Machine learning is divided into two main categories

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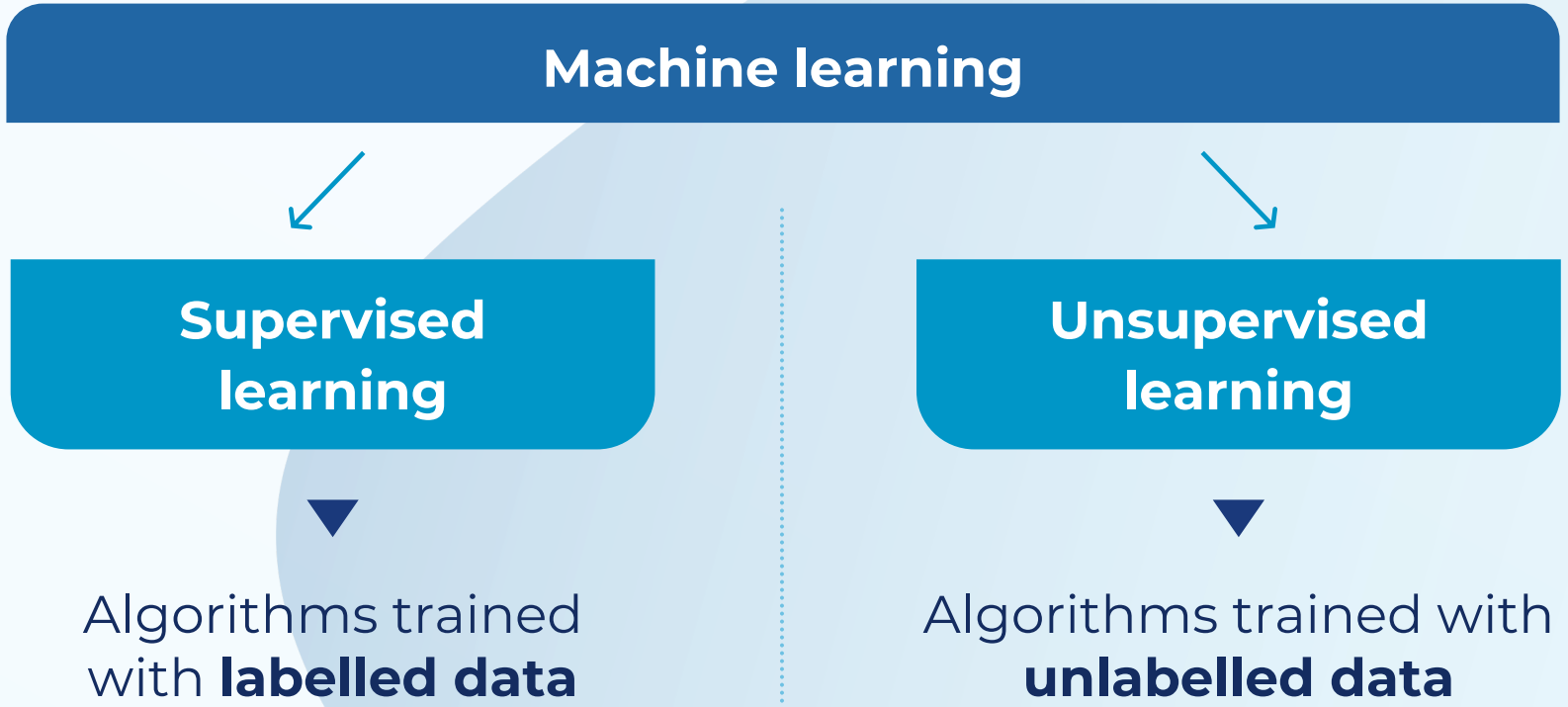

How does supervised learning work?

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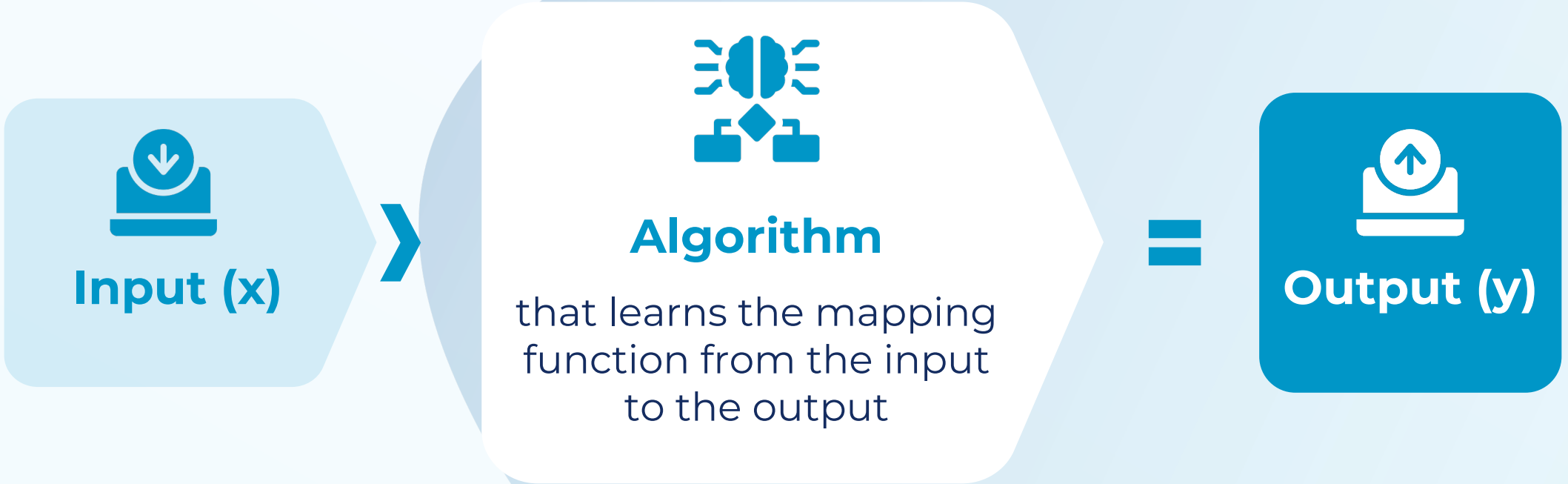

A supervised learning technique: regression

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How does regression work?

- Regression models use an algorithm to understand the relationship between **a dependent variable** (input) and **an independent variable** (output).
- They are helpful for **predicting numerical values** based on different features' values. E.g., temperature forecast based on wind, humidity and pressure.

Regression aims

to build a relationship between each feature and the output for predictions

Linear relationships ▶ Linear regression

Linear regression uses a best fitting straight line – **“regression line”**

$$y = wX + b$$

- **y** — dependent variable
- **w** — weight; the slope of the gradient of the line - indicates the impact X has on Y
- **X** — independent variable; used to predict the value of Y
- **b** — Bias; is the value of Y when there is no X or X is zero

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A simple linear regression model

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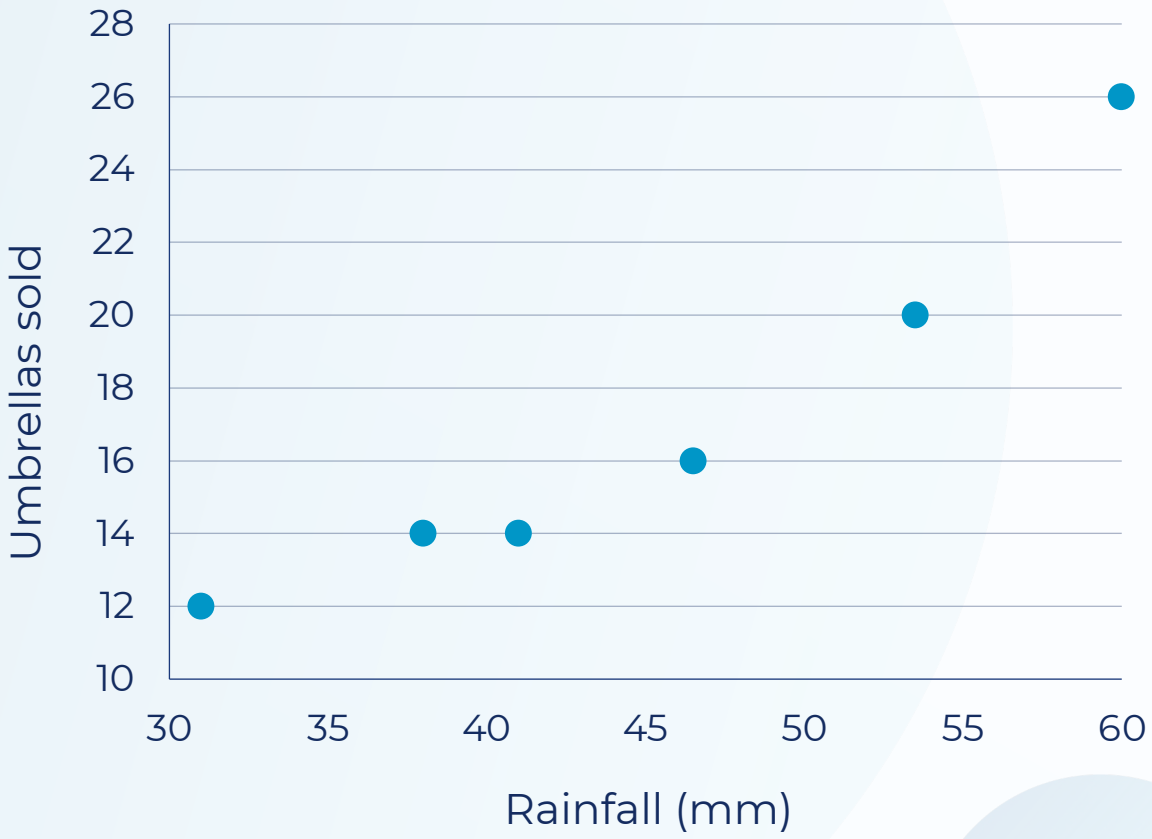
Simple linear regression only has one Y variable and one X variable:

- **The independent variable x:** rainfall measured in millimeters
- **The dependent variable y:** the number of umbrellas sold

▶ We can predict the number of umbrellas, or Y, for any quantity of rain.



How can we calculate the regression line?

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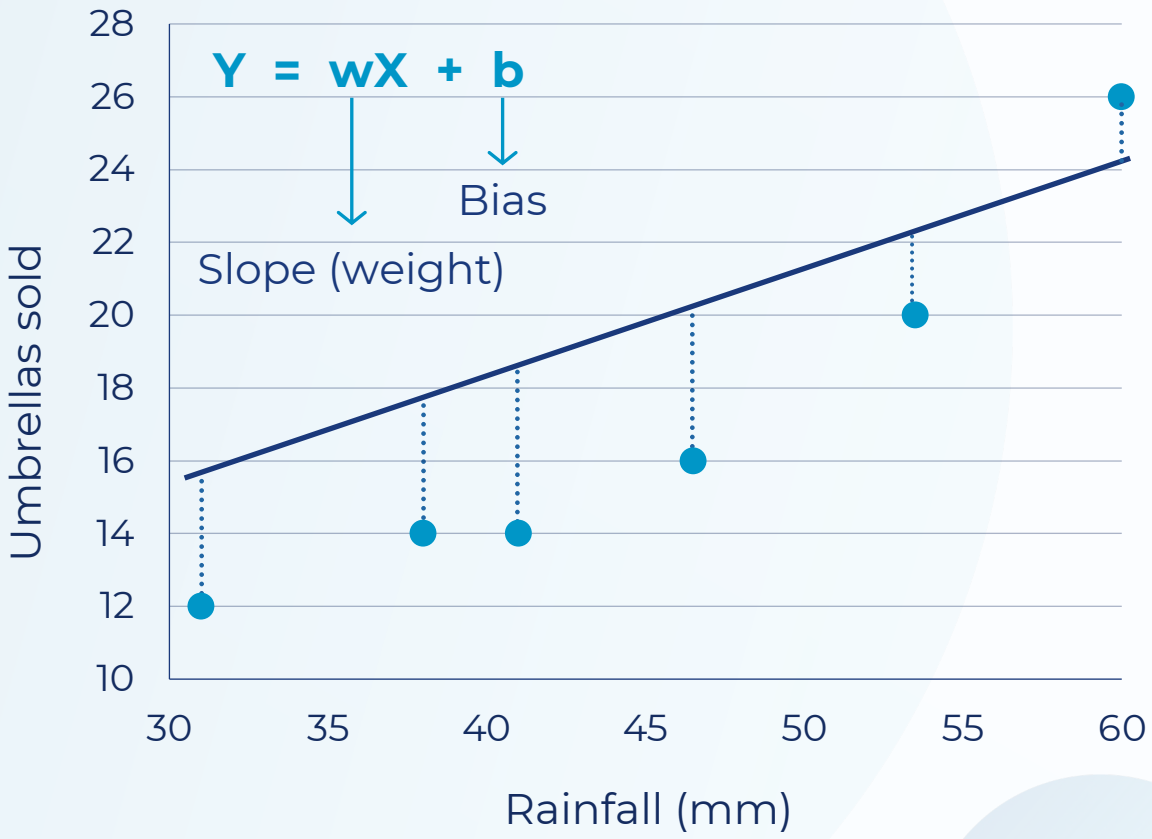
1. We draw a line to represent the relationship
2. We measure the distances between the line and each datapoint (the residuals)
3. We sum up the residuals
4. We adjust the weight & the bias to minimize this sum



Multiple features call for multiple linear regression

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Multiple features ▶ **Multiple linear regression**

The aim is to **predict output variable** using multiple features

$$y = w_1x_1 + w_2x_2 + \ldots + b$$

- Multiple linear regression can have many independent variables to one dependent variable
- Datasets with multiple features like the number of bedrooms, age of the building, covered area, etc.

How can we evaluate the performance of a regression model?

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We use performance evaluation metrics

The most commonly used evaluation metrics is taking the difference between predicted and actual value of some test points:

- The mean of the squared difference is taken – **Mean Squared Error (MSE)**
- The size of the error is measured by taking the square root of MSE - **Root Mean Squared Error (RMSE)**

Evaluating the performance of a regression model using MSE & RMSE

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$$MSE = \frac{1}{n} \sum_{i=1}^{n} (y_i - \hat{y}_i)^2$$

$$RMSE = \sqrt{\frac{1}{n} \sum_{i=1}^{n} (y_i - \hat{y}_i)^2}$$

MSE = Mean squared error
n = Number of data points
Y_i = Observed values
$\hat{y}_i$ = Predicted values