Building Blocks for Neural Networks

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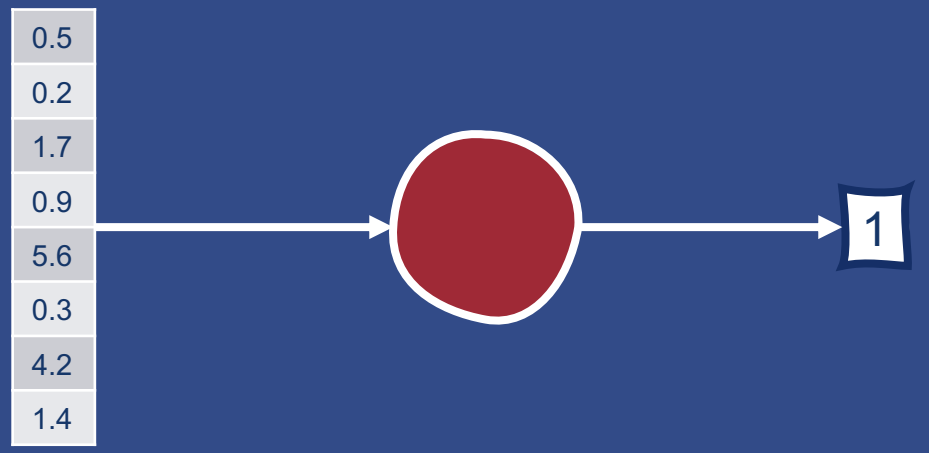
UIC CS 421

Building Blocks for Neural Networks

- At their core, neural networks are comprised of **computational units**
- Computational units:
  1. Take a set of real-valued numbers as input
  2. Perform some computation on them
  3. Produce a single output



Computational Units

- The computation performed by each unit is a weighted sum of inputs
  - Assign a weight to each input
  - Add one additional bias term

- More formally, given a set of inputs $x_1, \ldots, x_n$, a unit has a set of corresponding weights $w_1, \ldots, w_n$ and a bias b, so the weighted sum z can be represented as:
  - $z = b + \sum_i w_i x_i$

Sound familiar?

- This is exactly the same sort of weighted sum of inputs that we needed to find with logistic regression!
- Recall that we can also represent the weighted sum z using vector notation:
  - $z = w \cdot x + b$

Computational Units

- The weighted sum of inputs computes a **linear function** of x
- As we already saw, neural networks learn **nonlinear functions**
- These nonlinear functions are commonly referred to as **activations**
- The output of a computation unit is thus the **activation value** for the unit, y
  - $y = f(z) = f(w \cdot x + b)$

There are many different activation functions!

exponential linear unit (elu)

softmax

scaled exponential linear unit (selu)

softplus

softsign

rectified linear unit (relu)

hyperbolic tangent (tanh)

sigmoid

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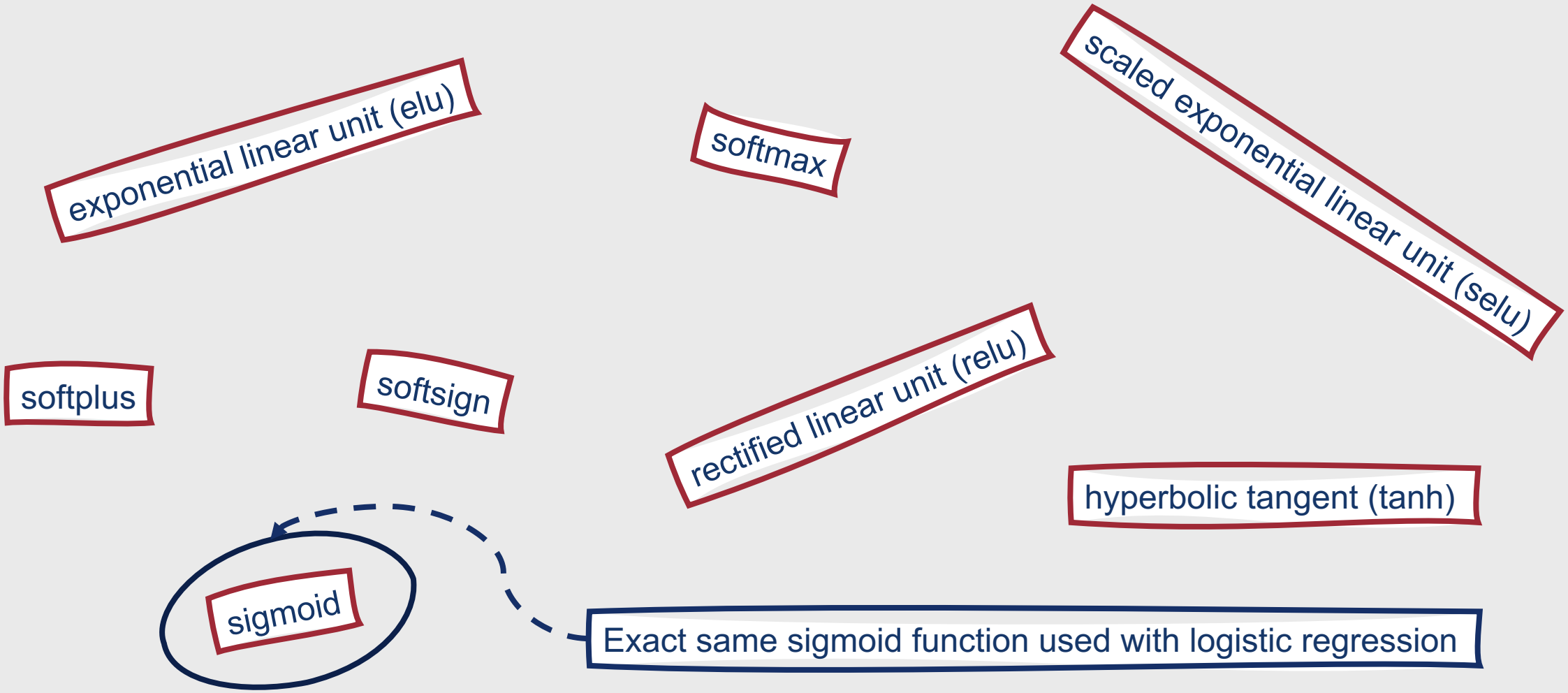
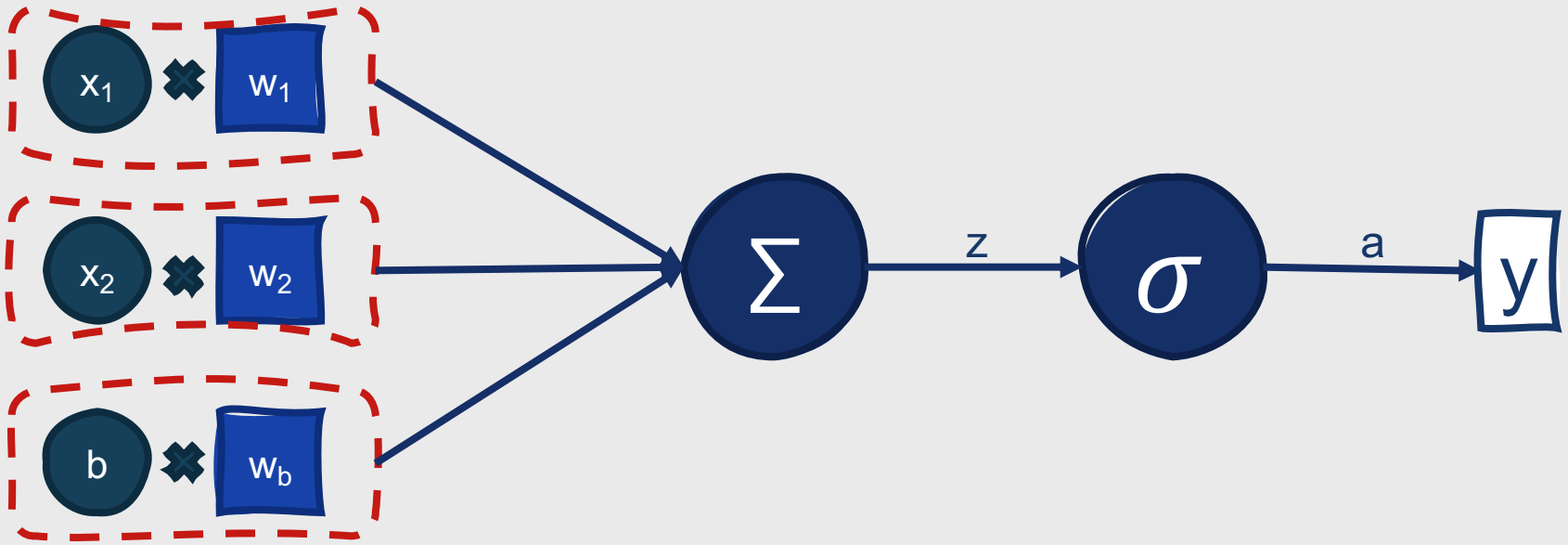
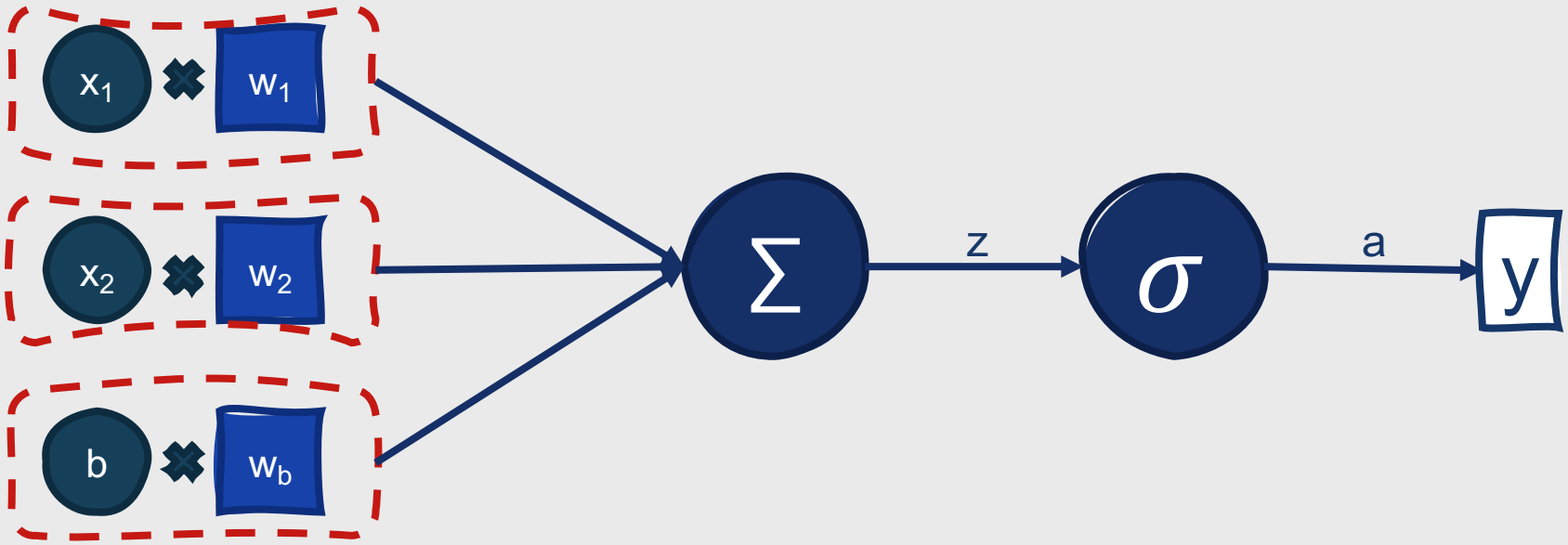


Computational Unit with Sigmoid Activation



Example: Computational Unit with Sigmoid Activation



Input: “beautiful brutalist architecture”

Weights (Input): [0.2, 0.3]
Weight (Bias): [0.5]

Bias: 1.0

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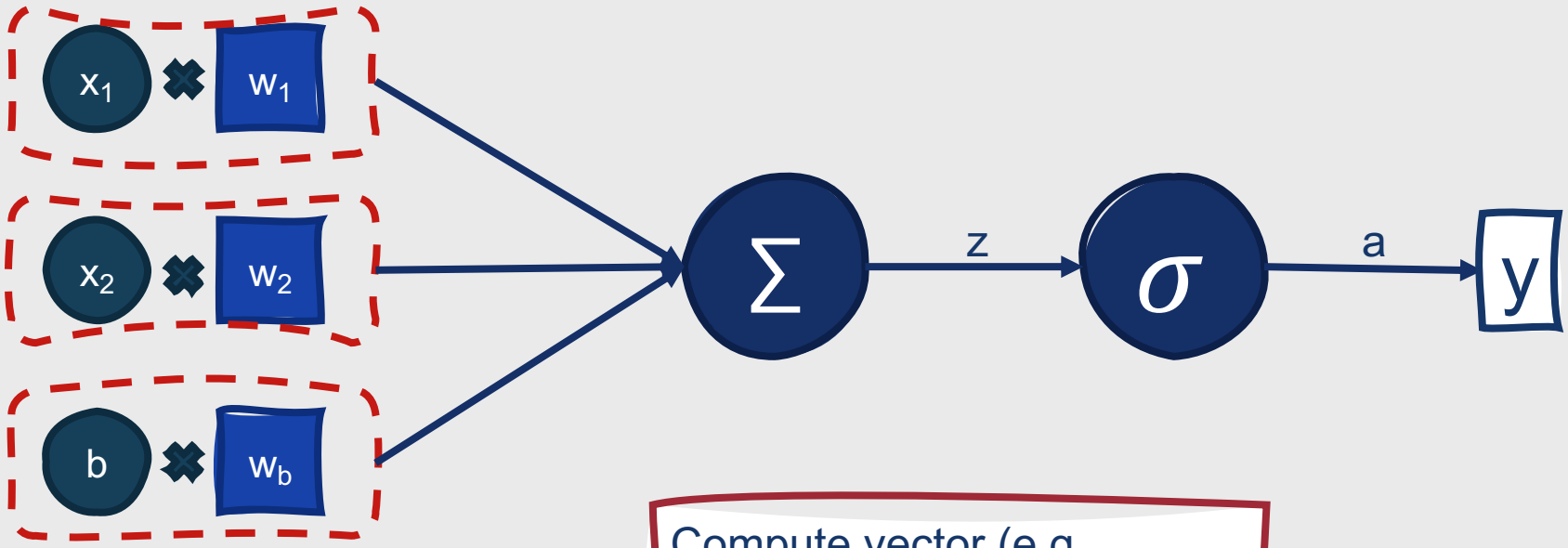

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Compute vector (e.g., averaged Word2Vec embeddings for “beautiful,” “brutalist,” and “architecture”)

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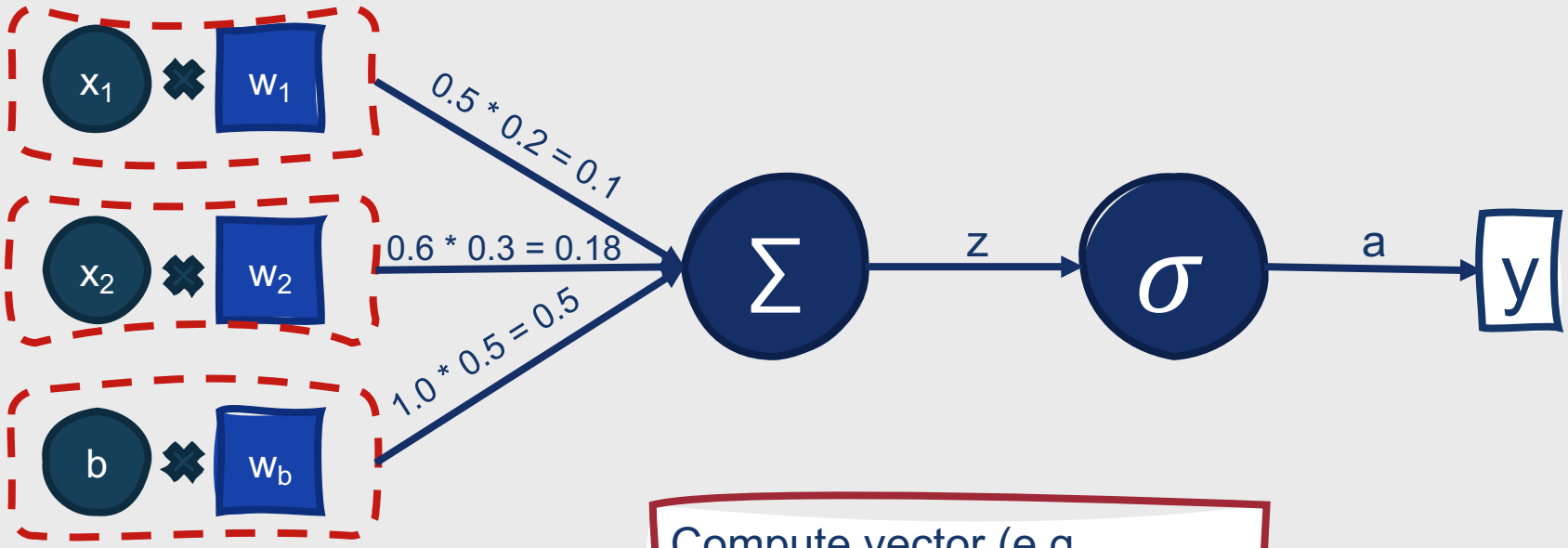

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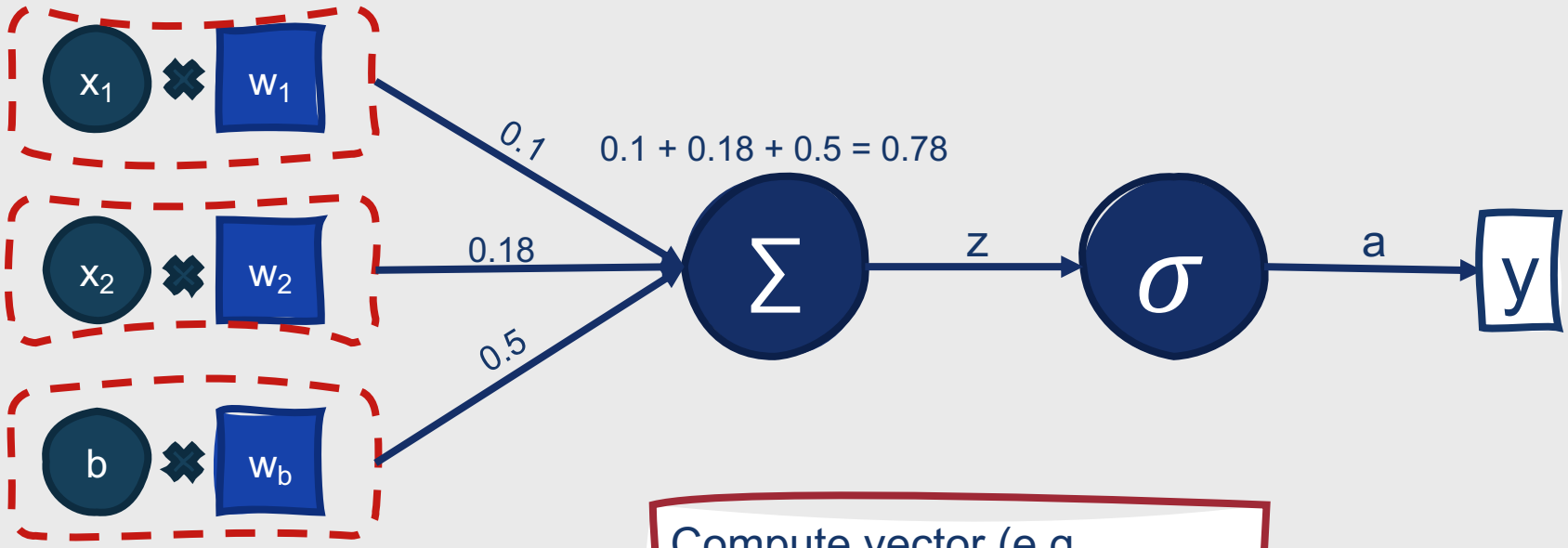

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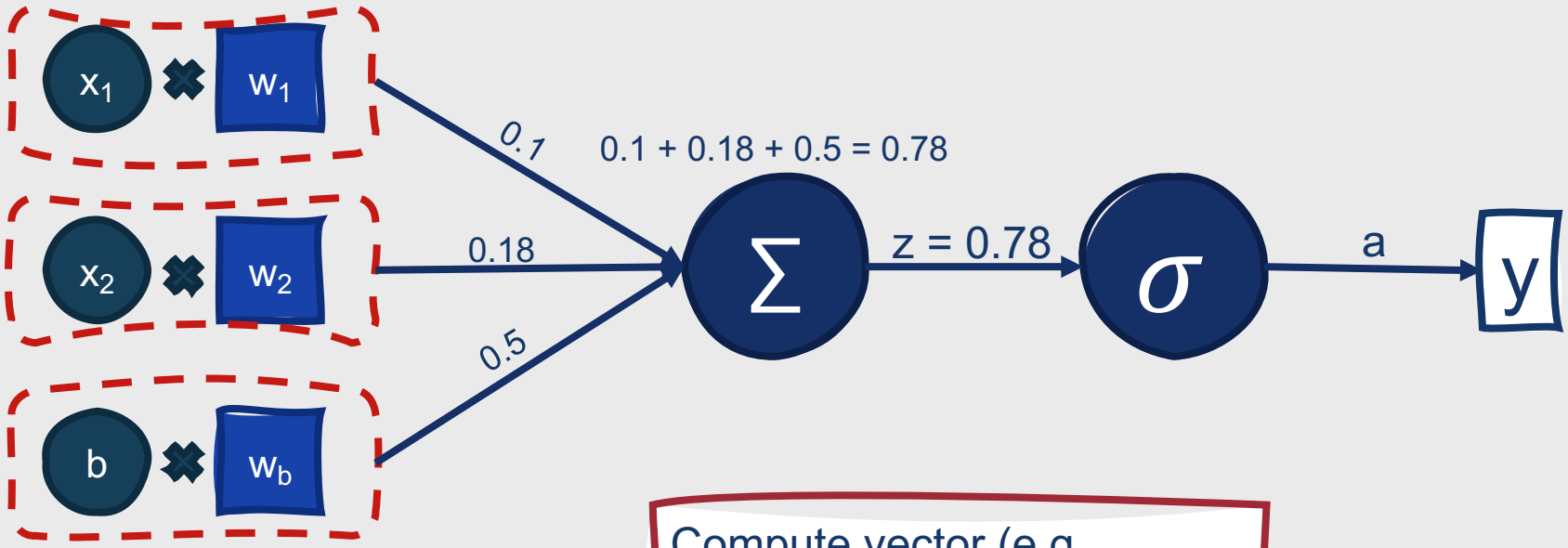

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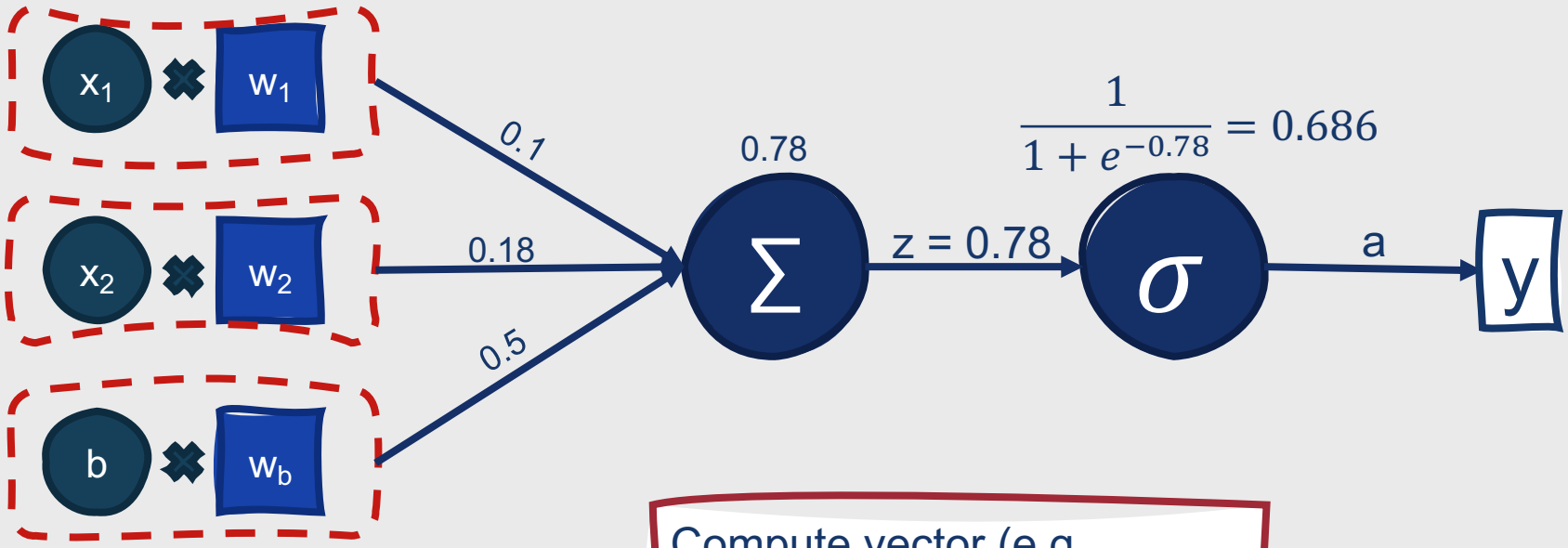

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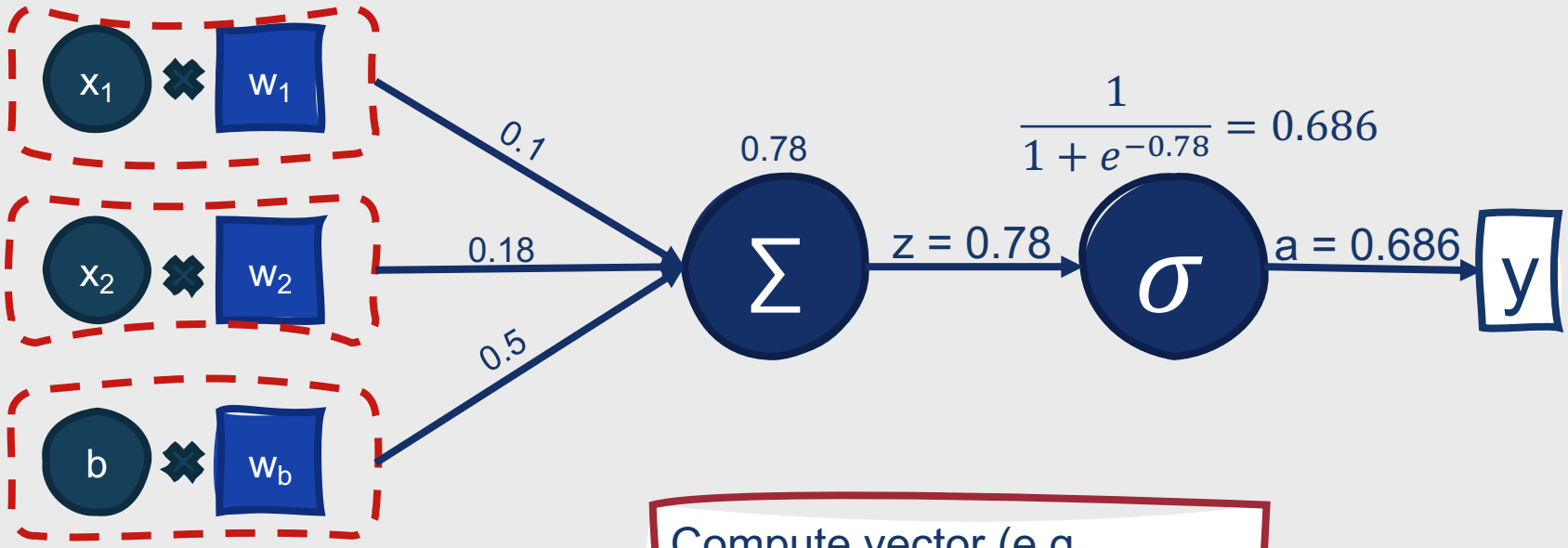

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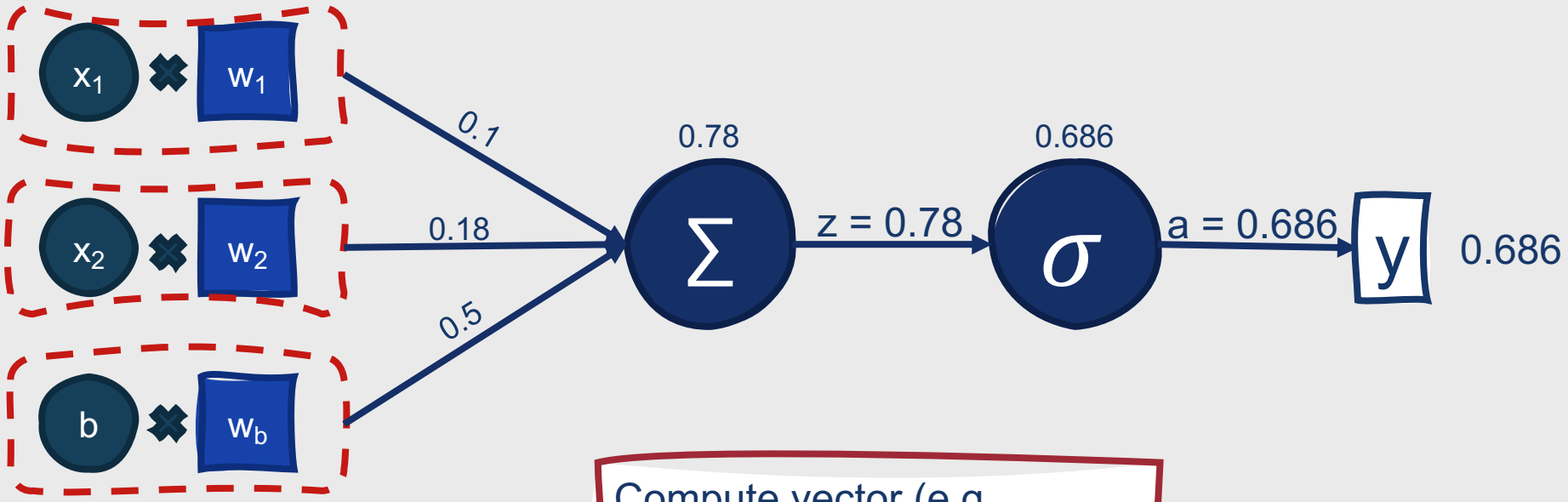

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