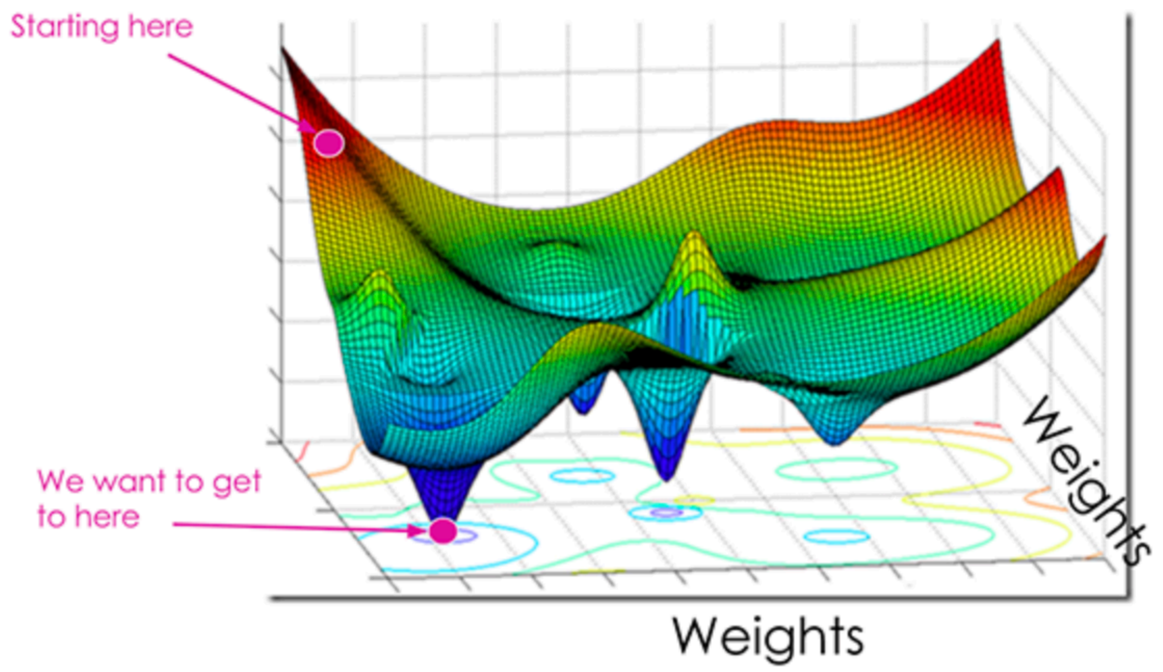

$\boxed{\text{The optimal parameters: } \bar{w}_1, \bar{w}_2, \bar{w}_3, \cdots, \bar{b}}$

Deploying

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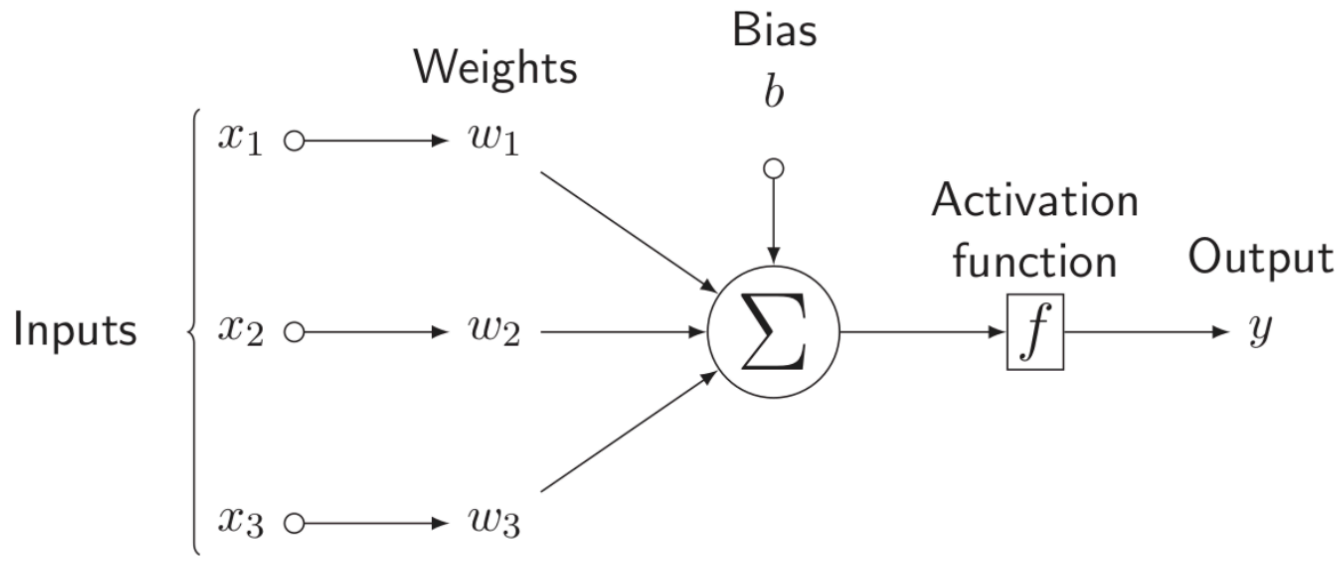

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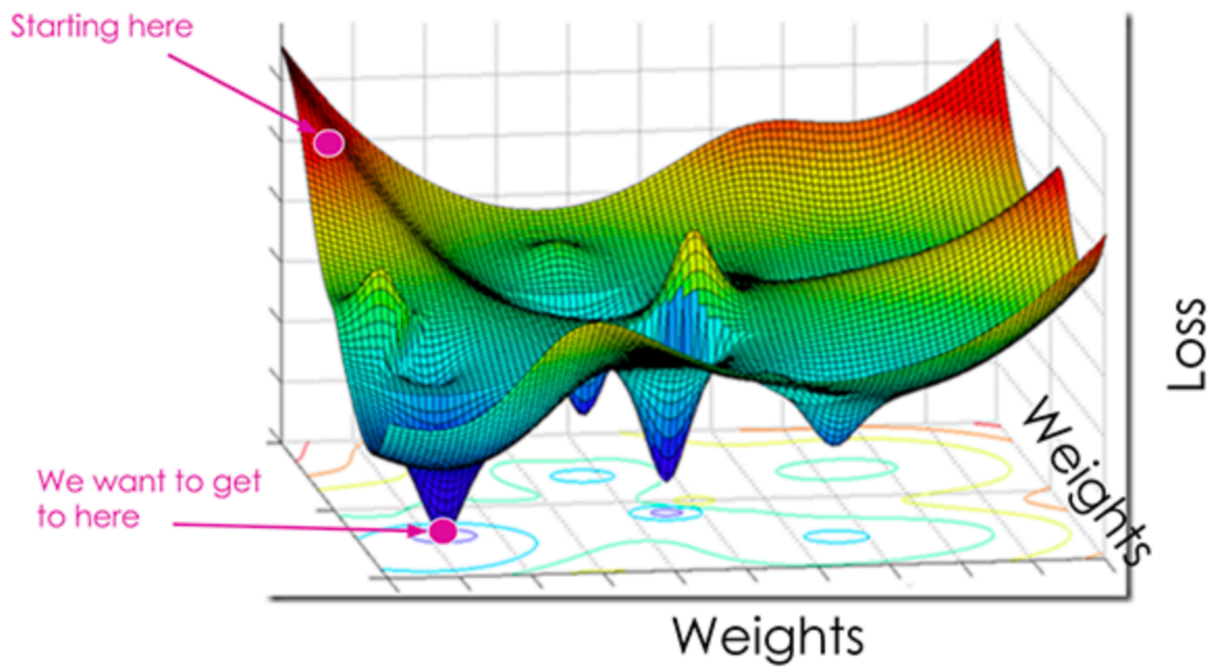

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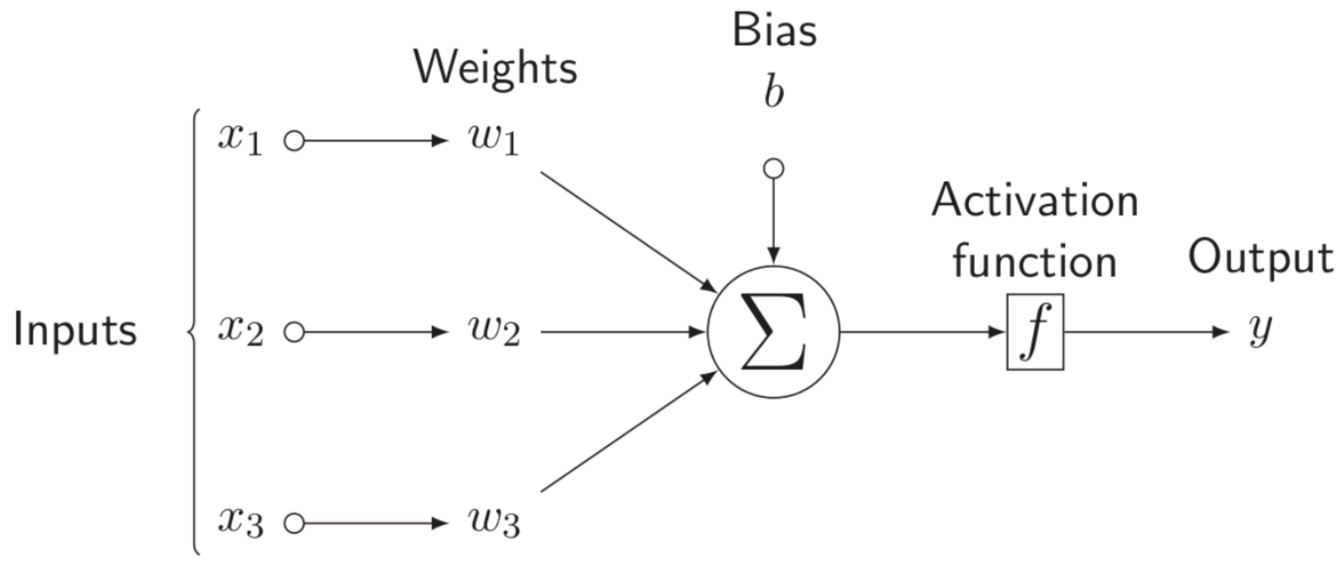

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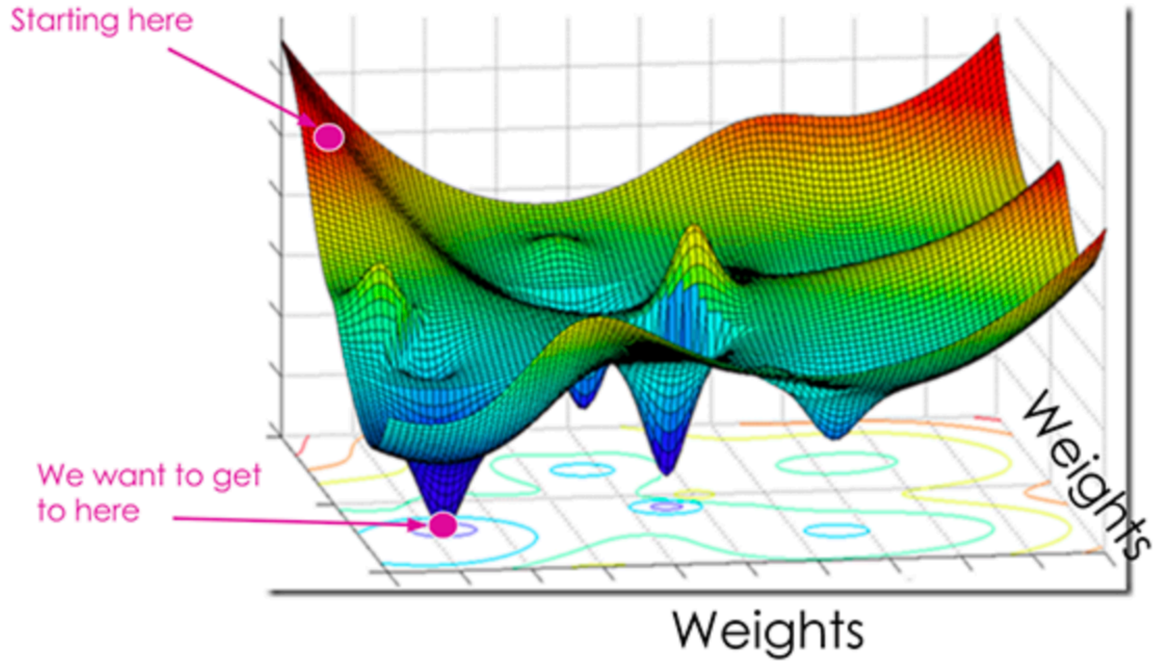

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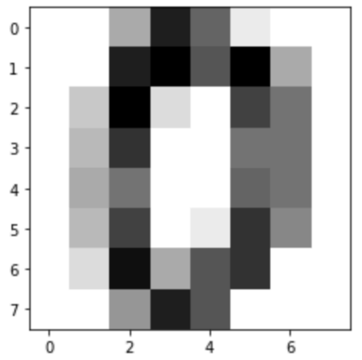

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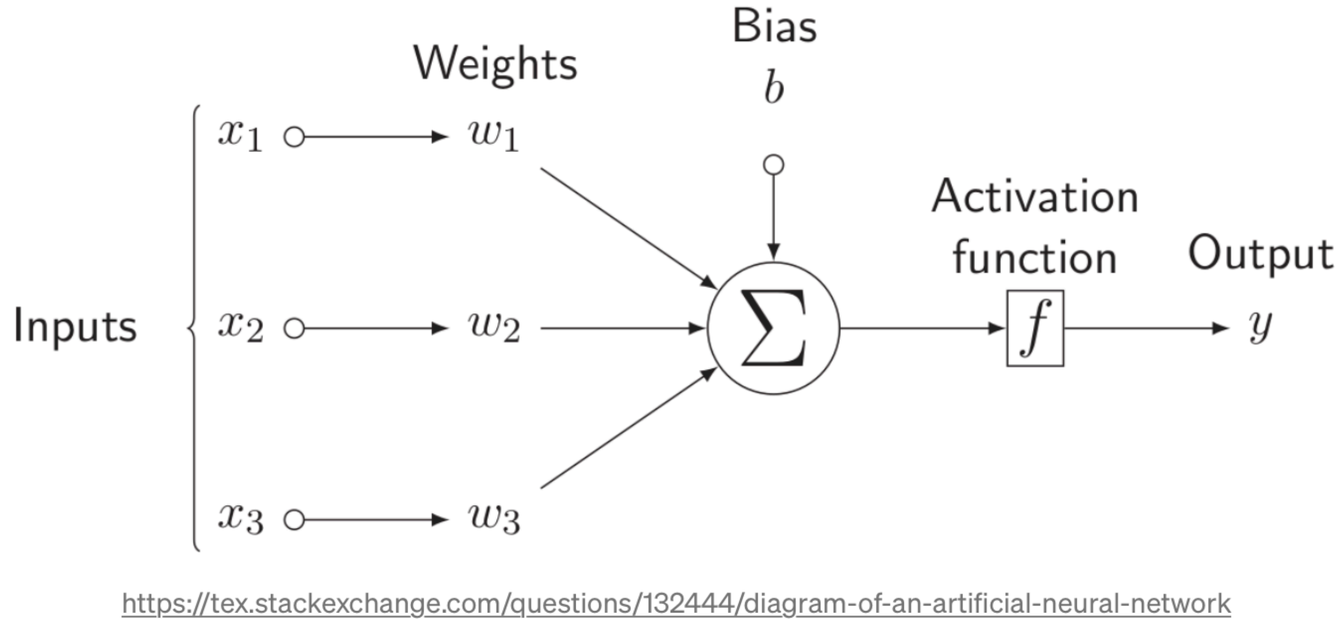

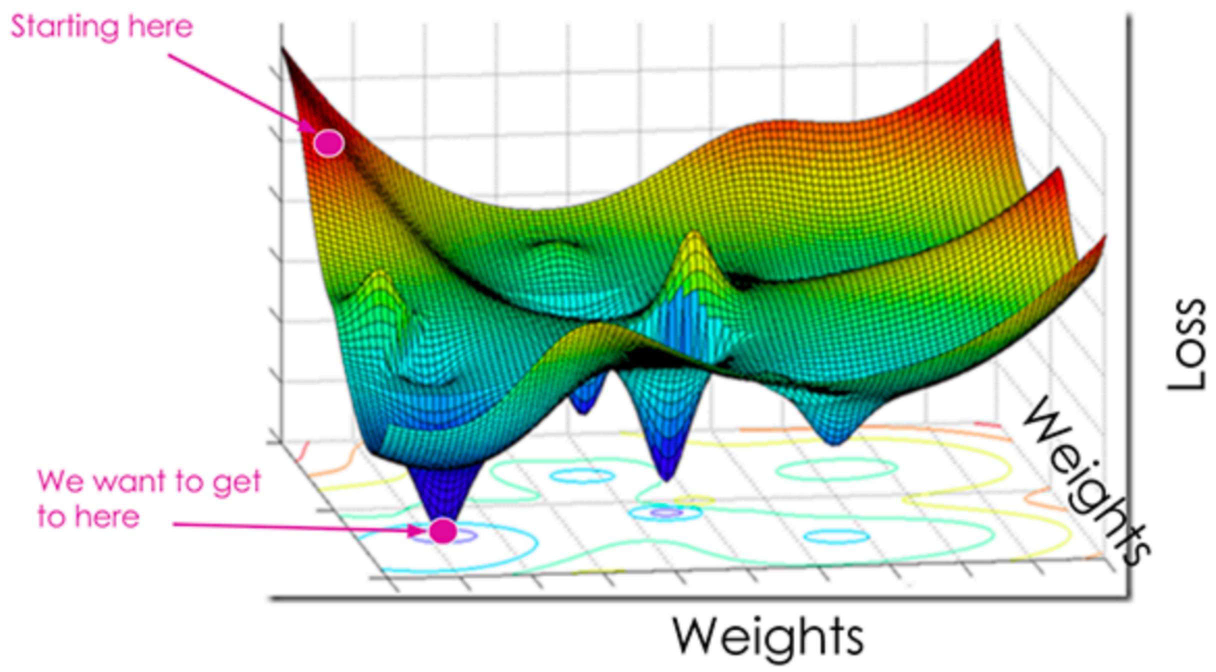

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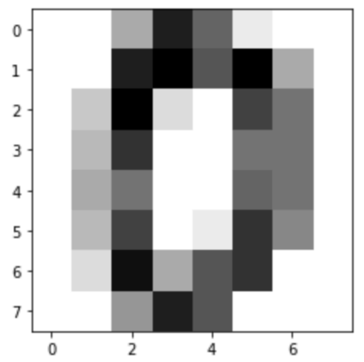

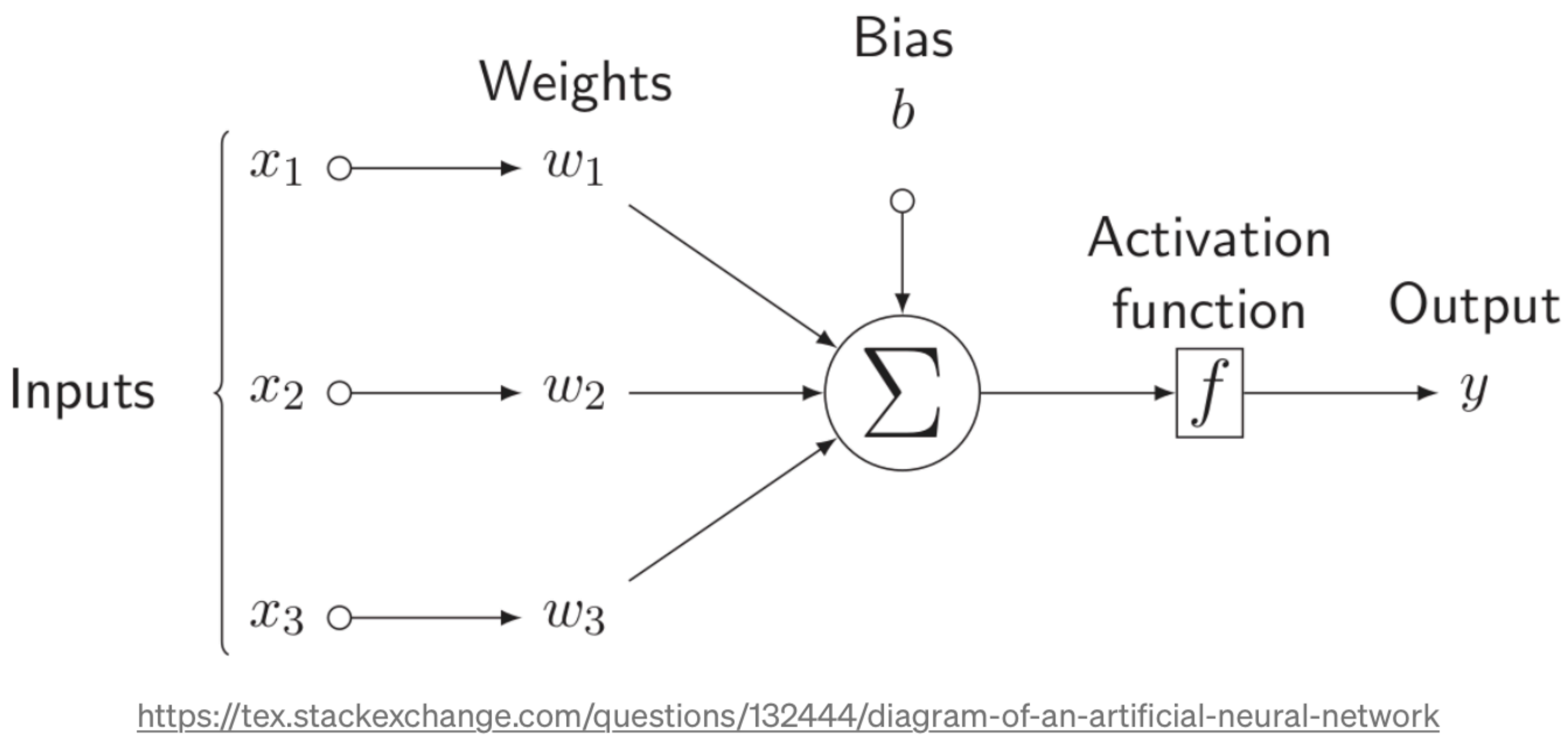

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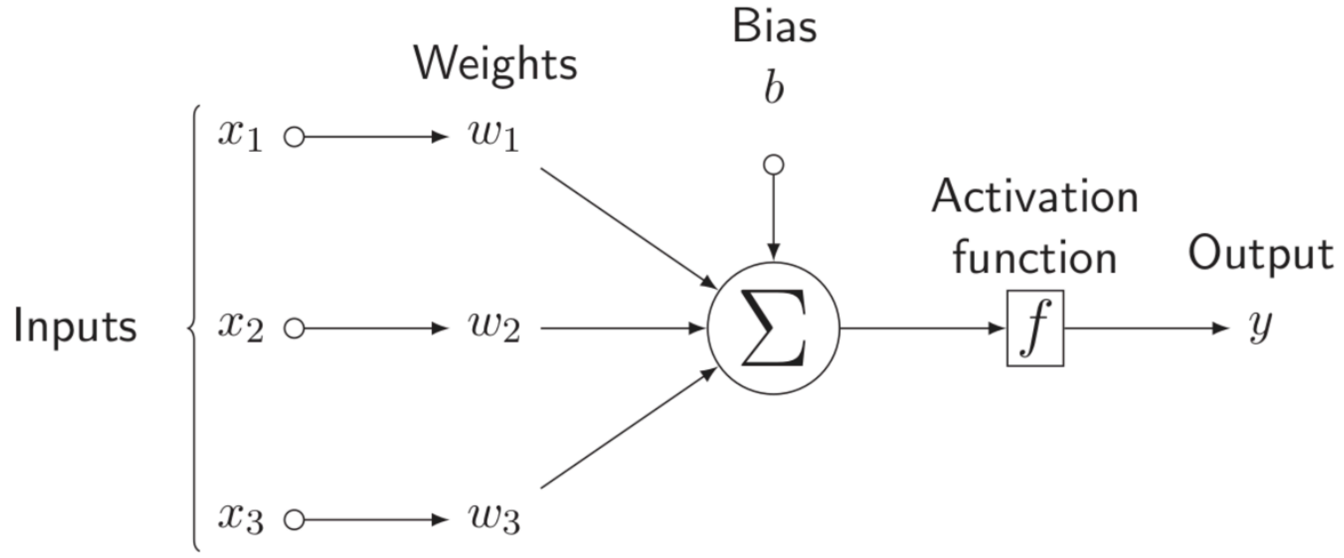

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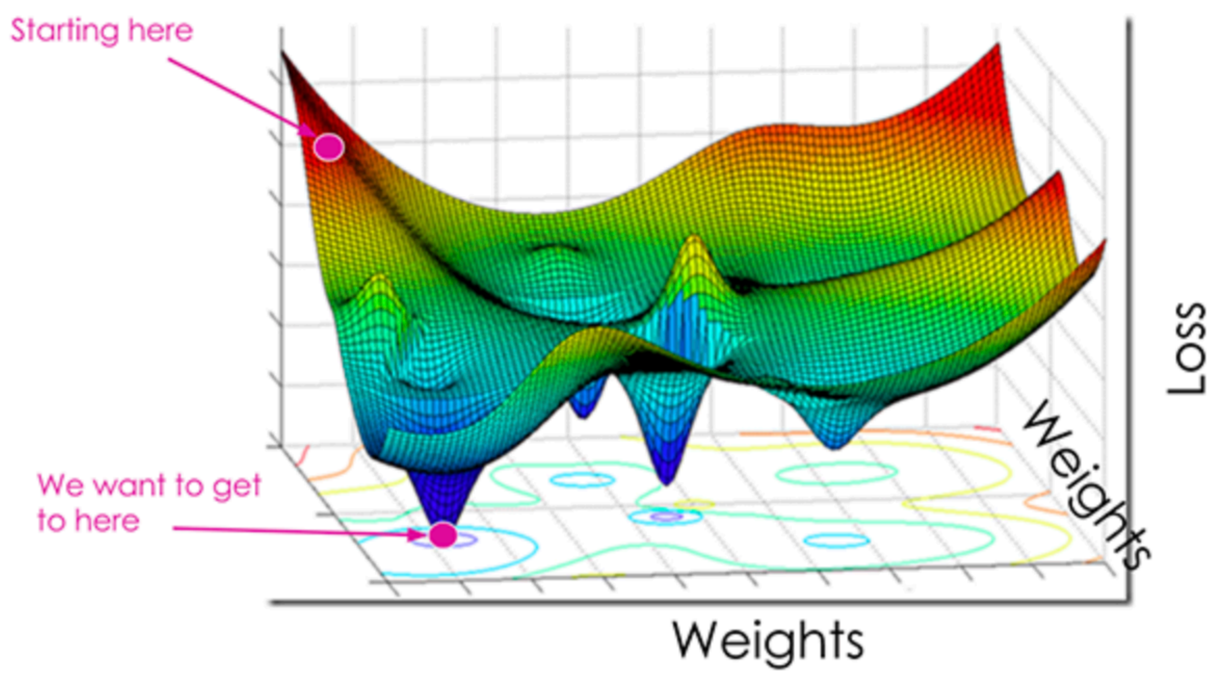

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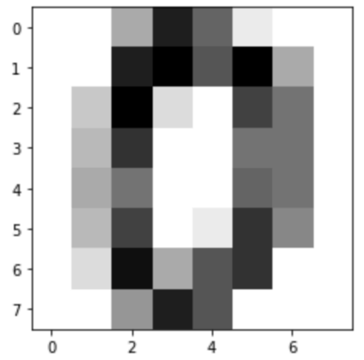

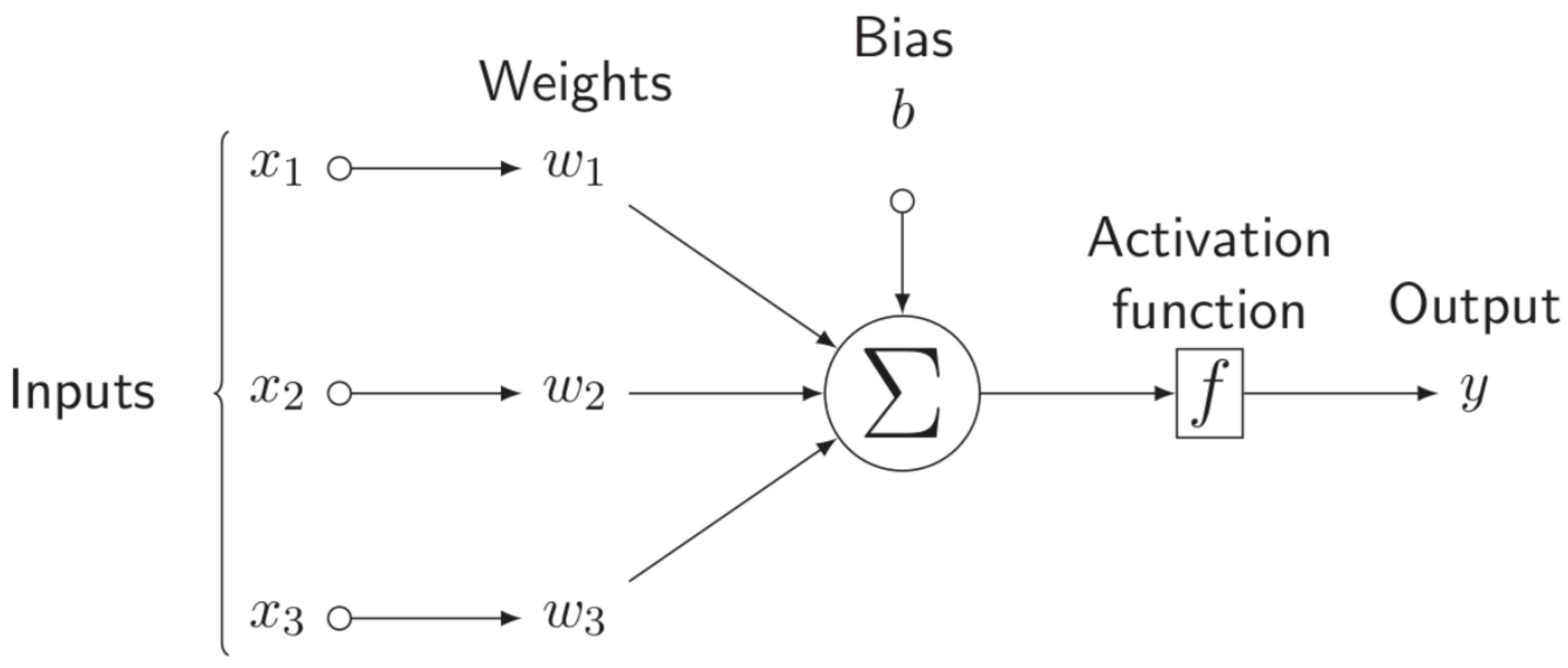

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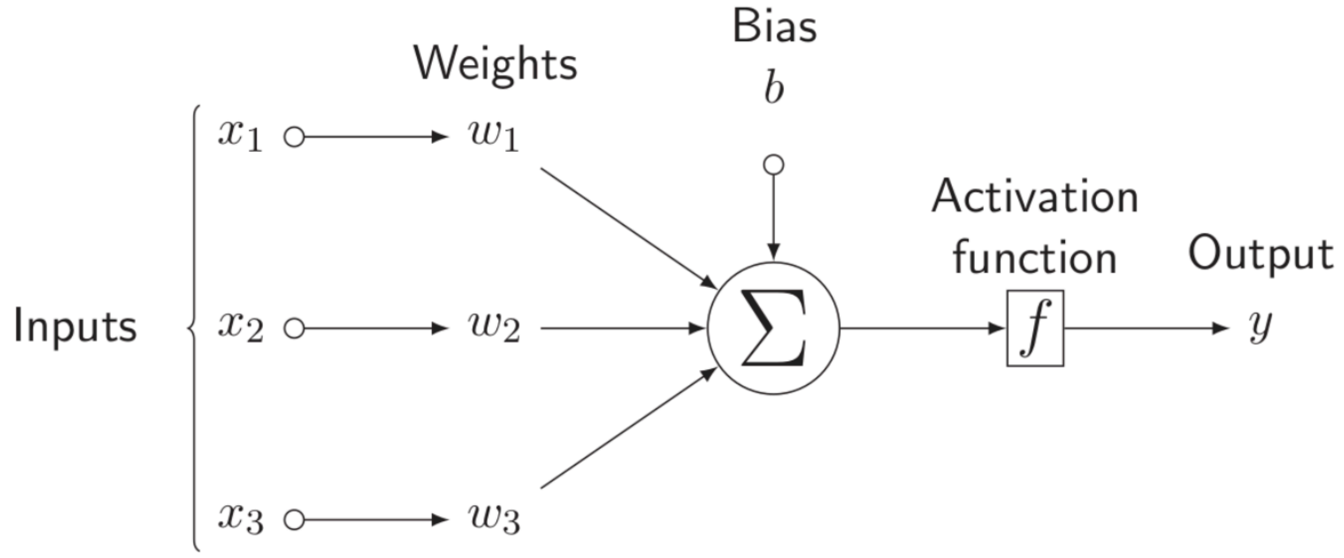

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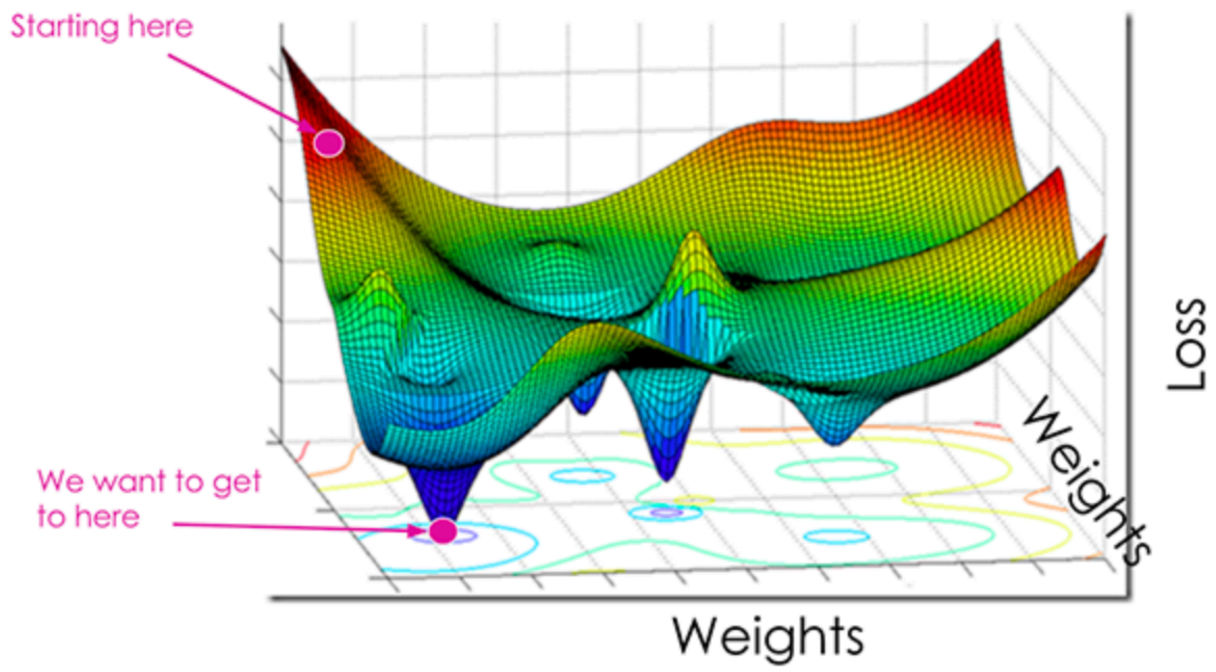

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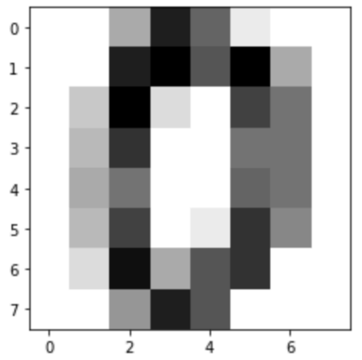

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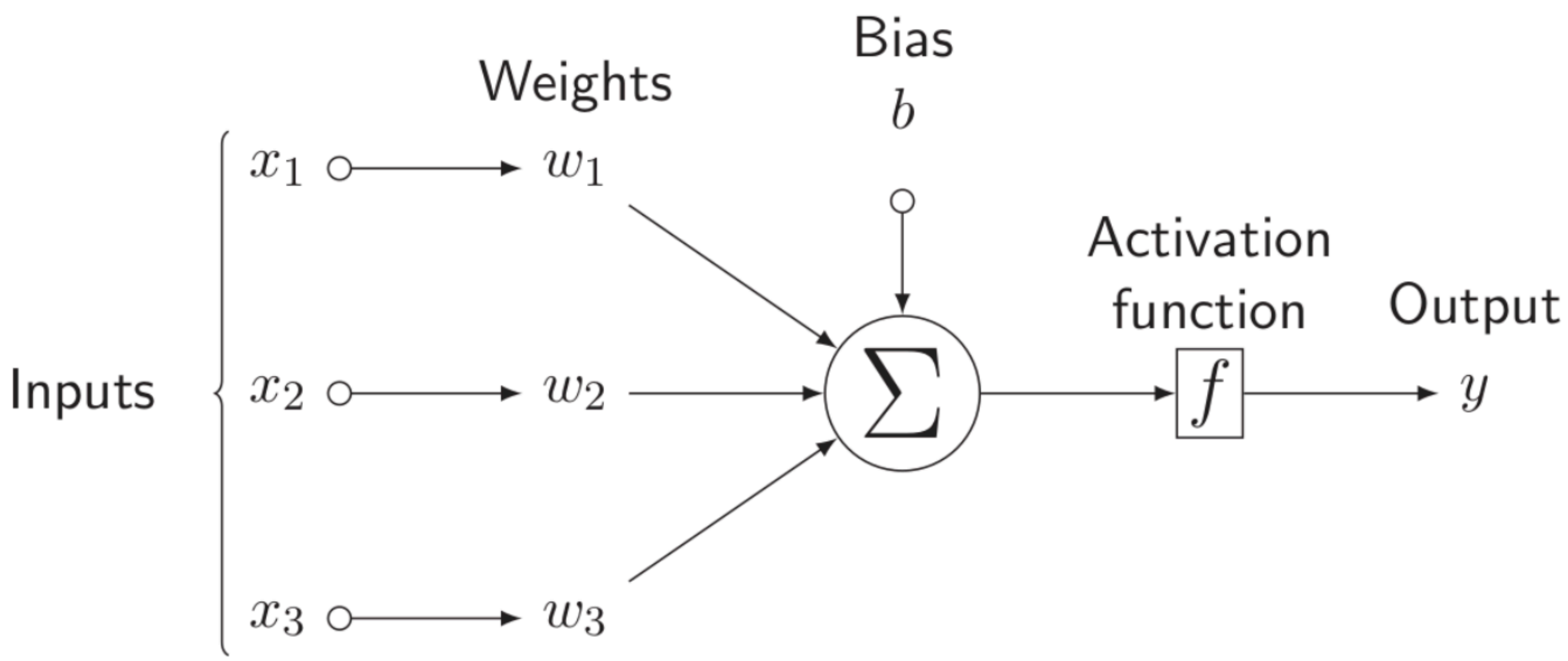

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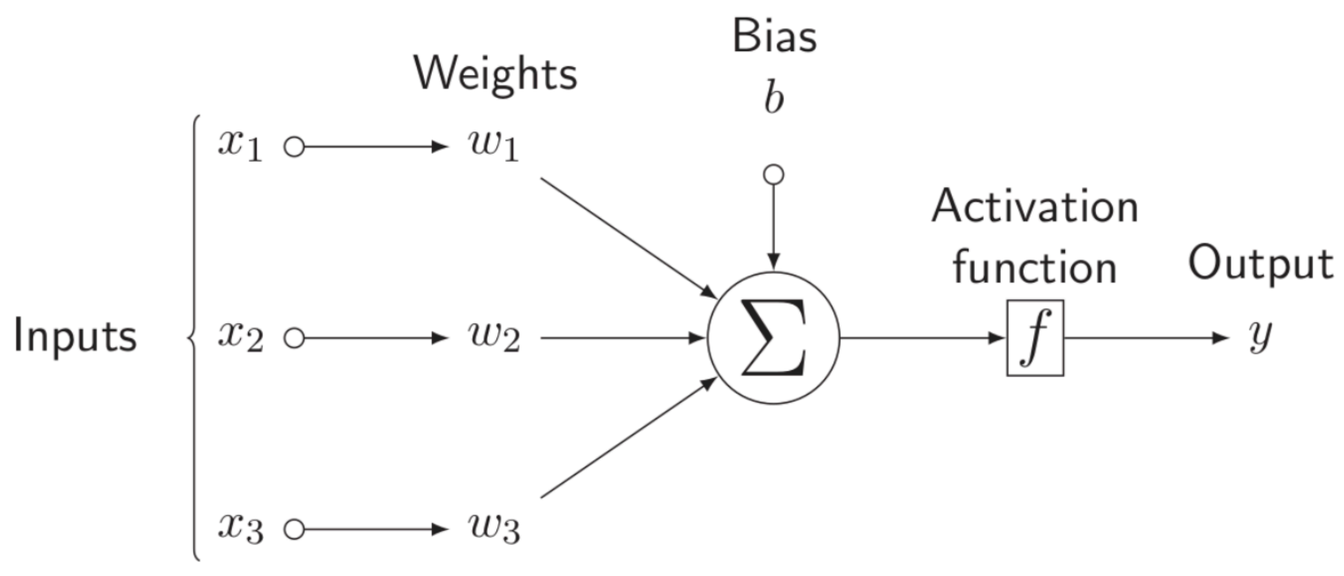

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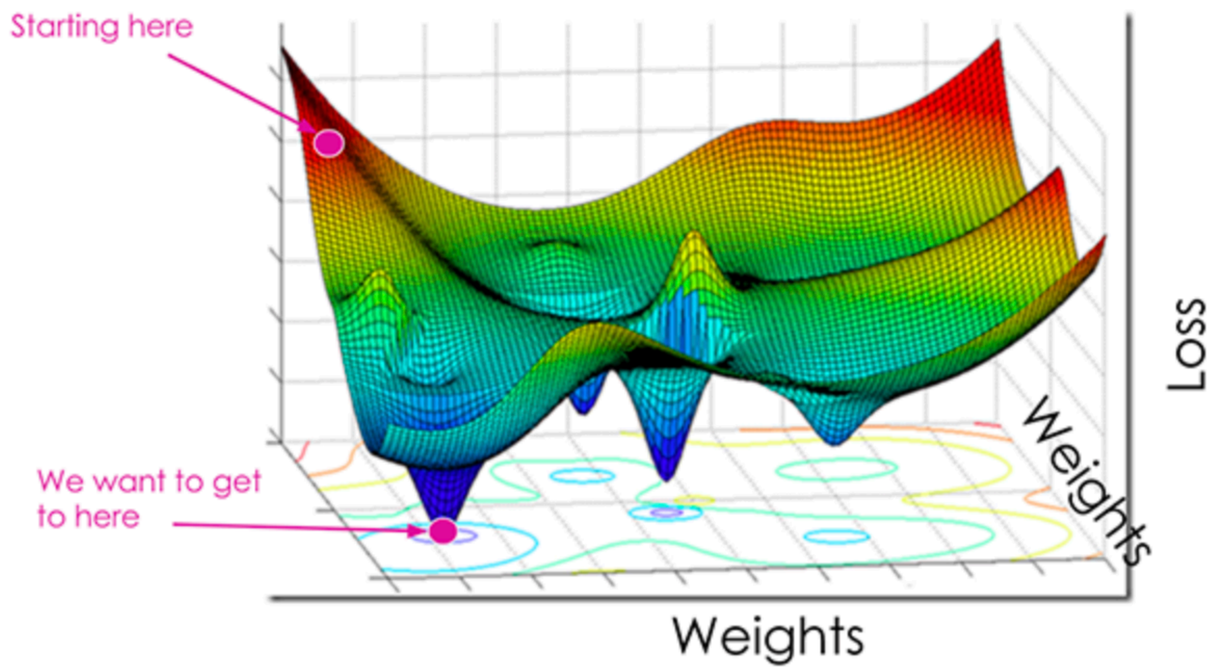

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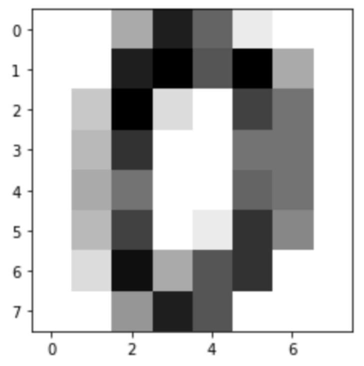

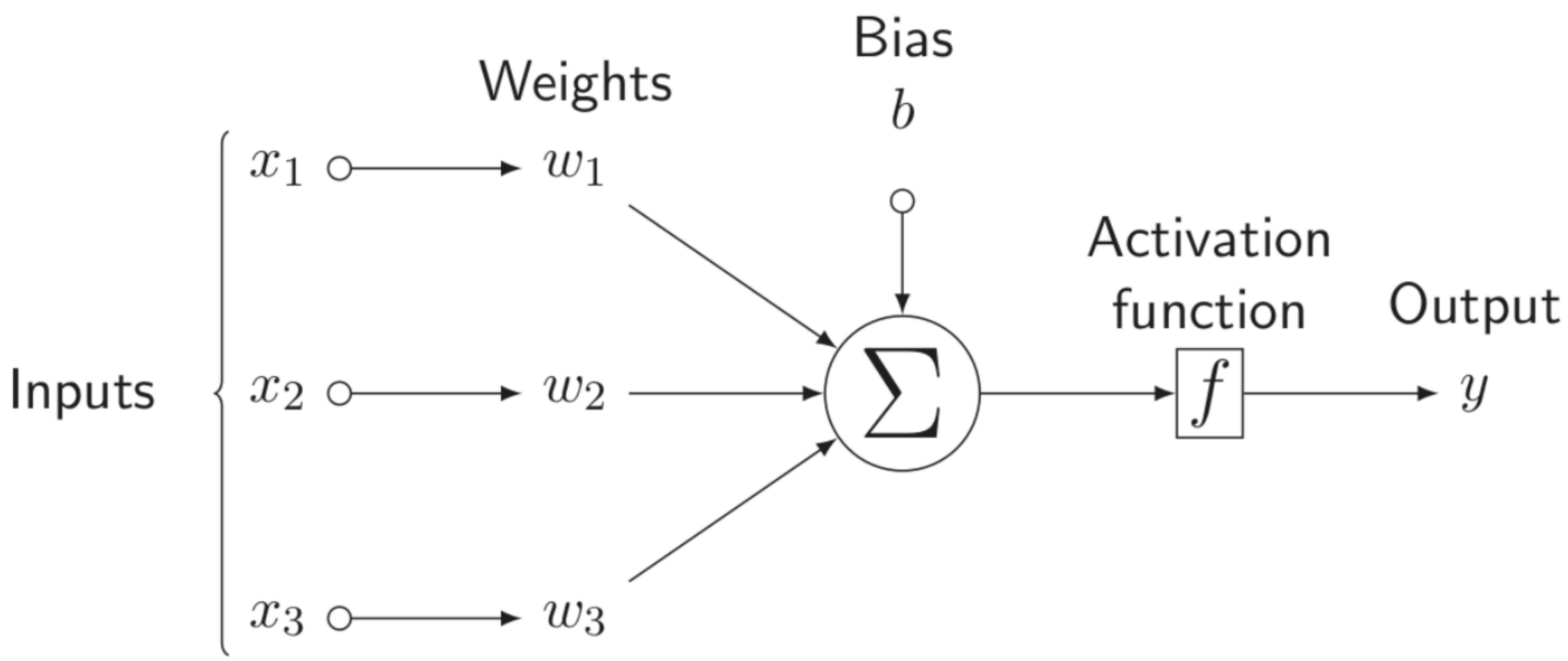

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It is a zero

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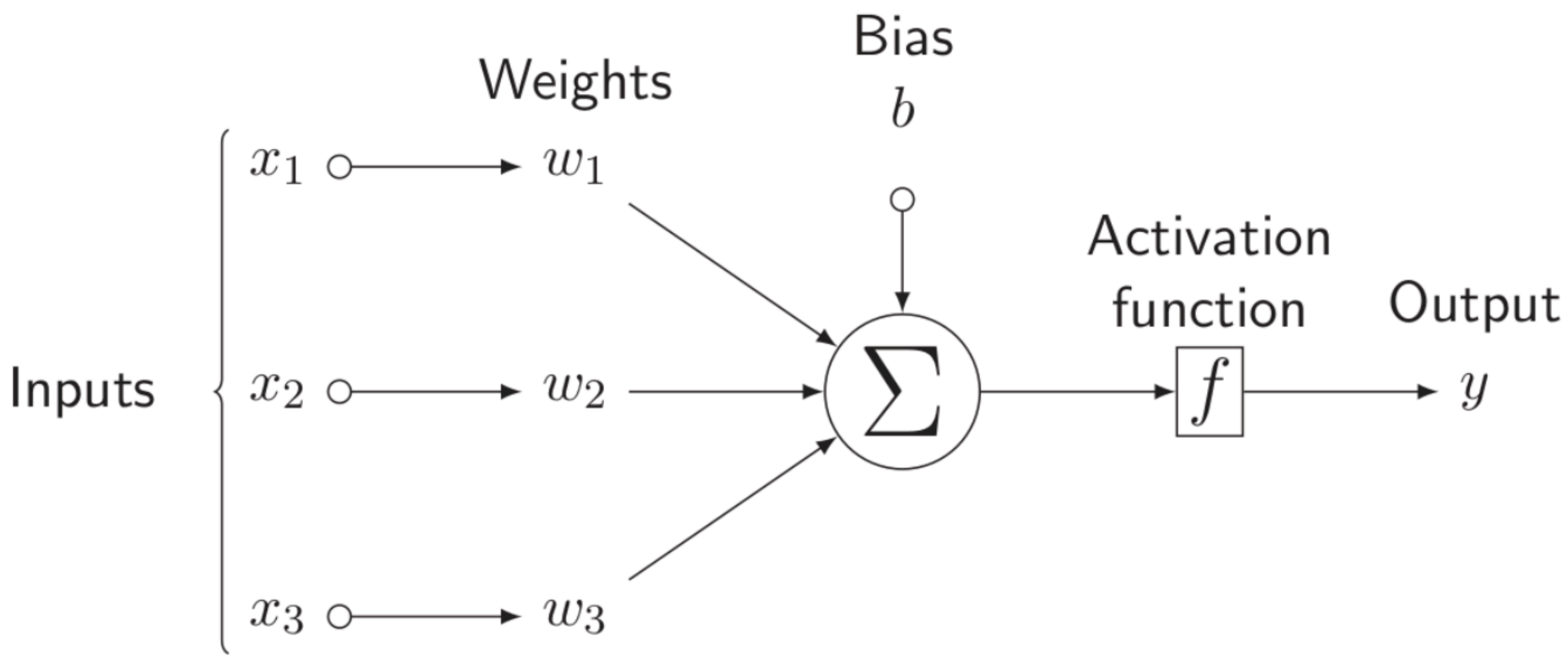

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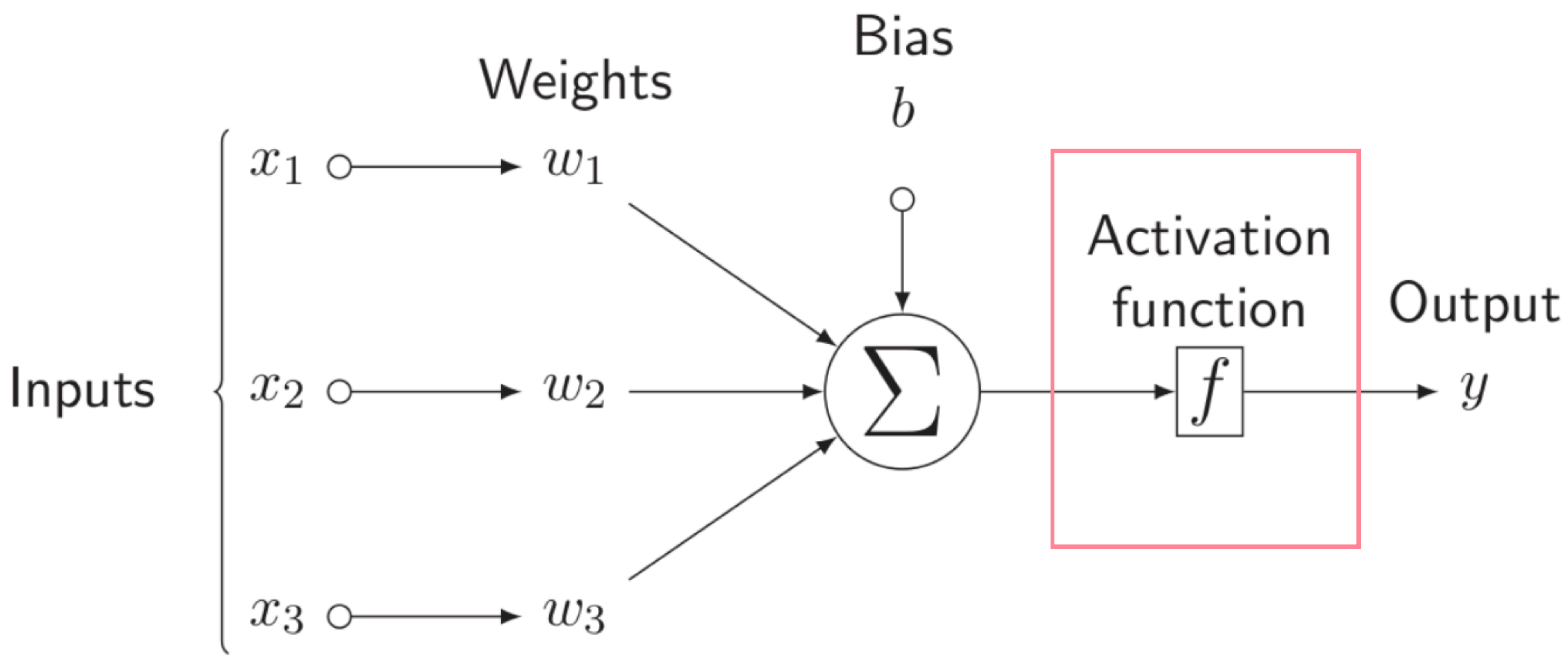

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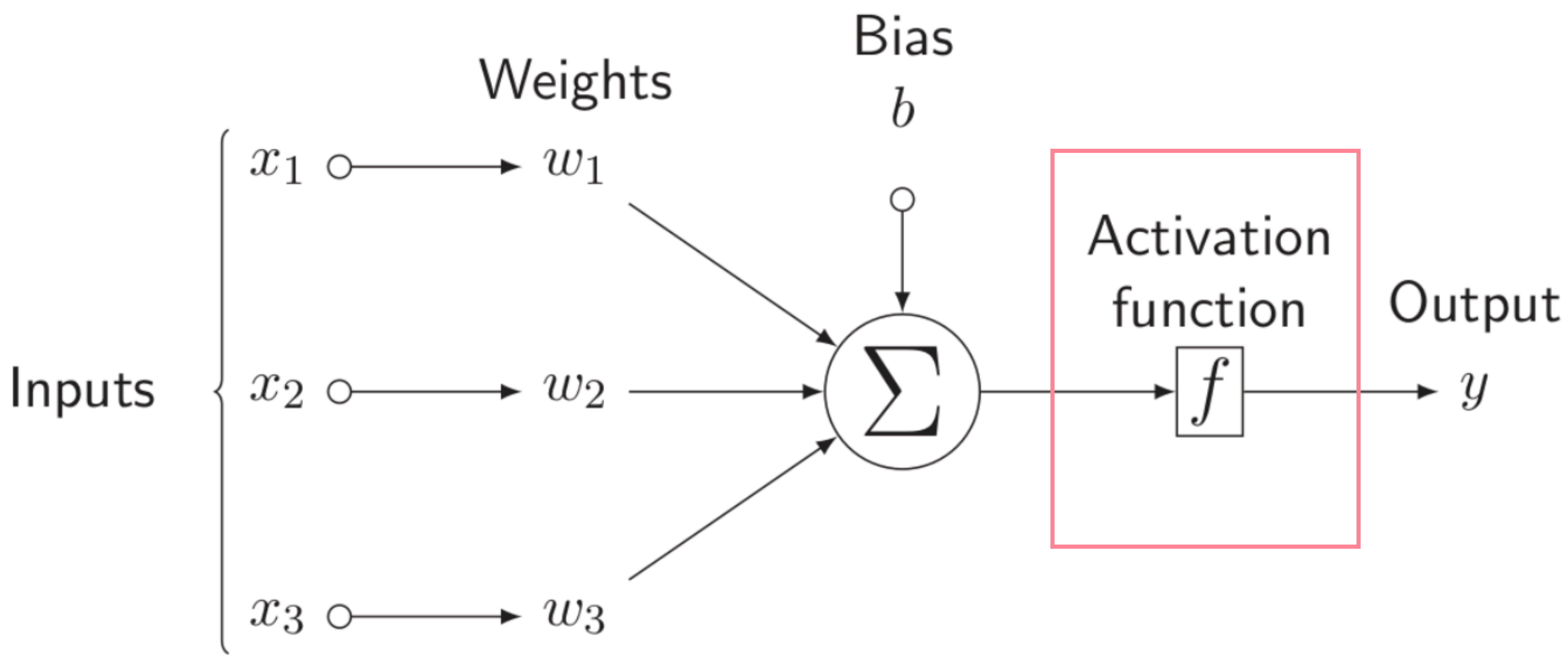

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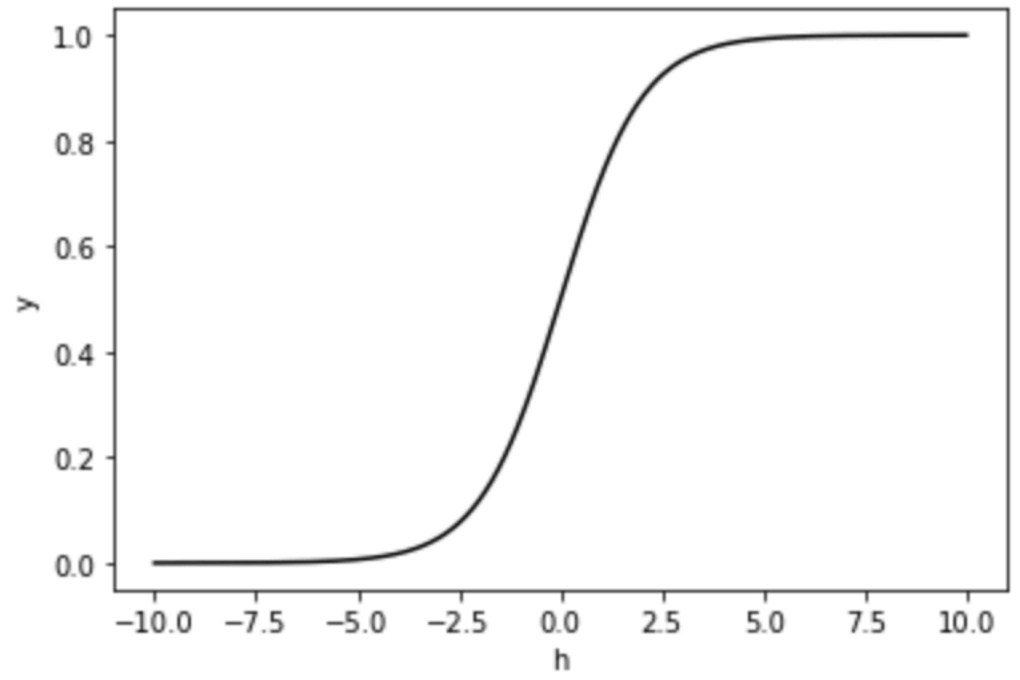

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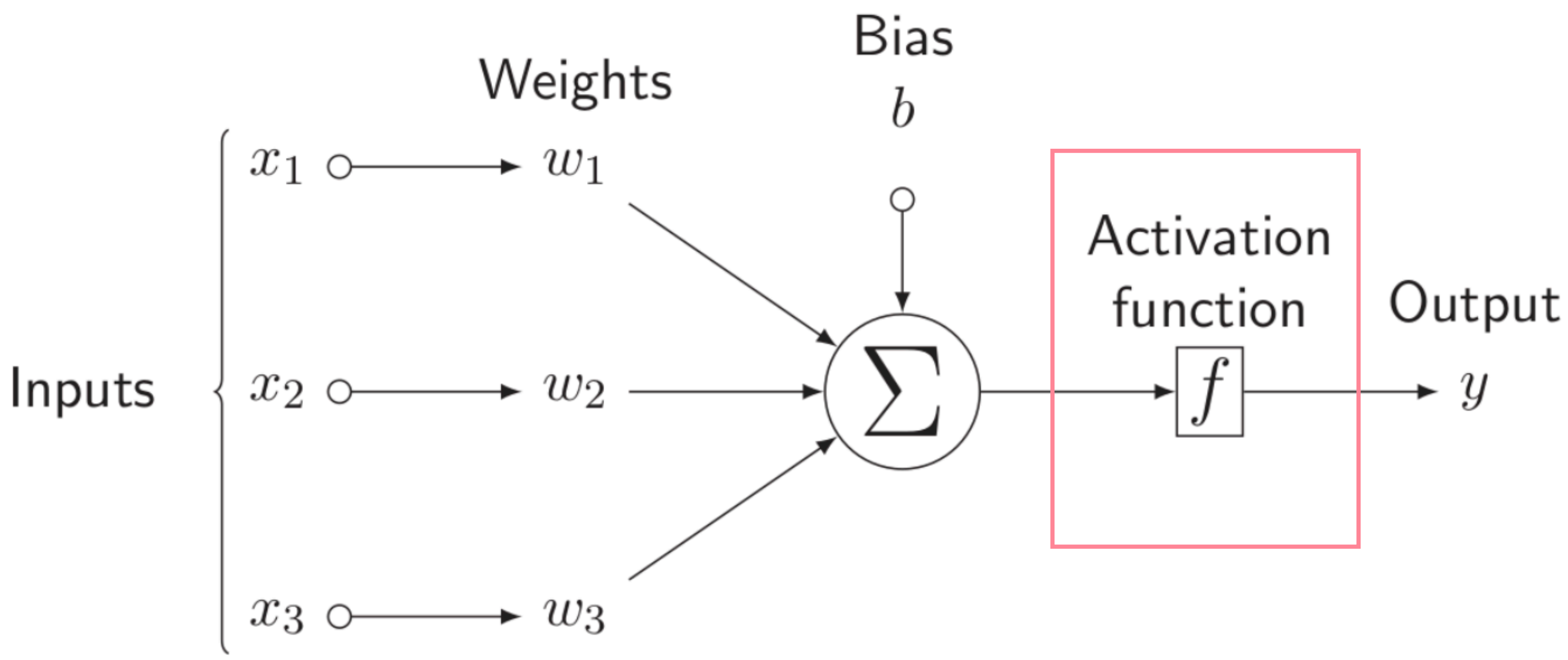

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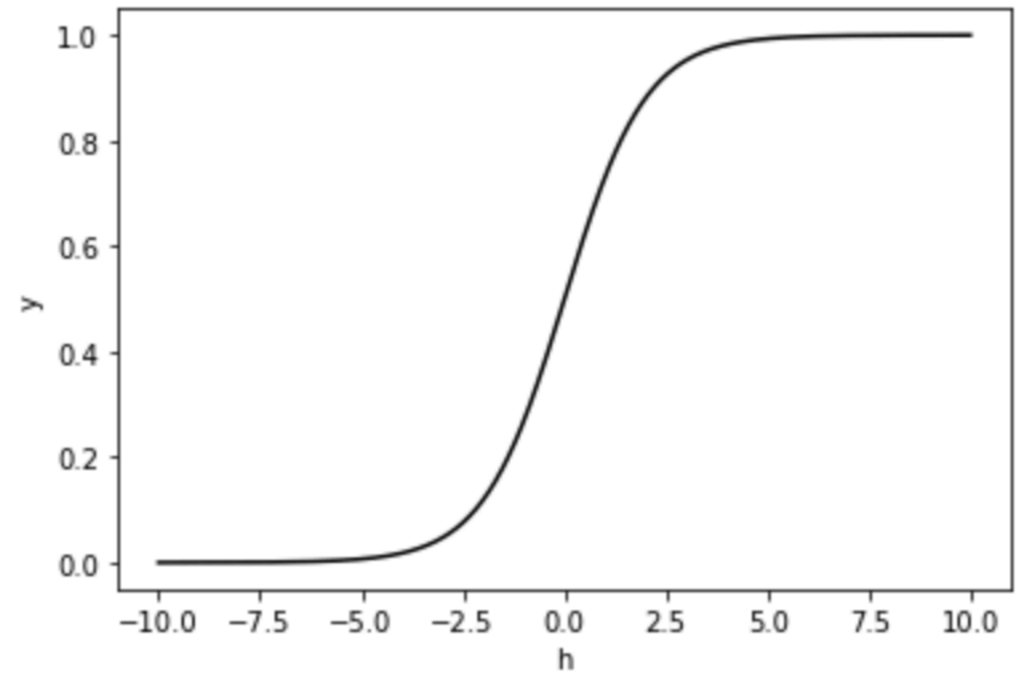

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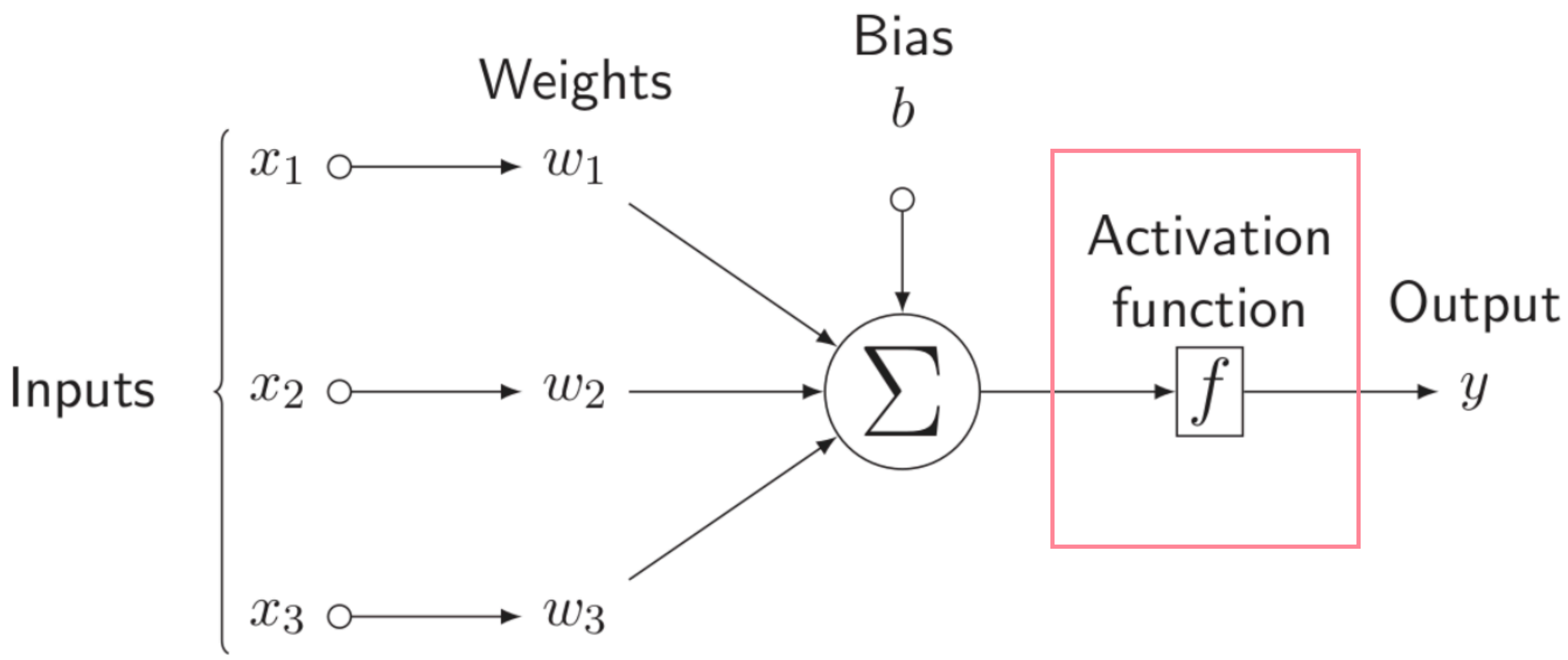

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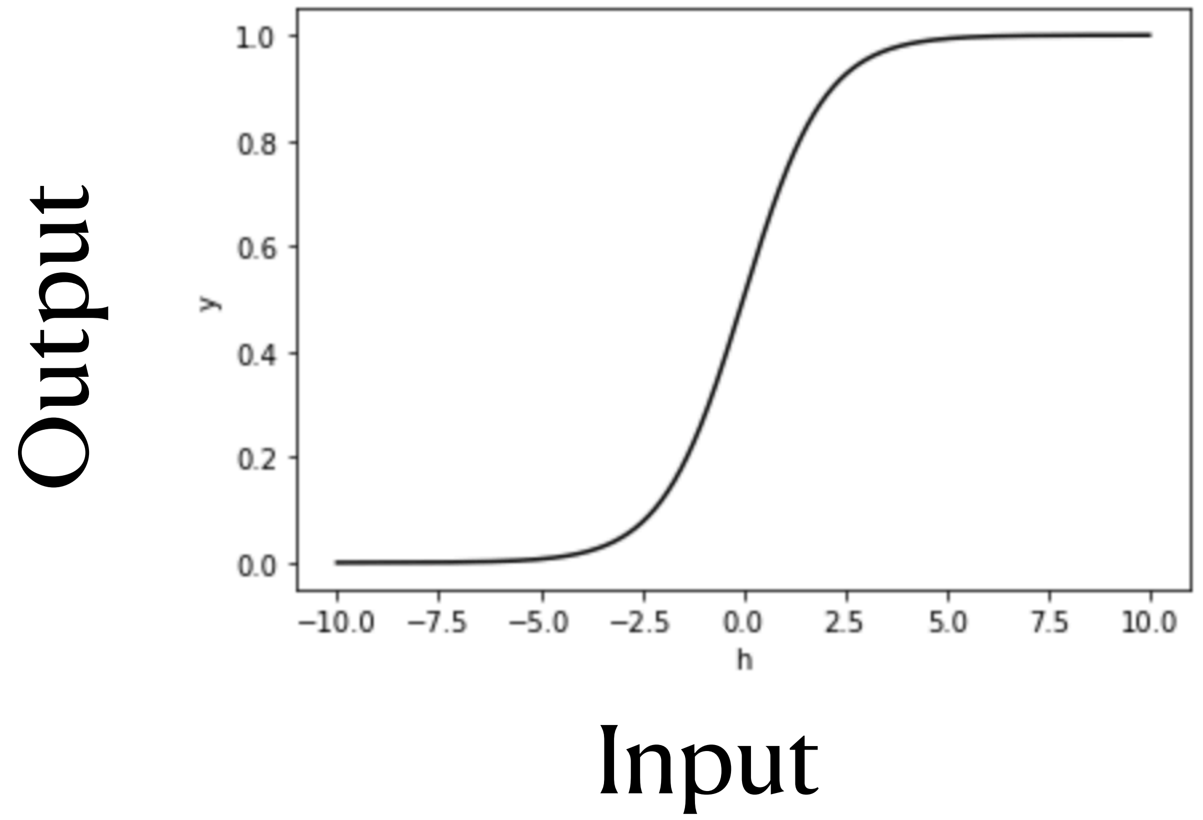

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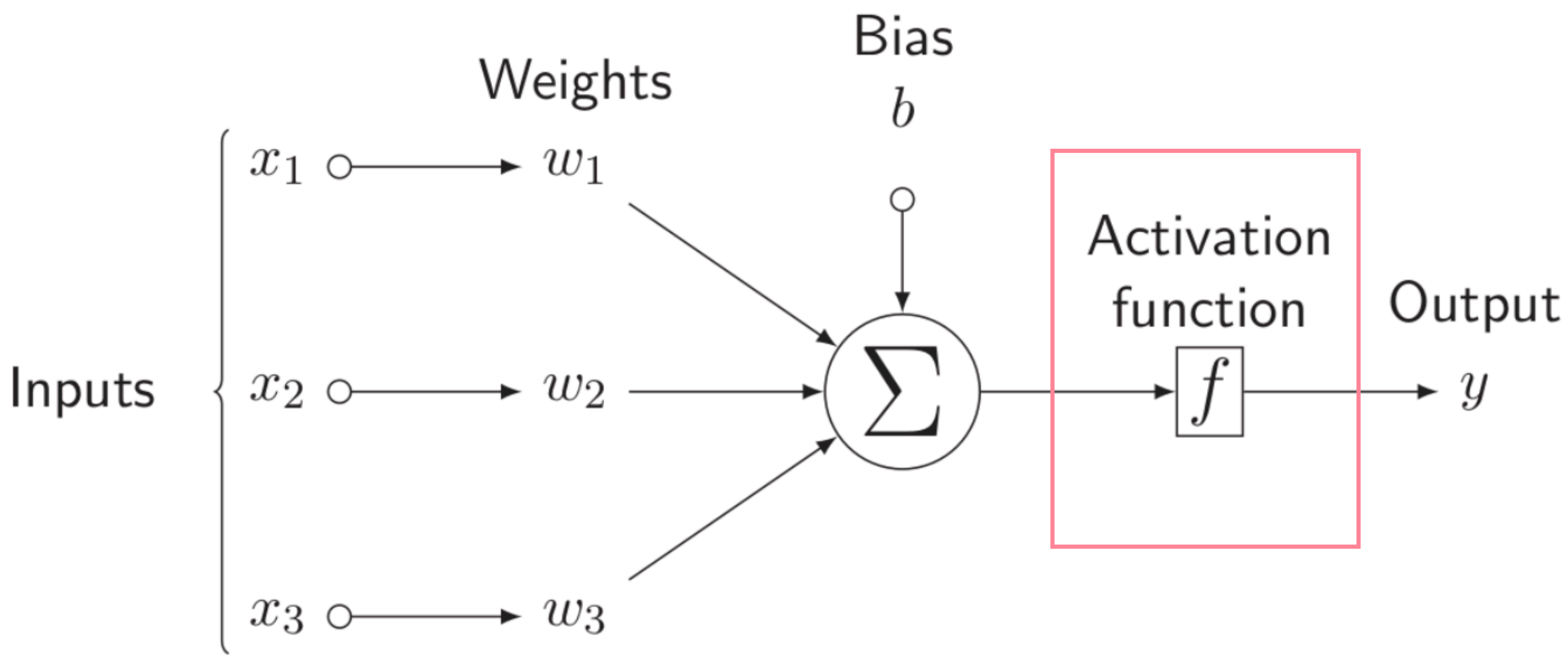

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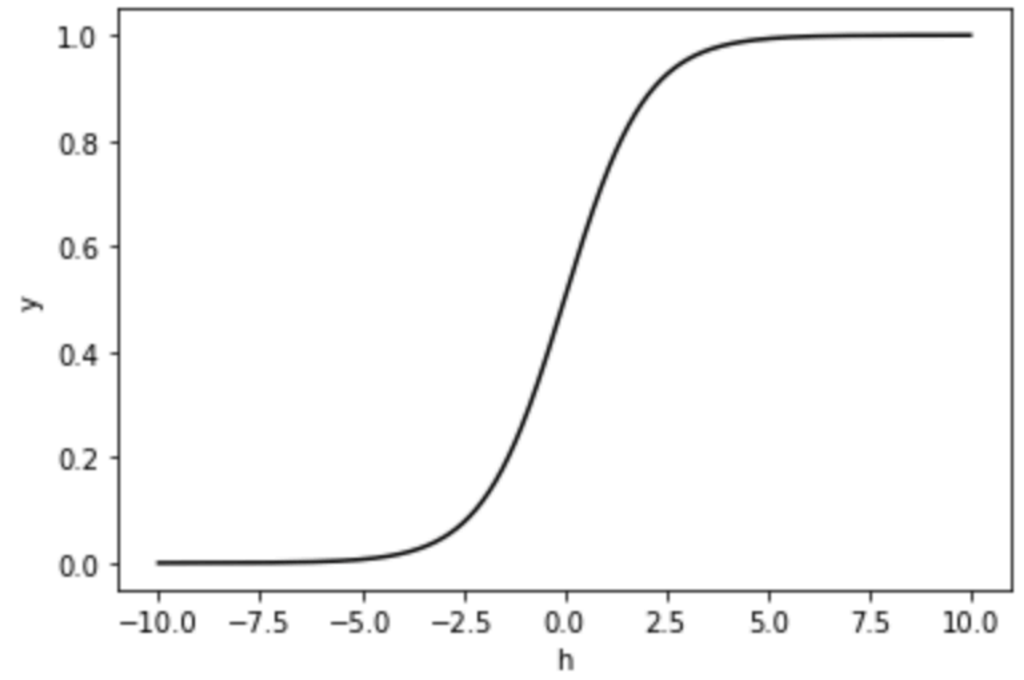

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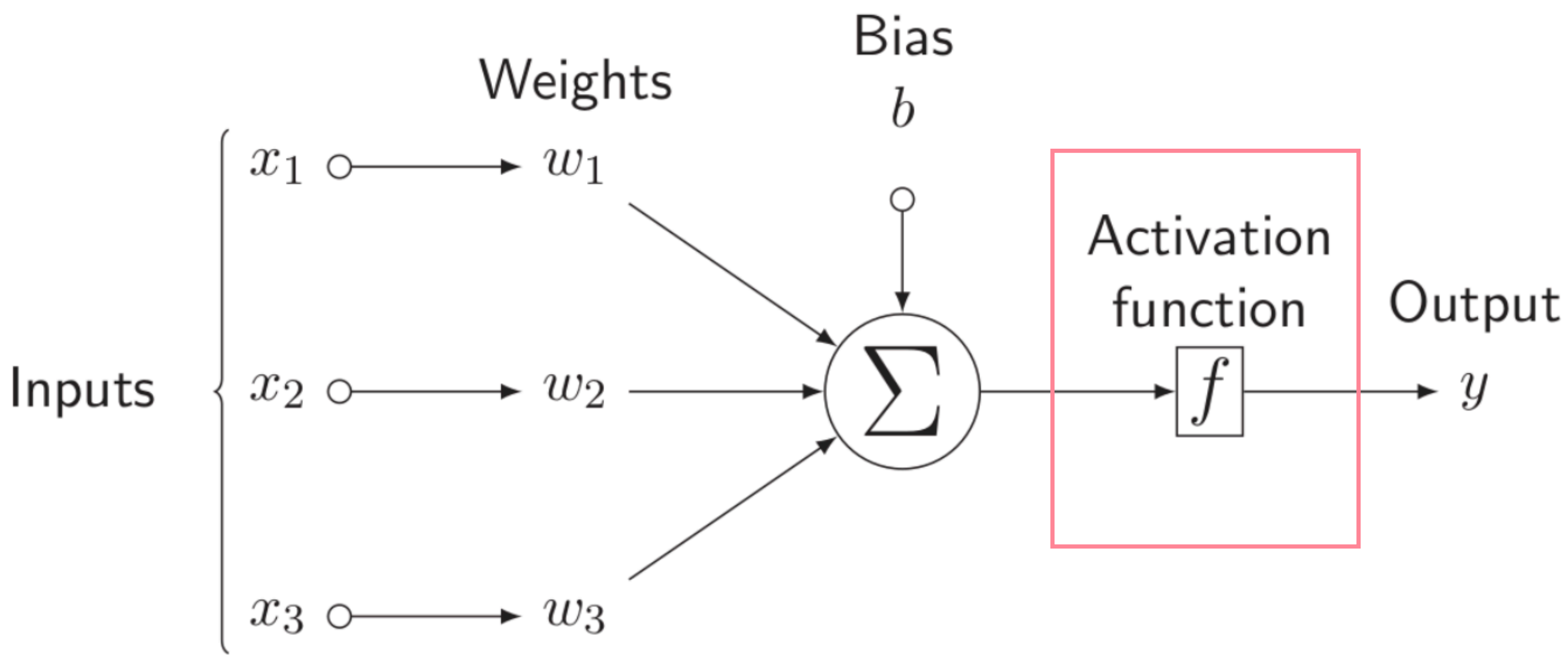

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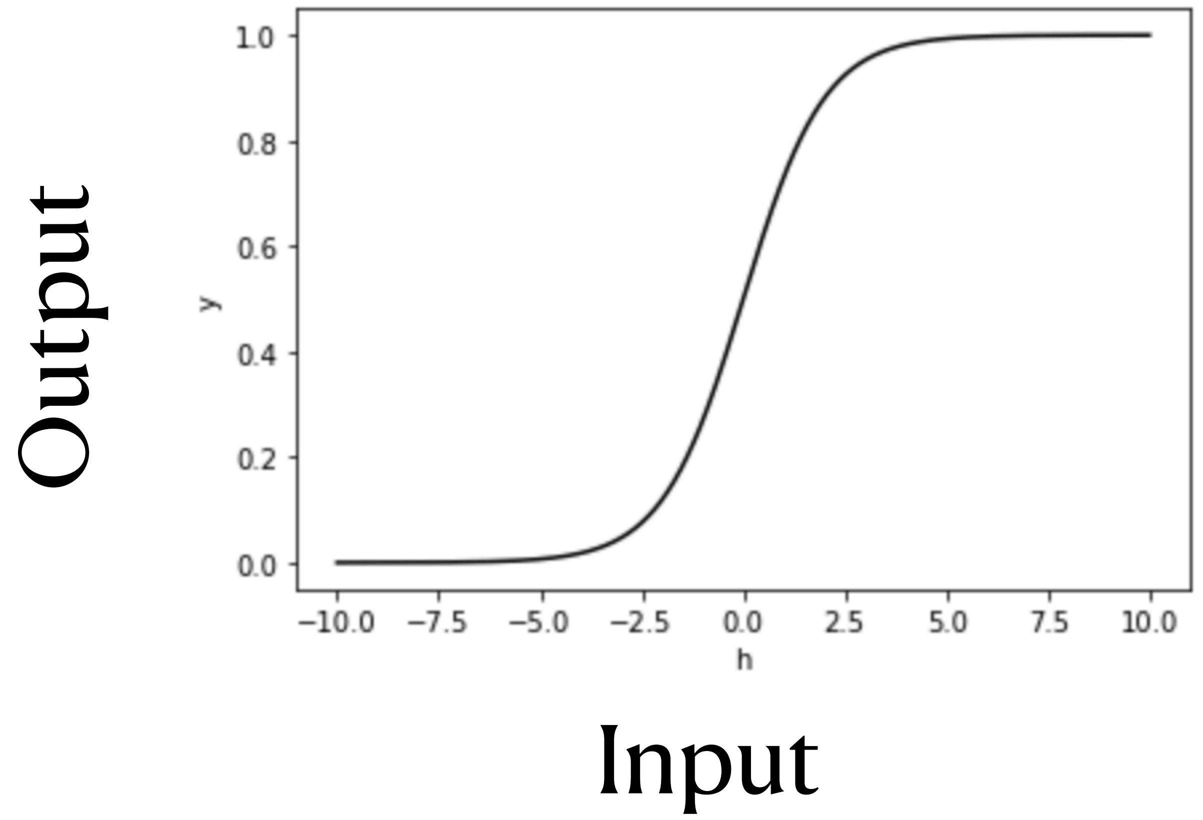

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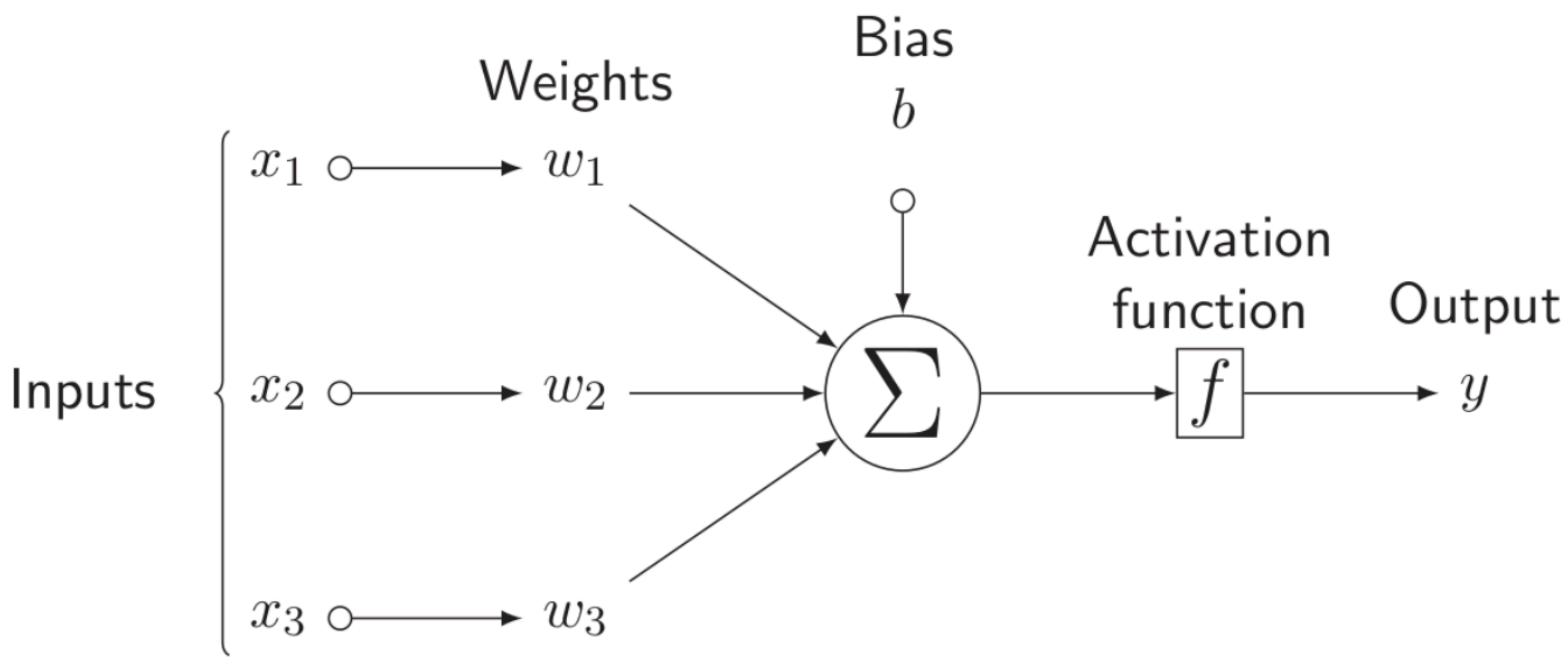

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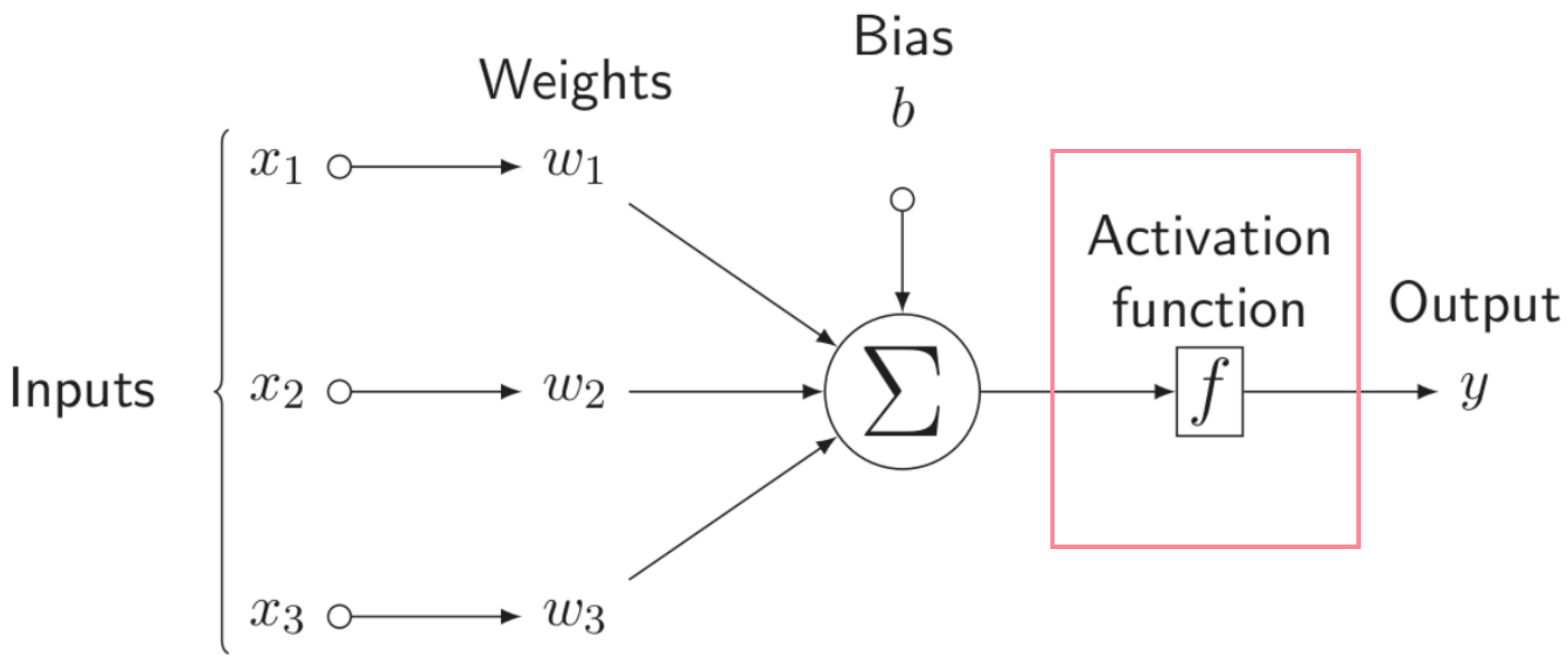

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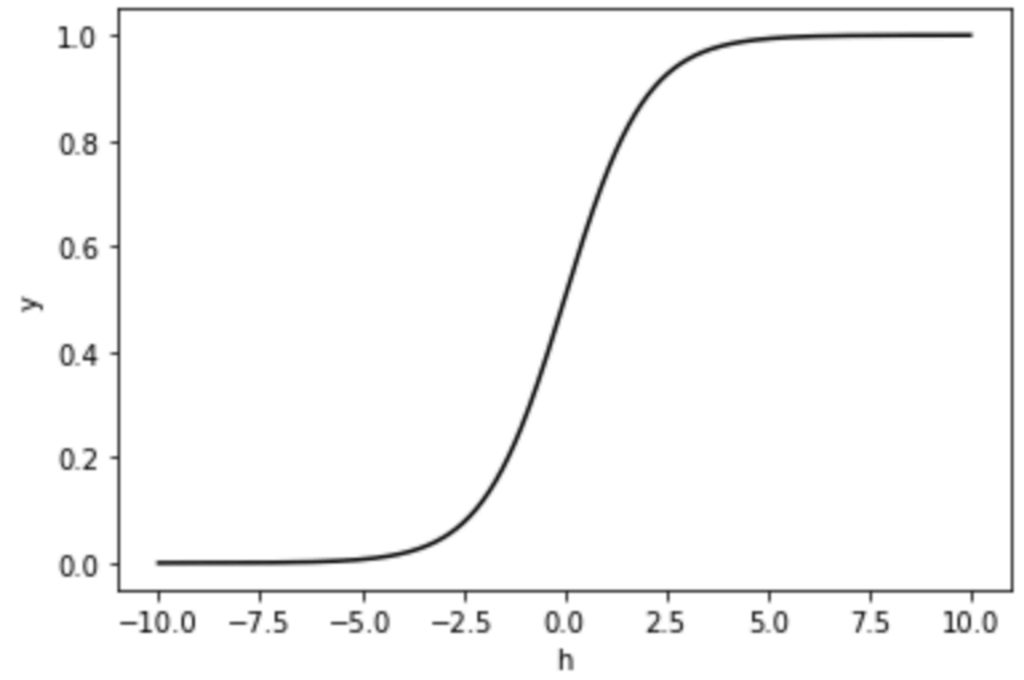

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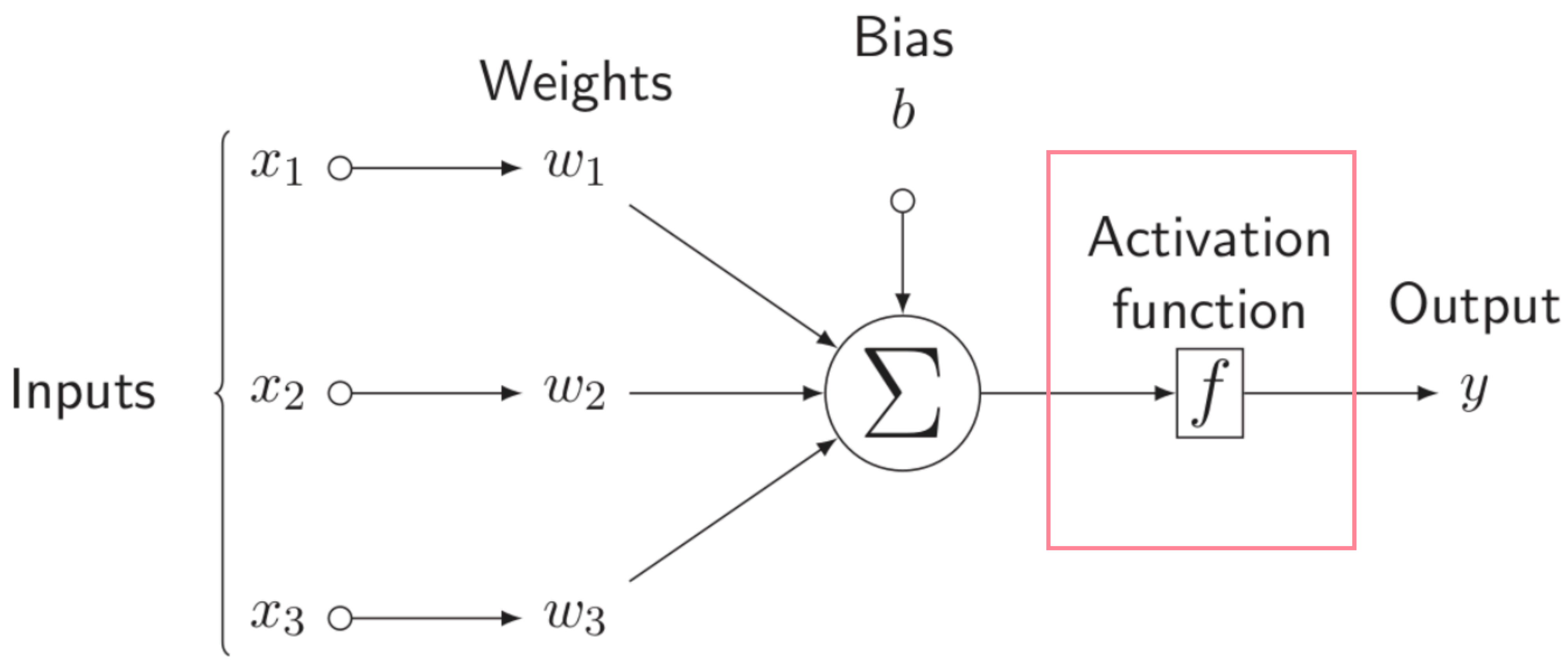

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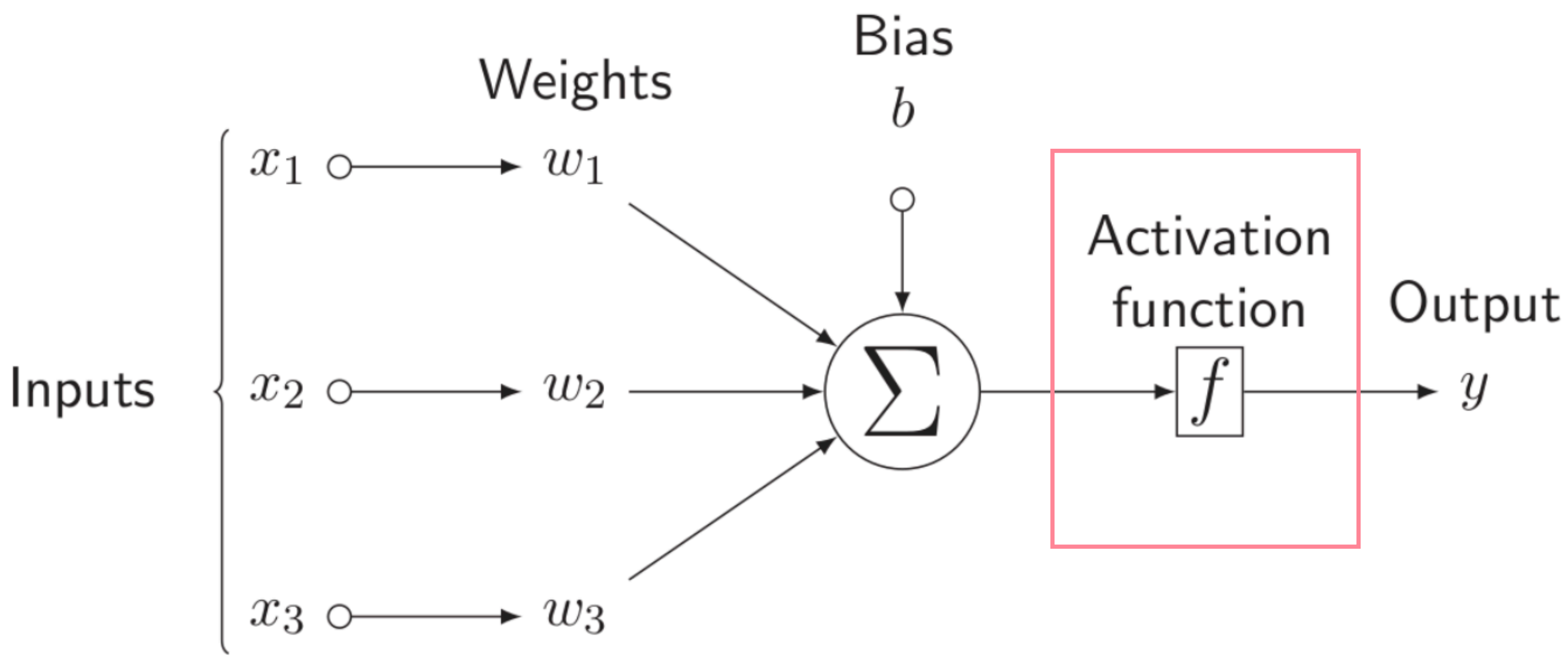

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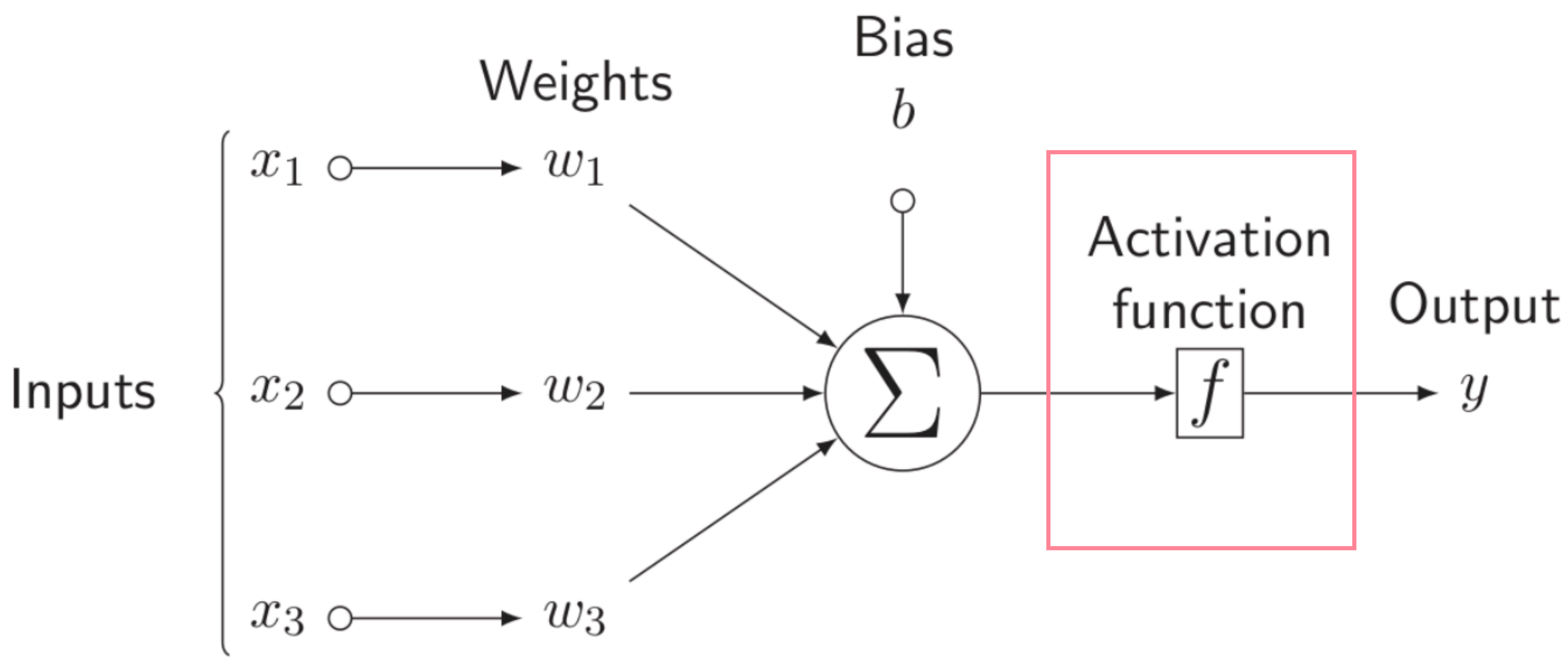

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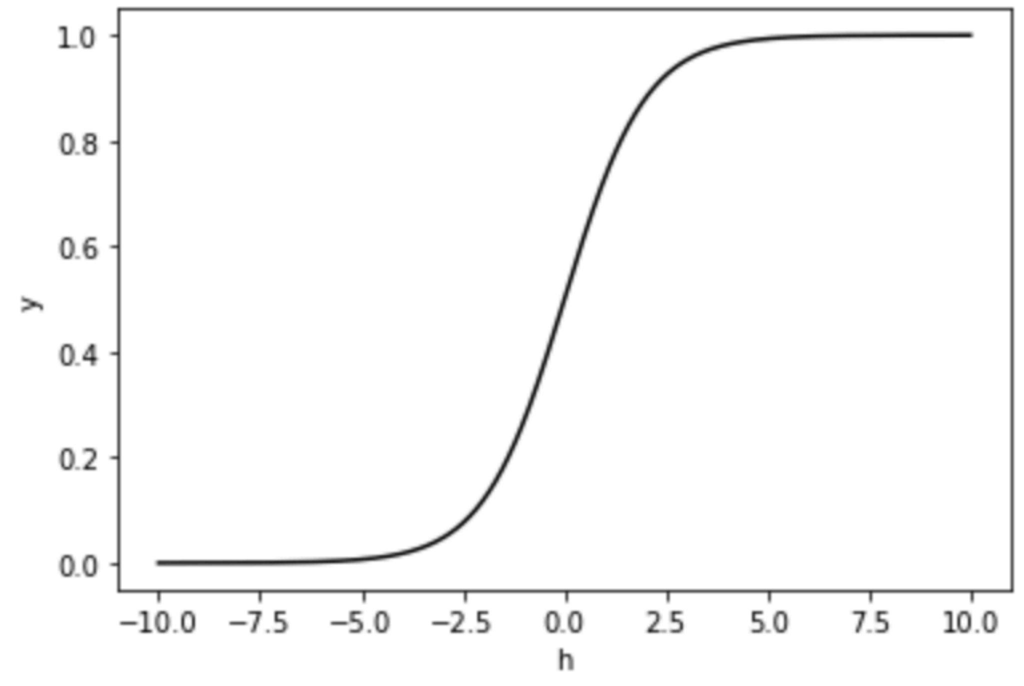

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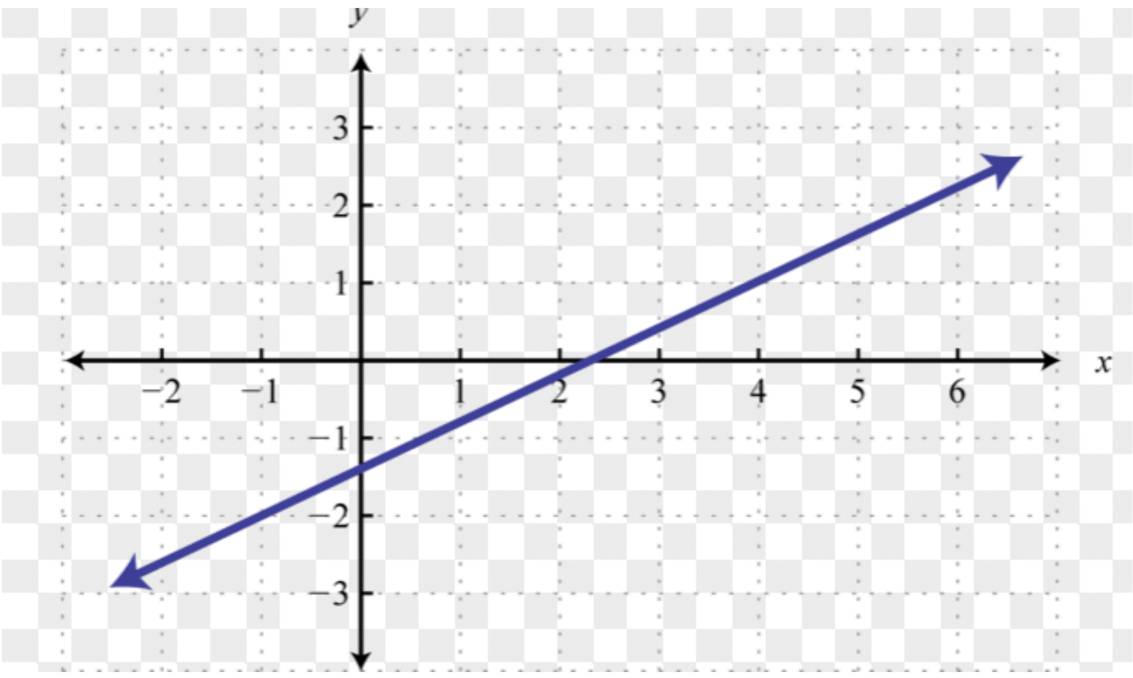

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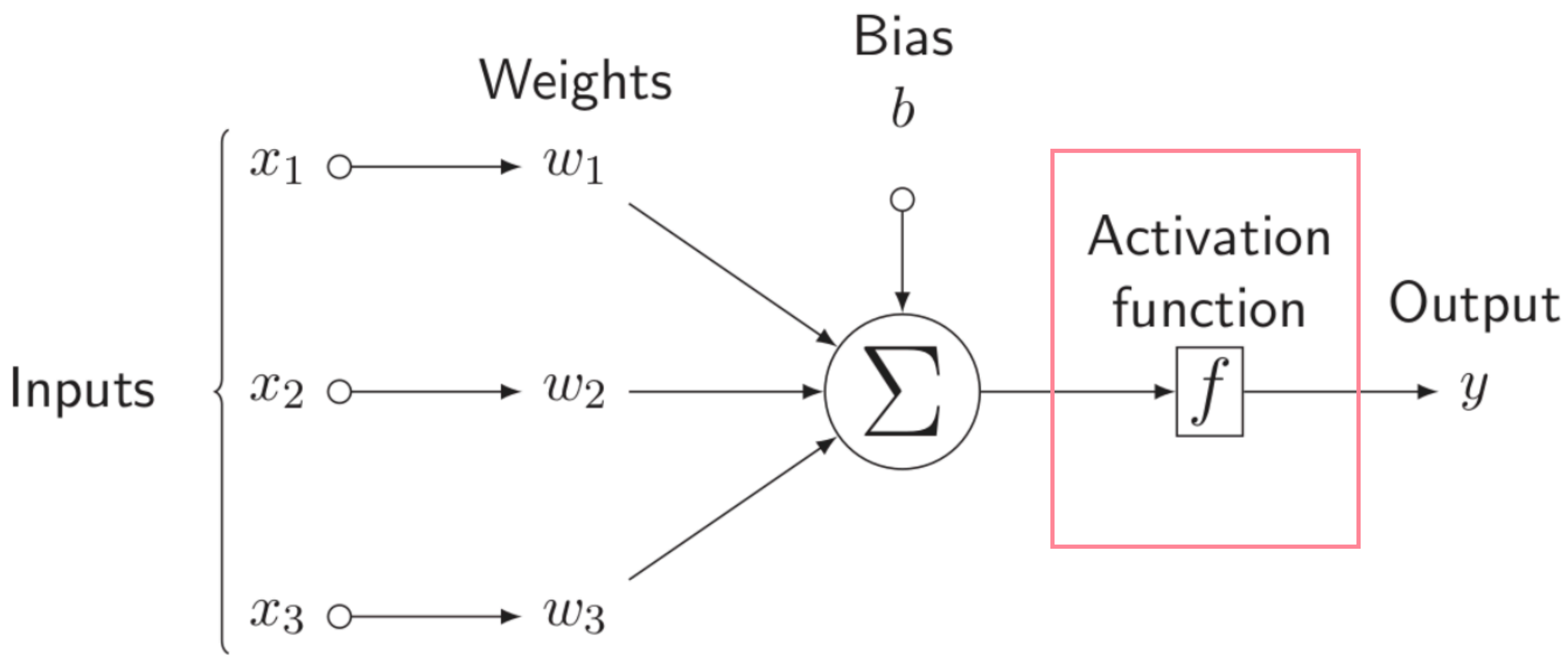

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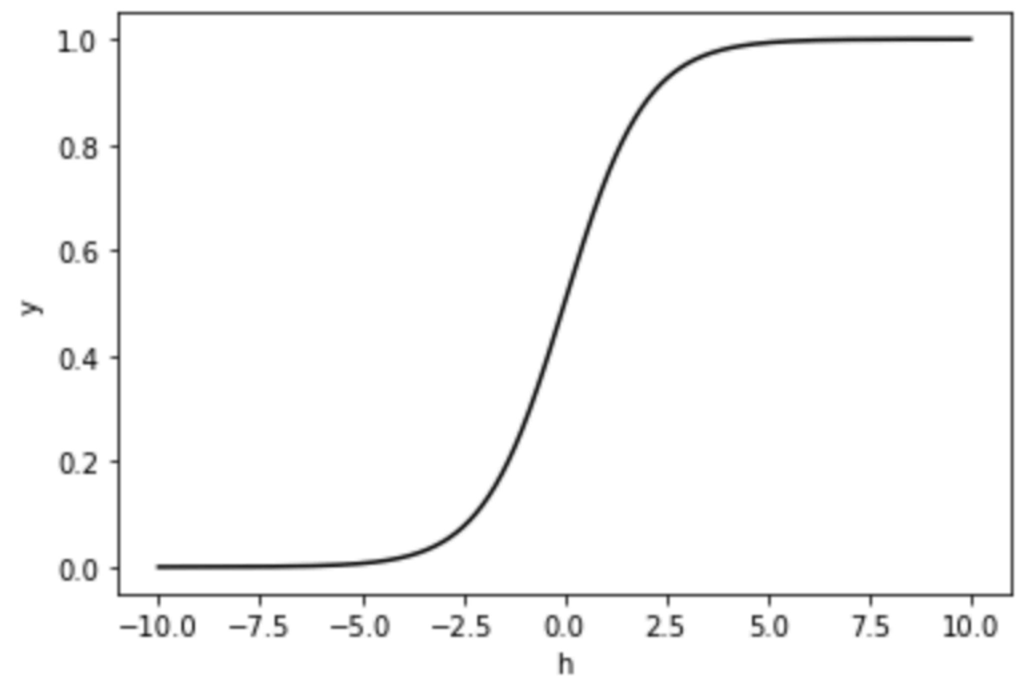

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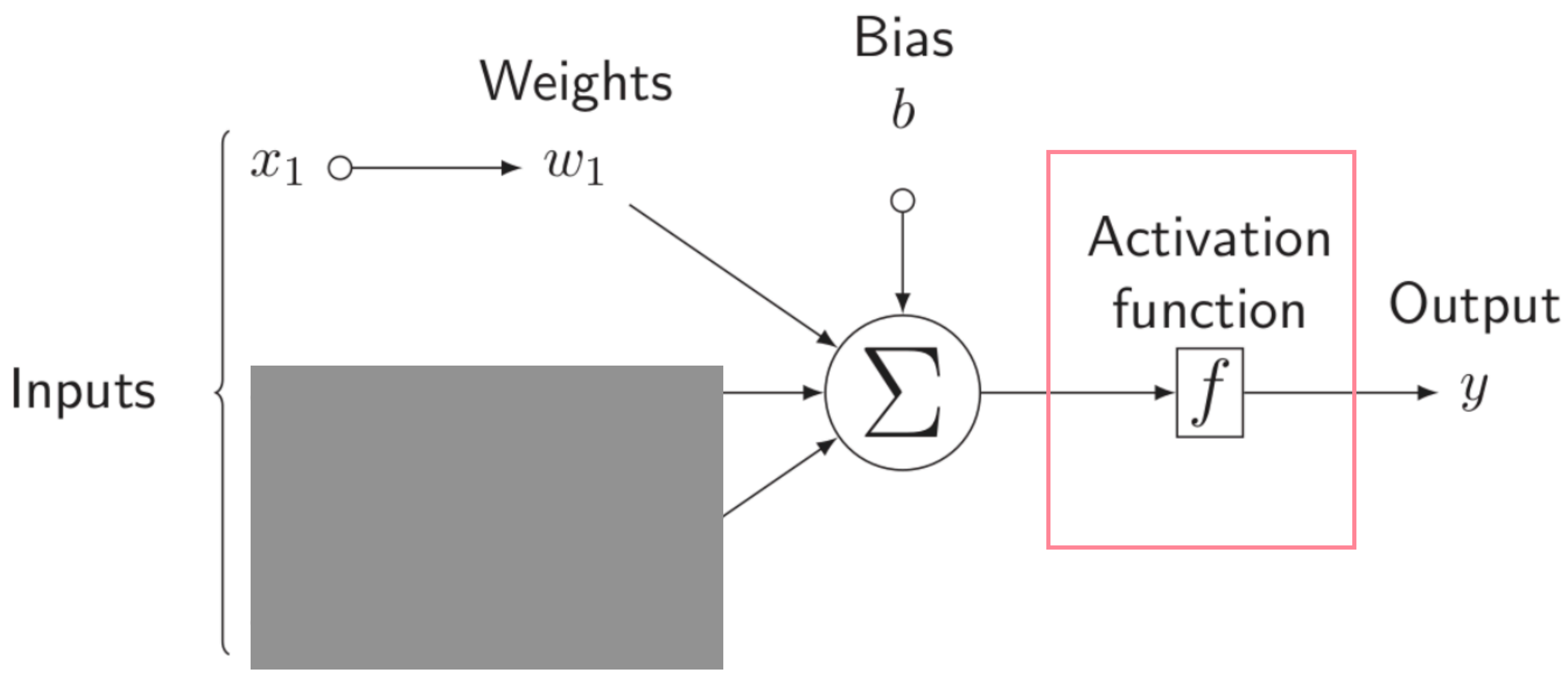

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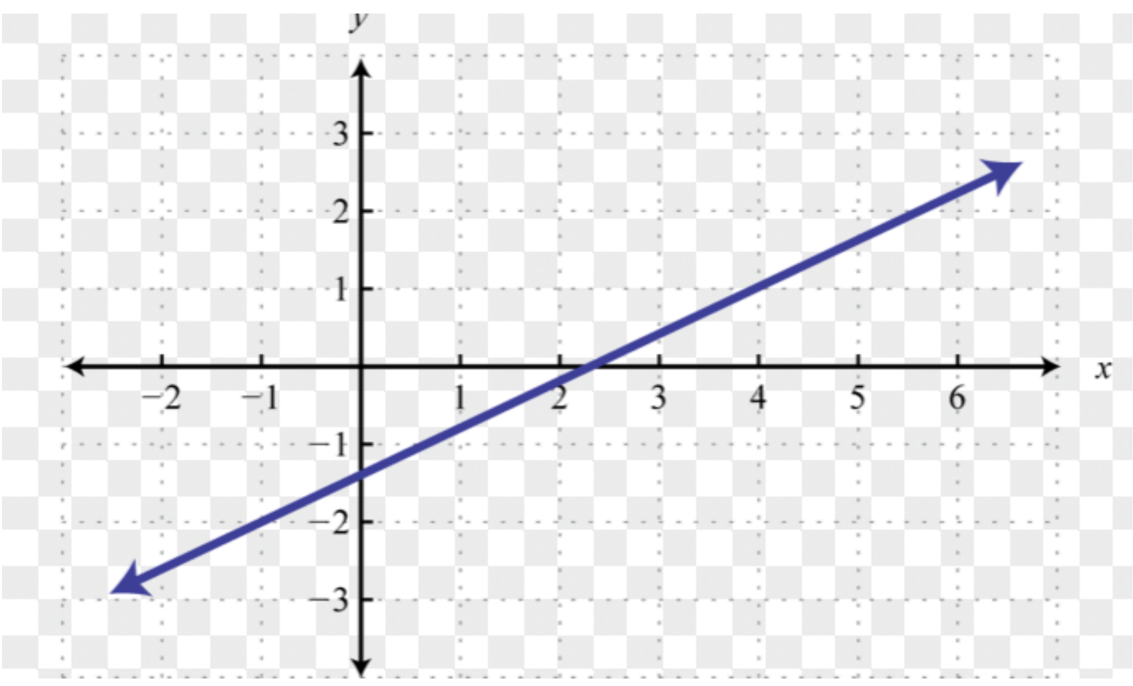

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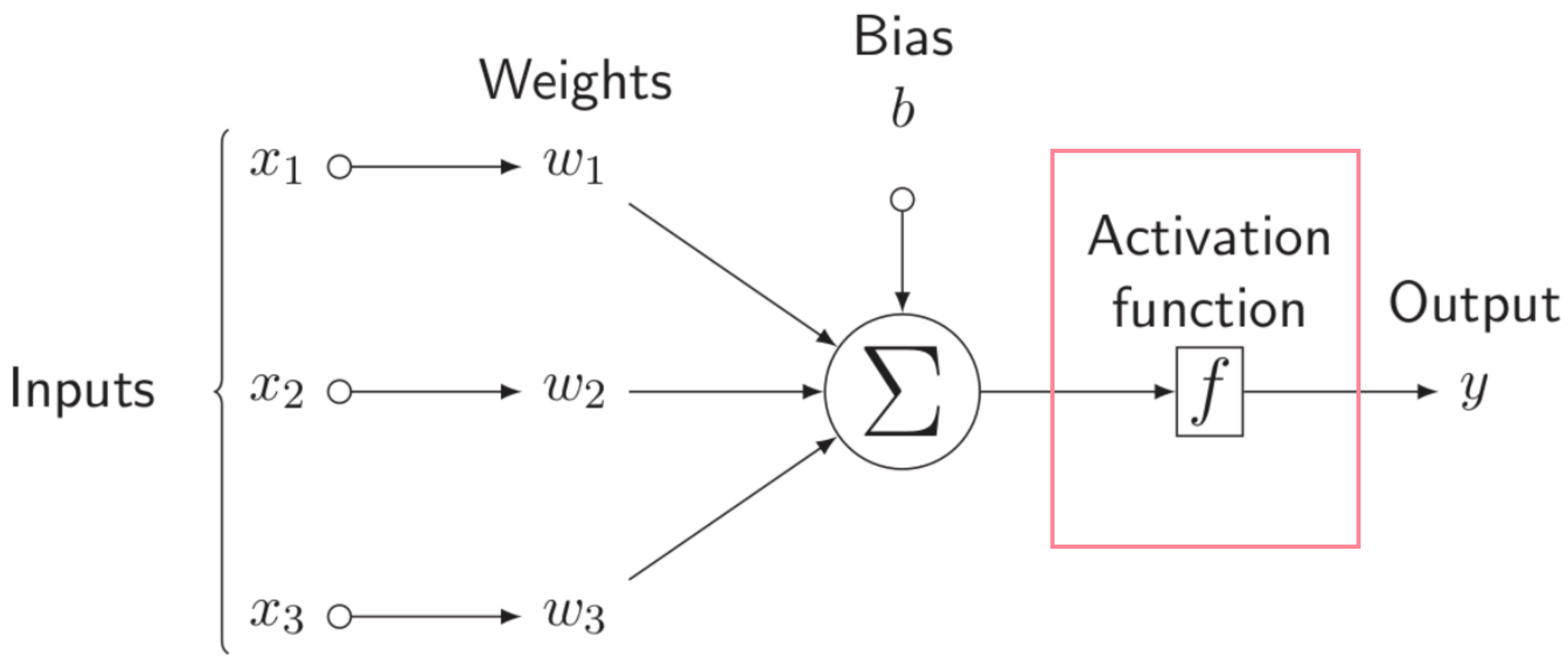

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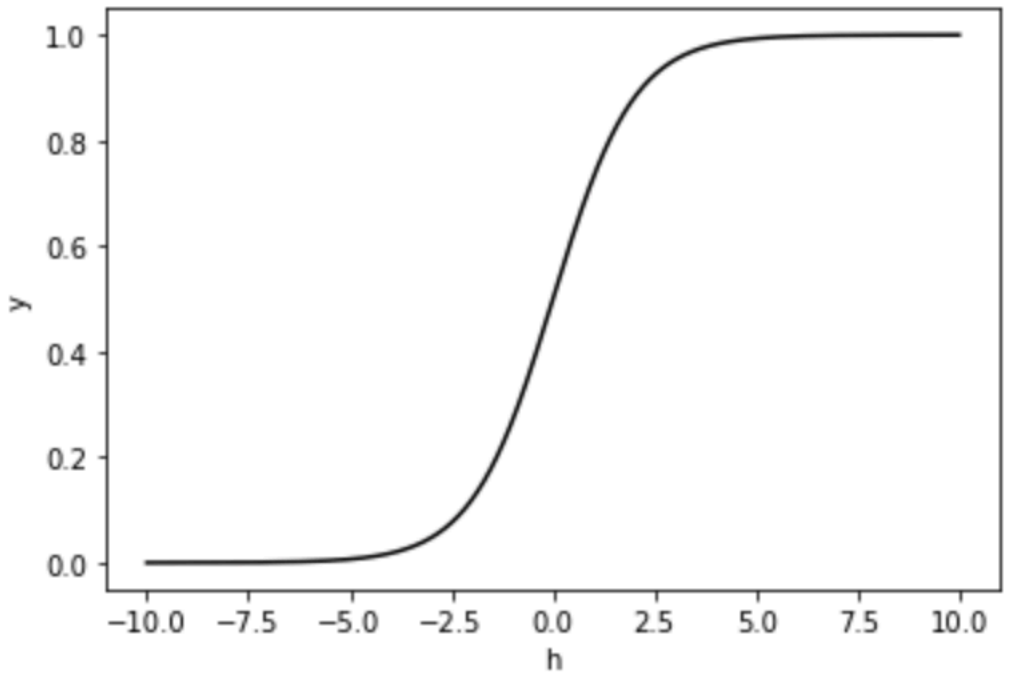

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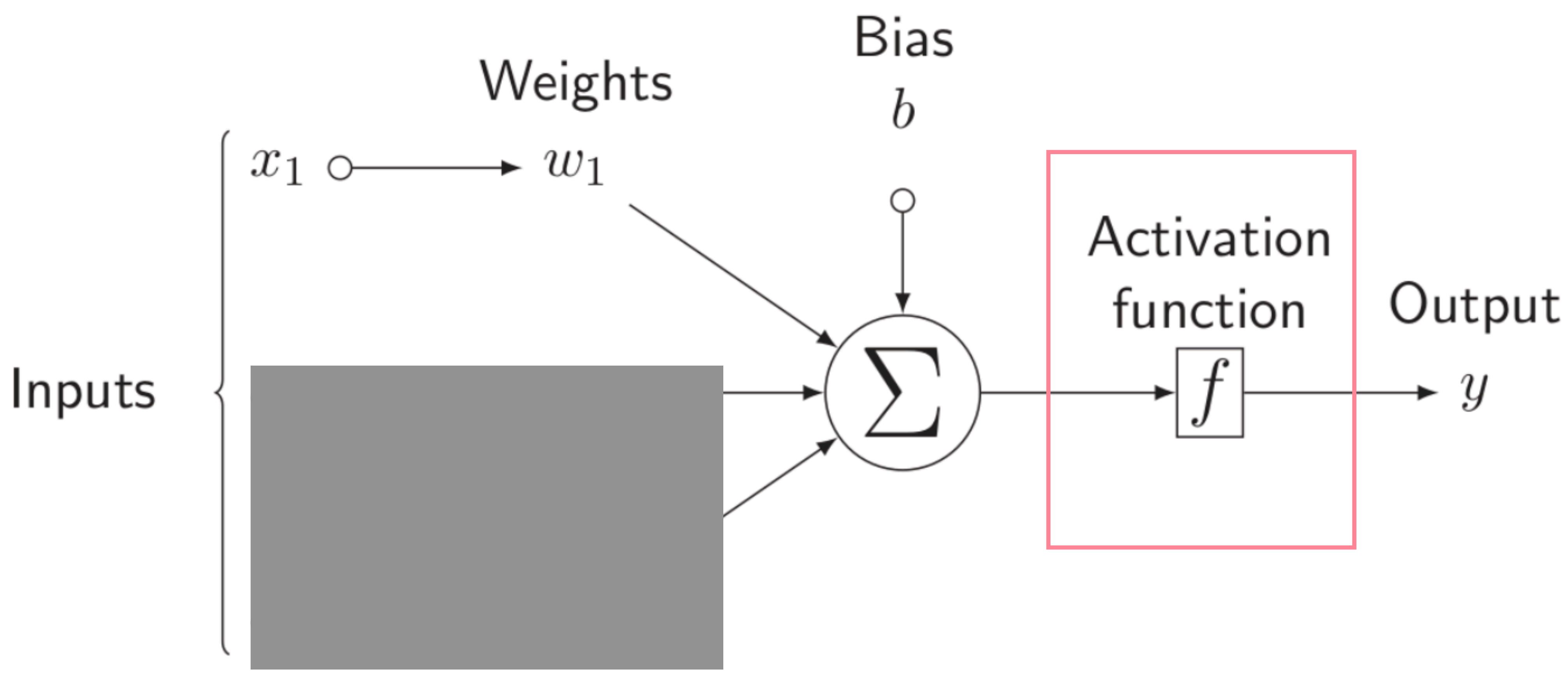

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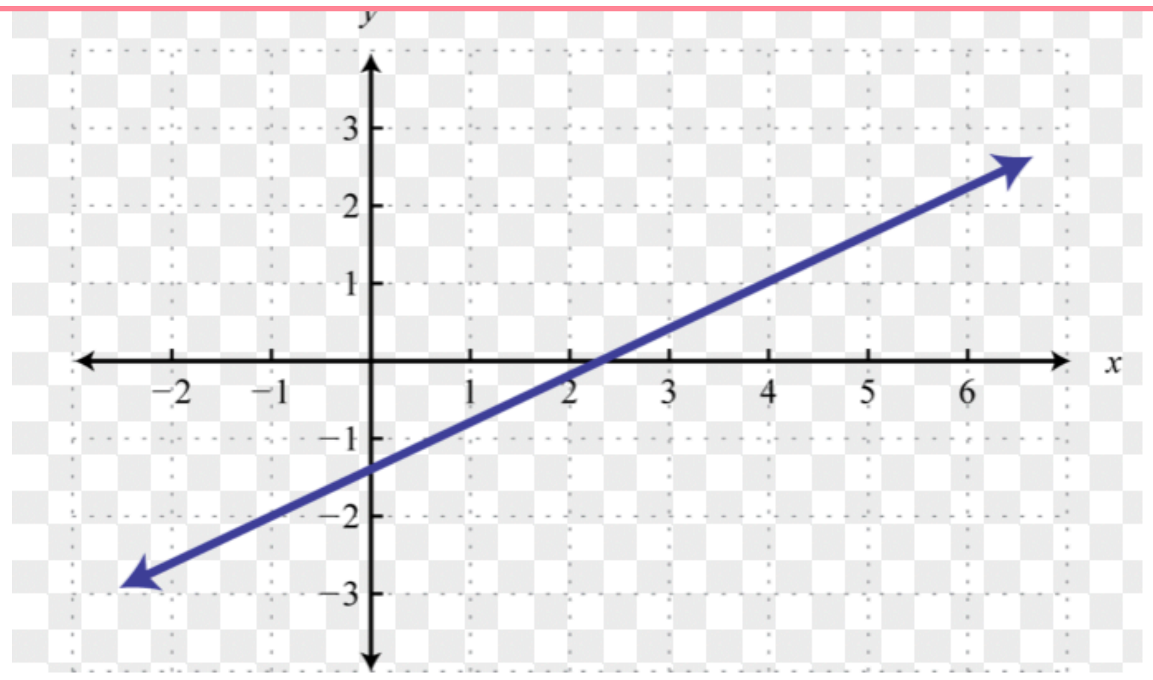
This becomes a linear REGRESSION task!!



A real-world problem

Advertising data set

Reading: You shall read p.59-p.64 first

In [26]:
```
advertising.head()
```

Out[26]:

	Unnamed: 0	TV	radio	newspaper	sales
0	1	230.1	37.8	69.2	22.1
1	2	44.5	39.3	45.1	10.4
2	3	17.2	45.9	69.3	9.3
3	4	151.5	41.3	58.5	18.5
4	5	180.8	10.8	58.4	12.9

We will review simple pandas in Lab video!

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Out[26]:

	Unnamed: 0	TV	radio	newspaper	sales
0	1	230.1	37.8	69.2	22.1
1	2	44.5	39.3	45.1	10.4
2	3	17.2	45.9	69.3	9.3
3	4	151.5	41.3	58.5	18.5
4	5	180.8	10.8	58.4	12.9

Input

We will review simple pandas in Lab video!

A real-world problem

Advertising data set

Reading: You shall read p.59-p.64 first

In [26]:
```
advertising.head()
```

Out[26]:

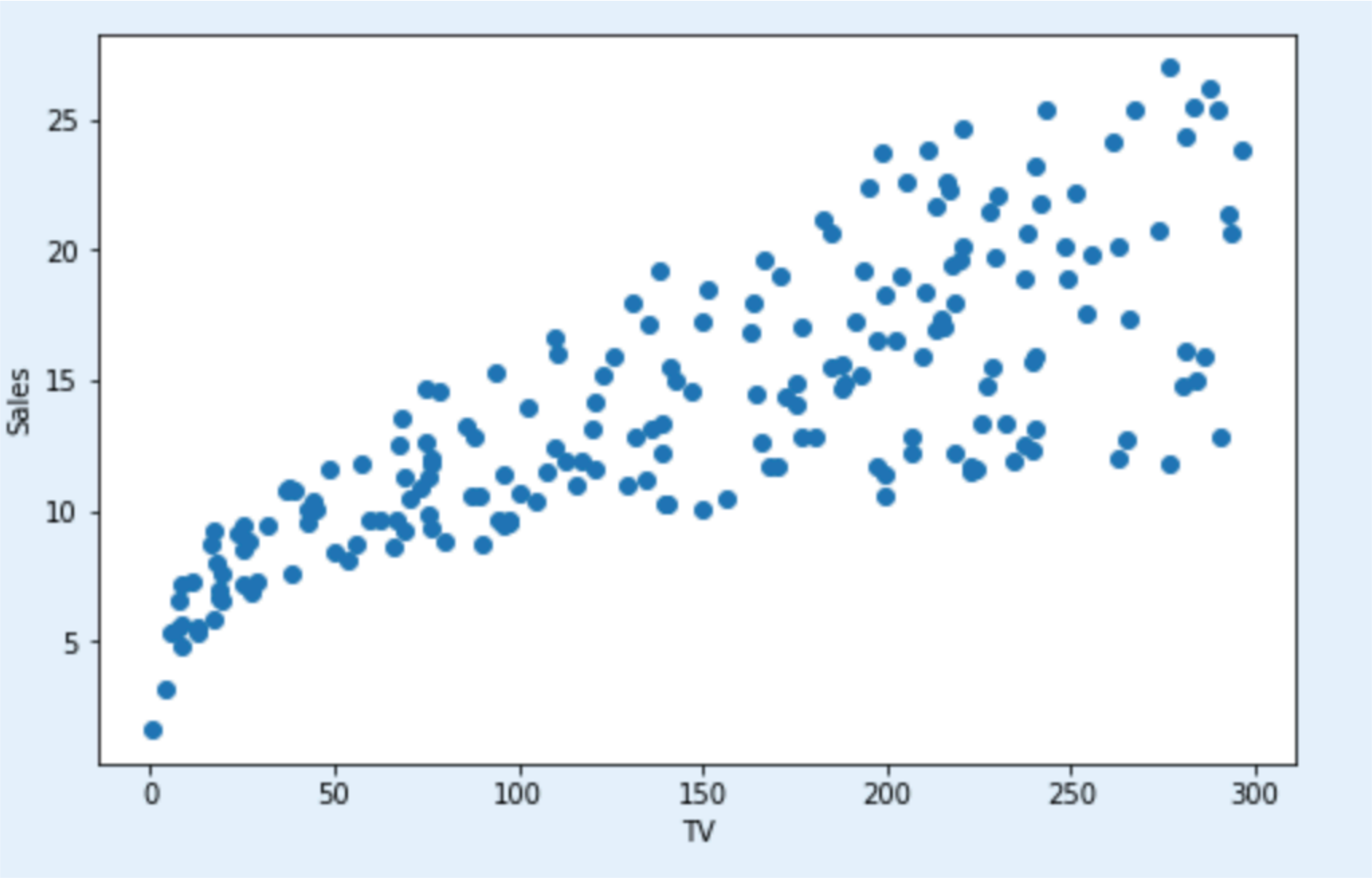
	Unnamed: 0	TV	radio	newspaper	sales
0	1	230.1	37.8	69.2	22.1
1	2	44.5	39.3	45.1	10.4
2	3	17.2	45.9	69.3	9.3
3	4	151.5	41.3	58.5	18.5
4	5	180.8	10.8	58.4	12.9

Output

Input

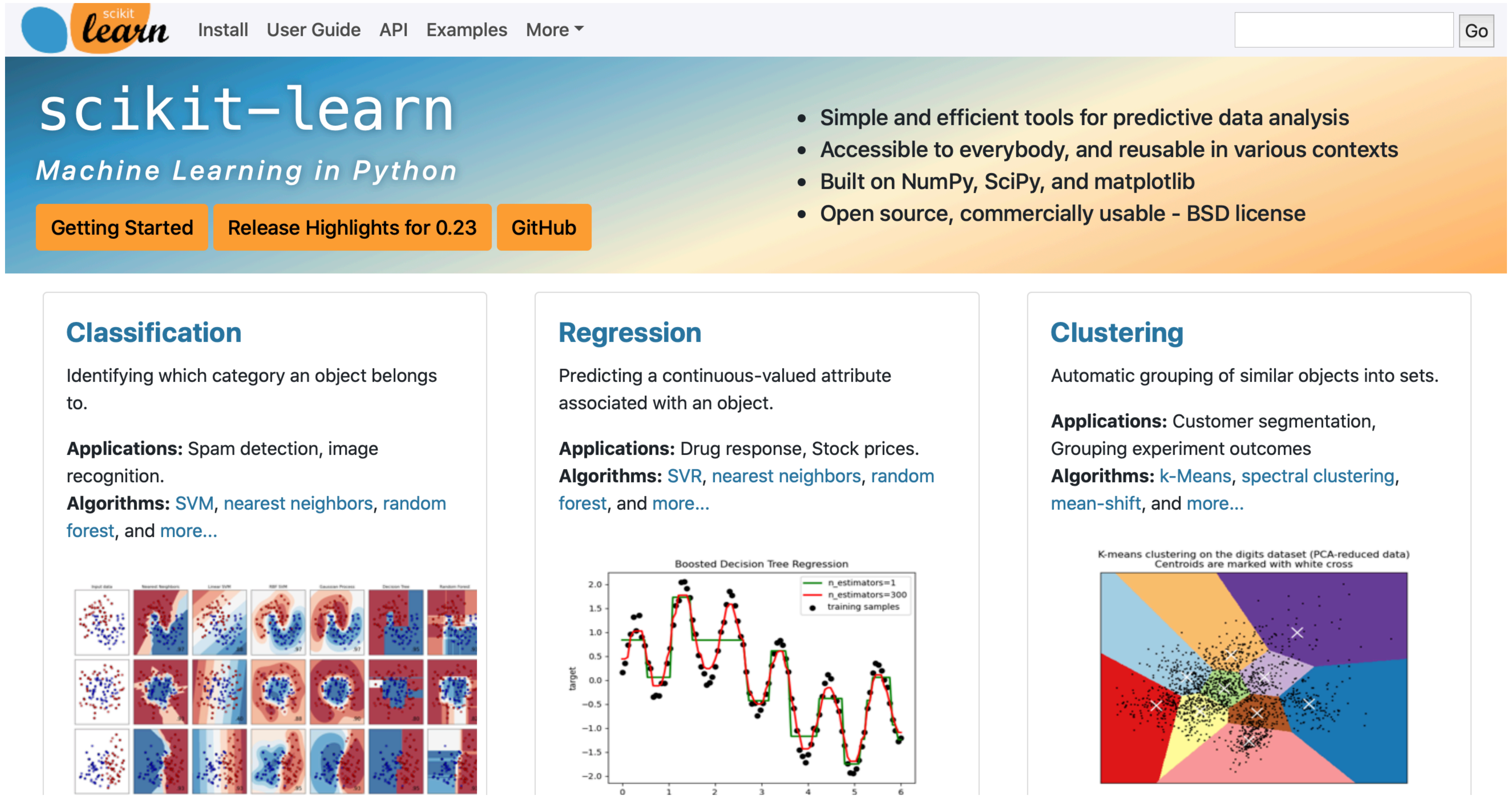
We will review simple pandas in Lab video!

Question: If the company is going to budget 100 units for the product in TV ad, what is the expected values in the sales?



Sci-kit learn in python

https://scikit-learn.org/stable/index.html



scikit learn | Install | User Guide | API | Examples | More | Go

scikit-learn

Machine Learning in Python

Getting Started | Release Highlights for 0.23 | GitHub

- Simple and efficient tools for predictive data analysis
- Accessible to everybody, and reusable in various contexts
- Built on NumPy, SciPy, and matplotlib
- Open source, commercially usable - BSD license

Classification

Identifying which category an object belongs to.

Applications: Spam detection, image recognition.
Algorithms: SVM, nearest neighbors, random forest, and more...

Regression

Predicting a continuous-valued attribute associated with an object.

Applications: Drug response, Stock prices.
Algorithms: SVR, nearest neighbors, random forest, and more...

Boosted Decision Tree Regression

Clustering

Automatic grouping of similar objects into sets.

Applications: Customer segmentation, Grouping experiment outcomes
Algorithms: k-Means, spectral clustering, mean-shift, and more...

K-means clustering on the digits dataset (PCA-reduced data)
Centroids are marked with white cross

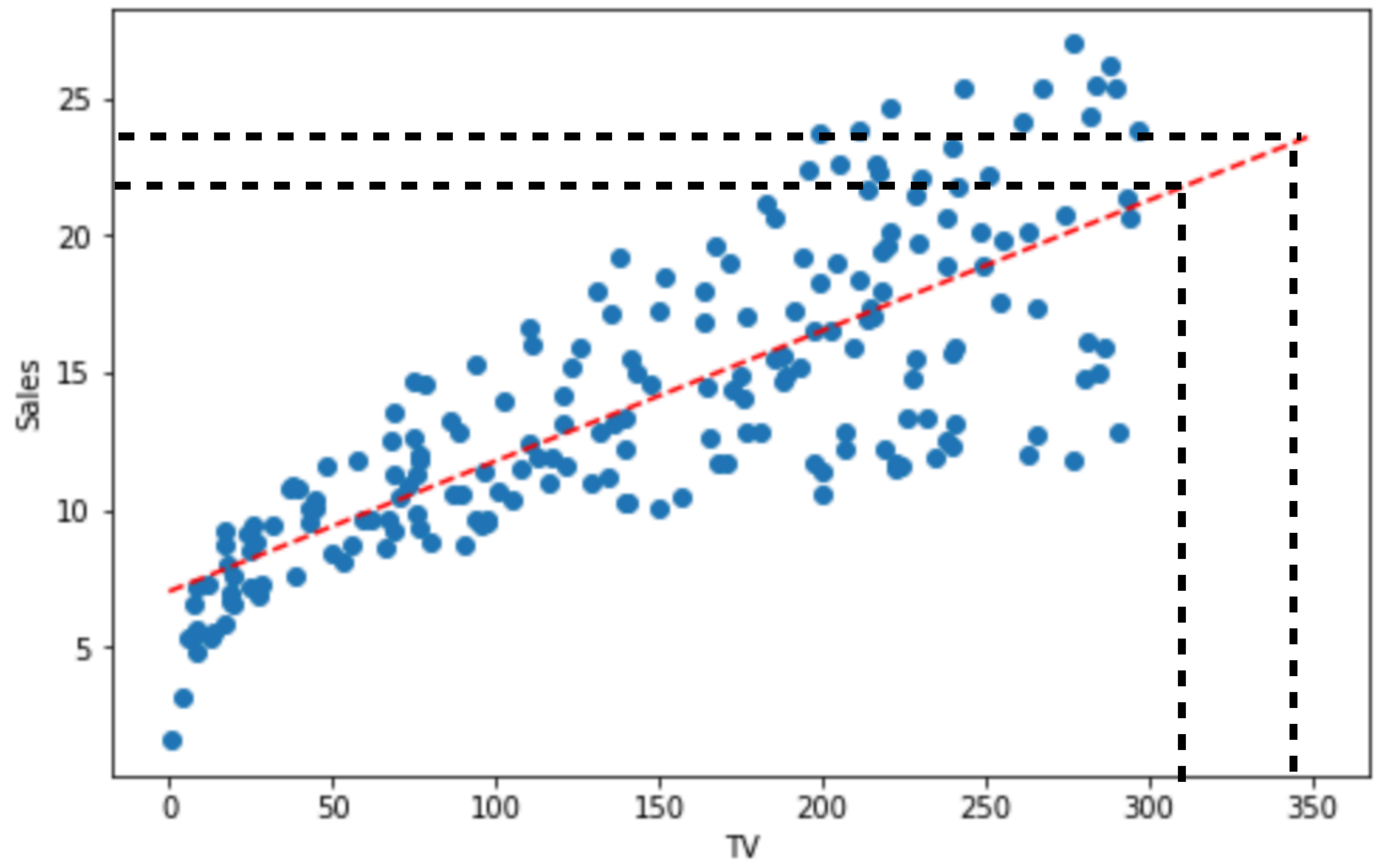
Use sk-learn to solve our problem

In [30]:
```
model_full = LinearRegression().fit(X_data, y_data)
```

In [31]:
```
sales_tv_slope = model_full.coef_
sales_tv_intercep = model_full.intercept_

x_star = [0.0,350.0]

plt.scatter(X_data,y_data)
plt.plot(x_star, reg_lin(x_star,sales_tv_slope,sales_tv_intercep),'r--')
plt.xlabel('TV')
plt.ylabel('Sales')
```



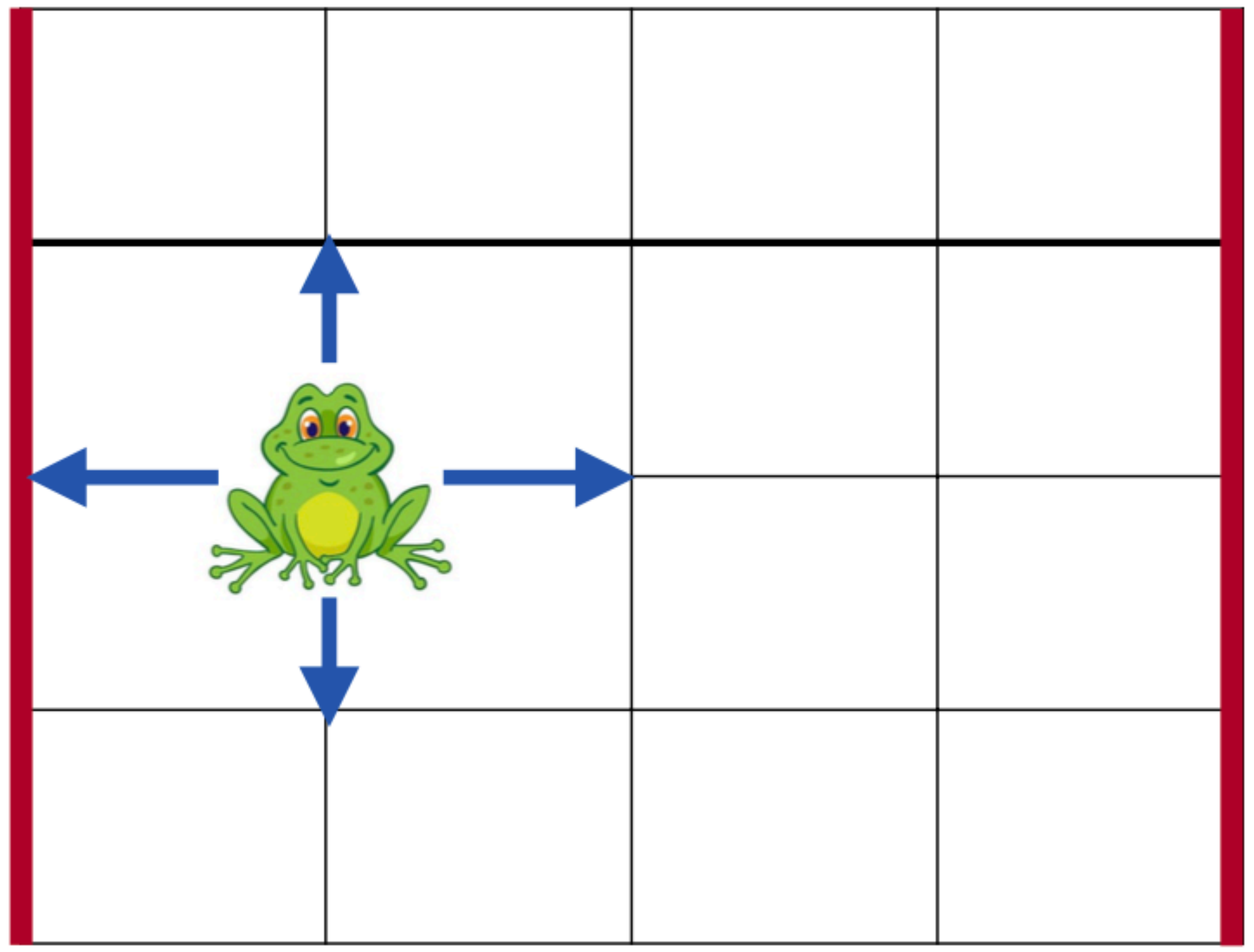
Homework

Simulation on a frog jump

Problem 13

A frog sitting at the point $(1, 2)$ begins a sequence of jumps, where each jump is parallel to one of the coordinate axes and has length 1, and the direction of each jump (up, down, right, or left) is chosen independently at random. The sequence ends when the frog reaches a side of the square with vertices $(0, 0)$, $(0, 4)$, $(4, 4)$, and $(4, 0)$. What is the probability that the sequence of jumps ends on a vertical side of the square?

$\textbf{(A)}\ \frac{1}{2} \qquad \textbf{(B)}\ \frac{5}{8} \qquad \textbf{(C)}\ \frac{2}{3} \qquad \textbf{(D)}\ \frac{3}{4} \qquad \textbf{(E)}\ \frac{7}{8}$



https://artofproblemsolving.com/wiki/index.php/2020_AMC_10A_Problems