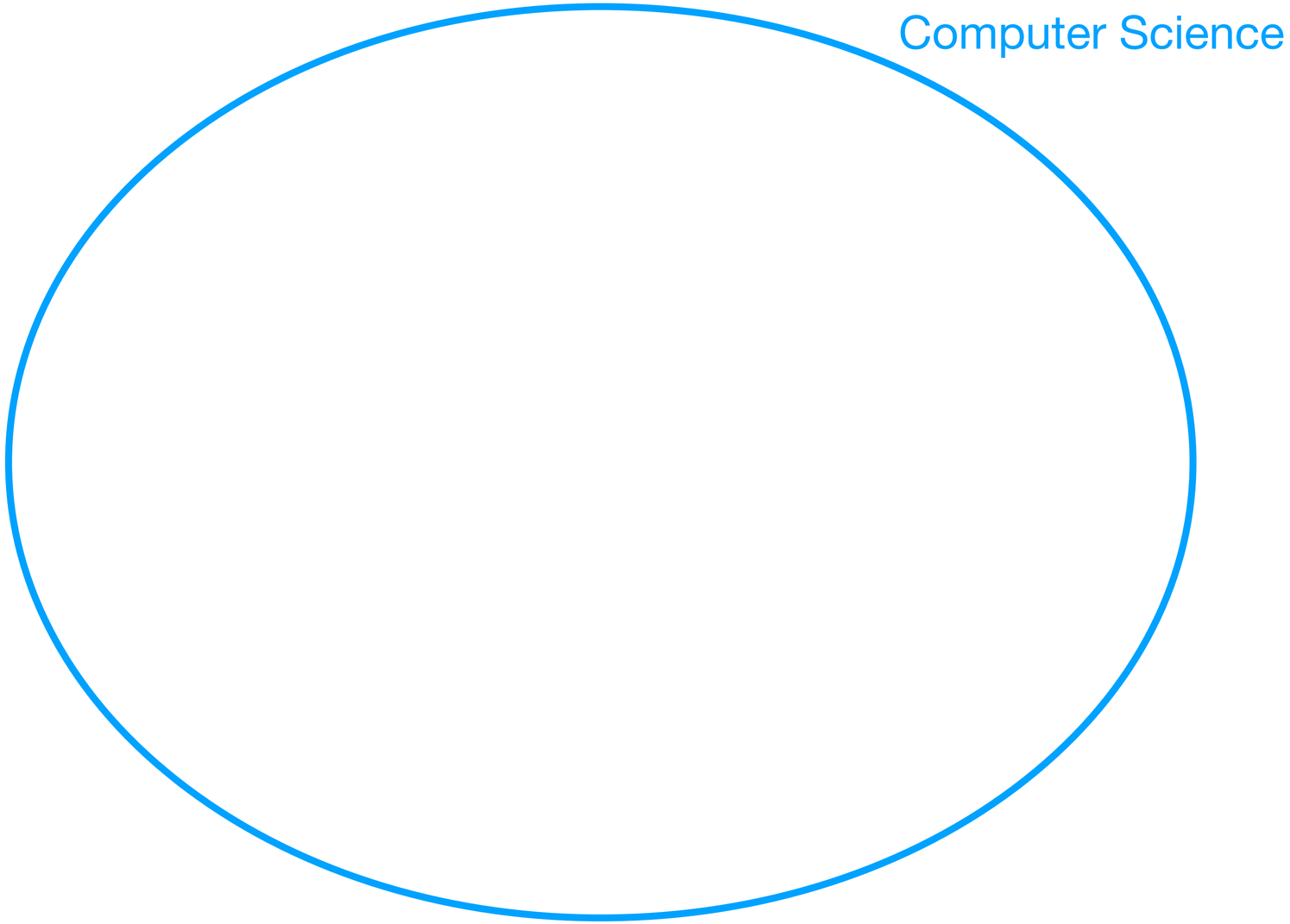
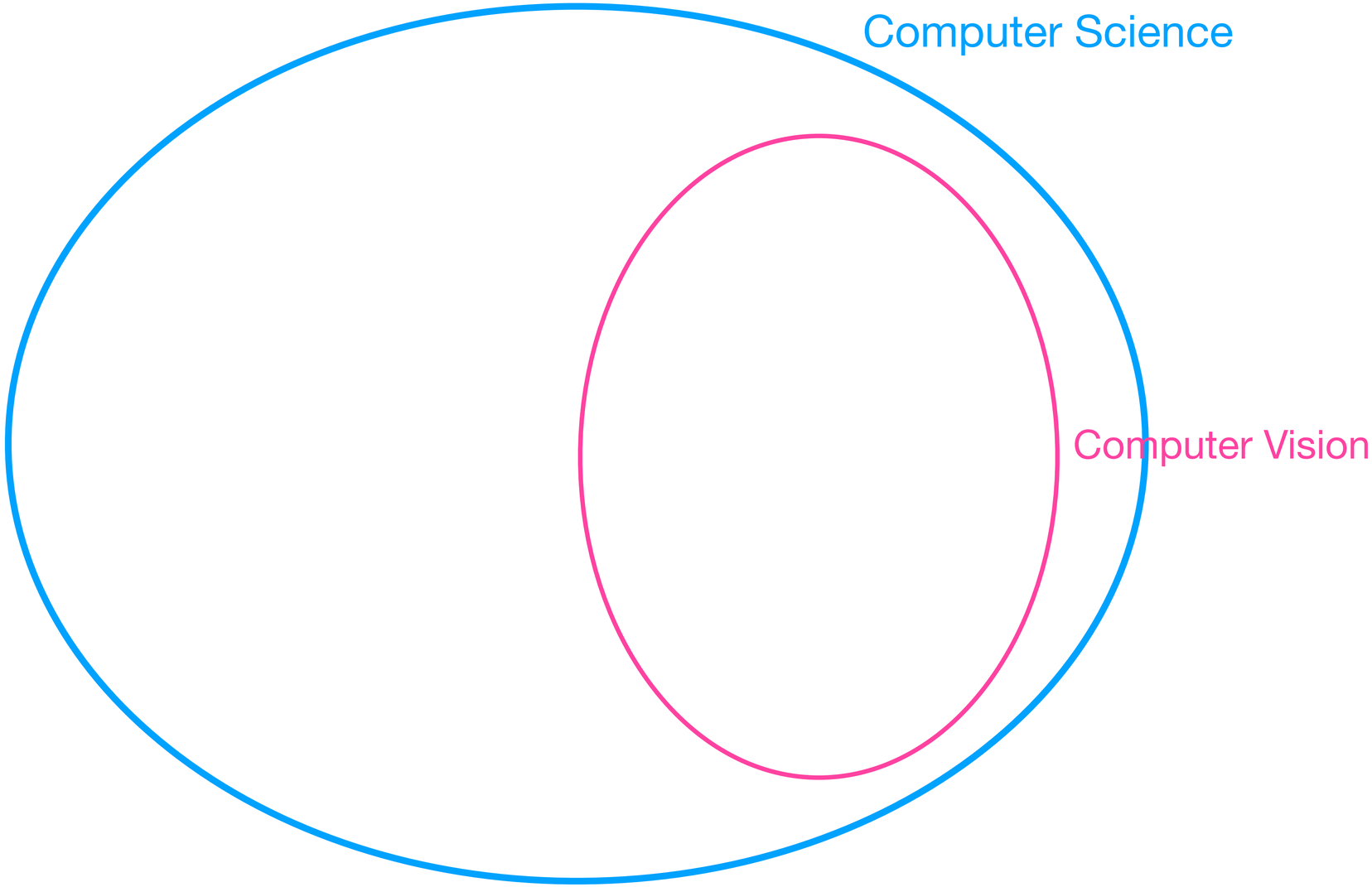
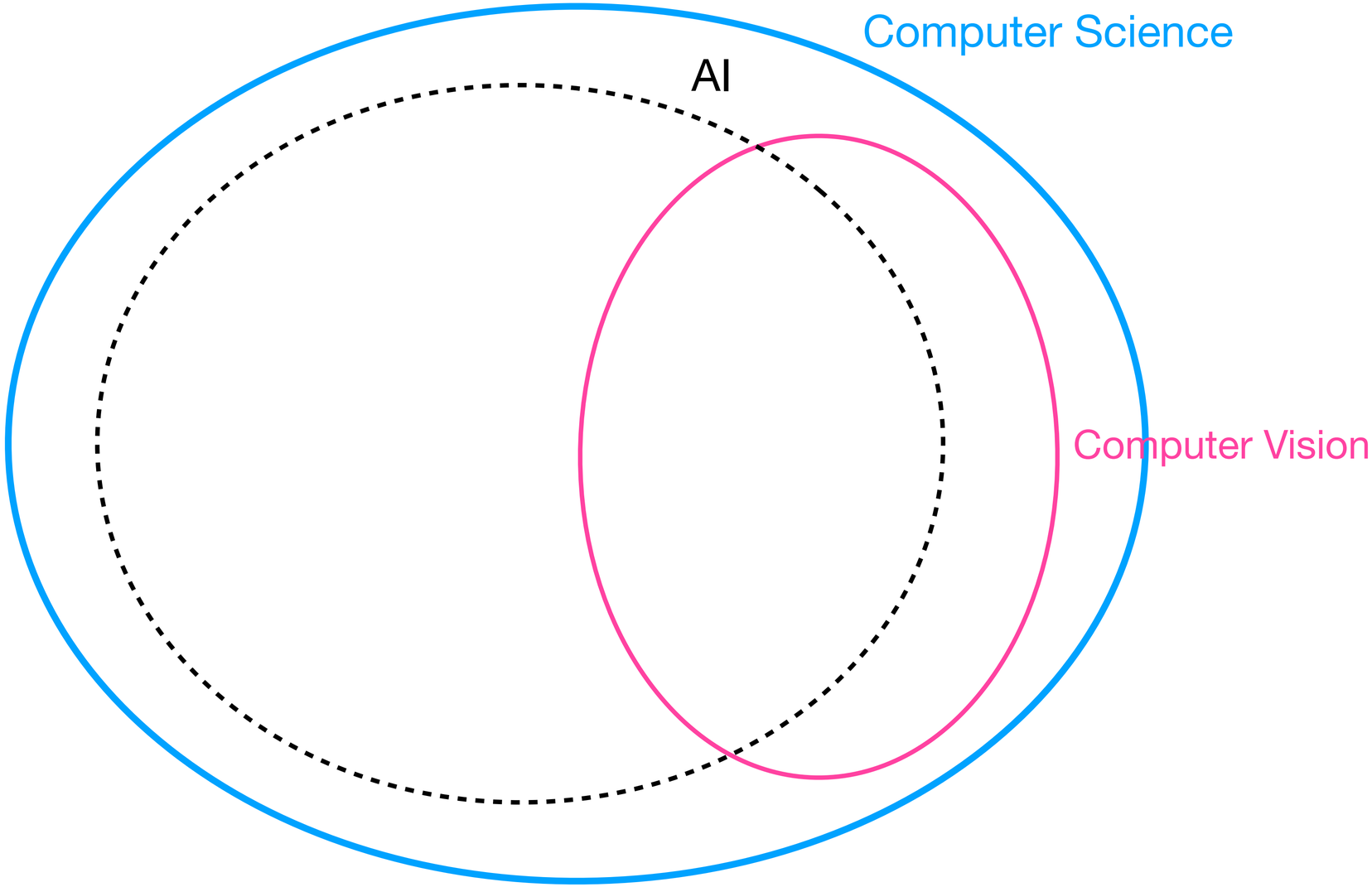
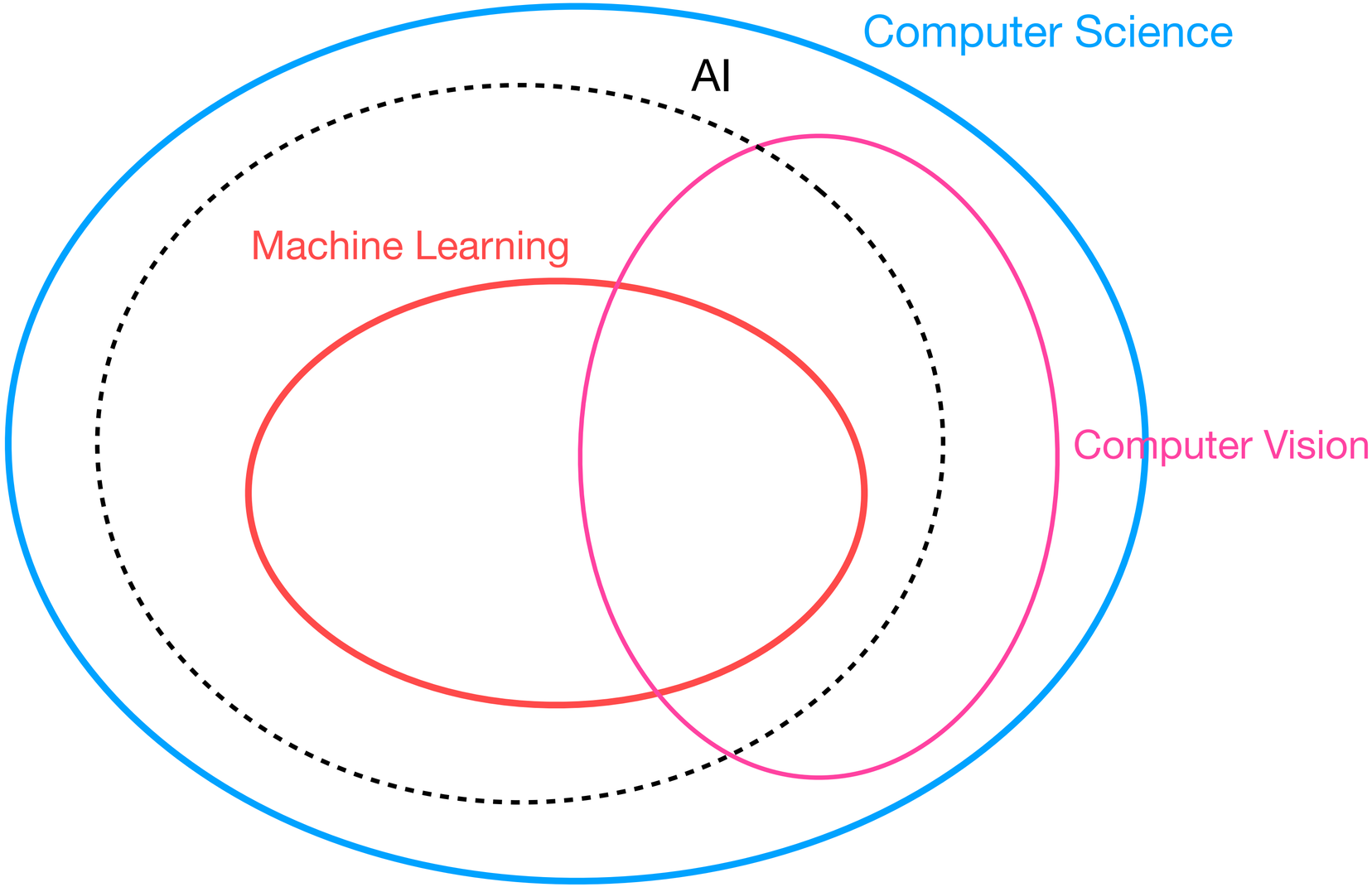
A (very) General Introduction to Deep Learning


Computer Science


Computer Science
Computer Vision


Computer Science
AI
Computer Vision


Computer Science
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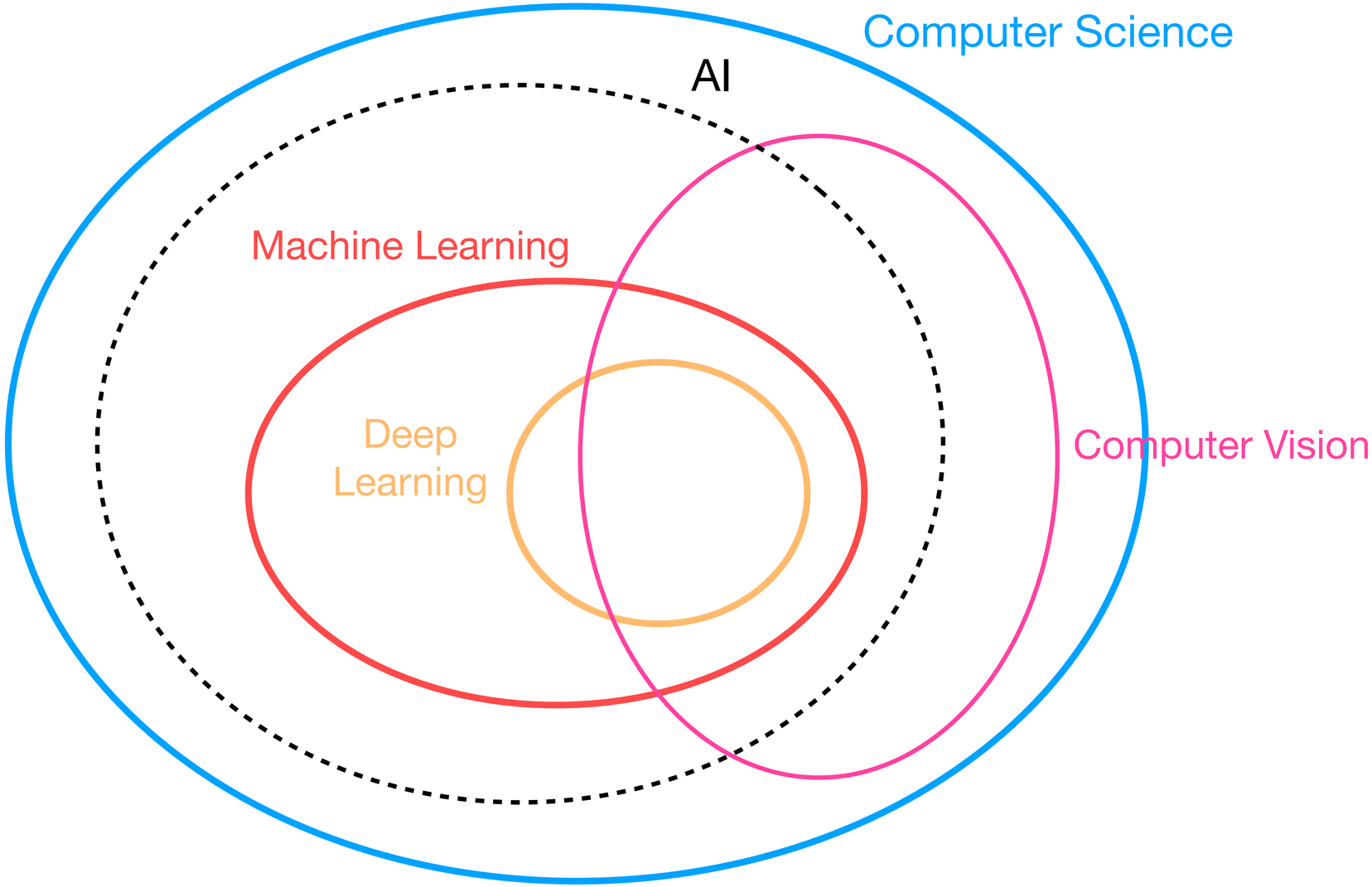
Computer Science
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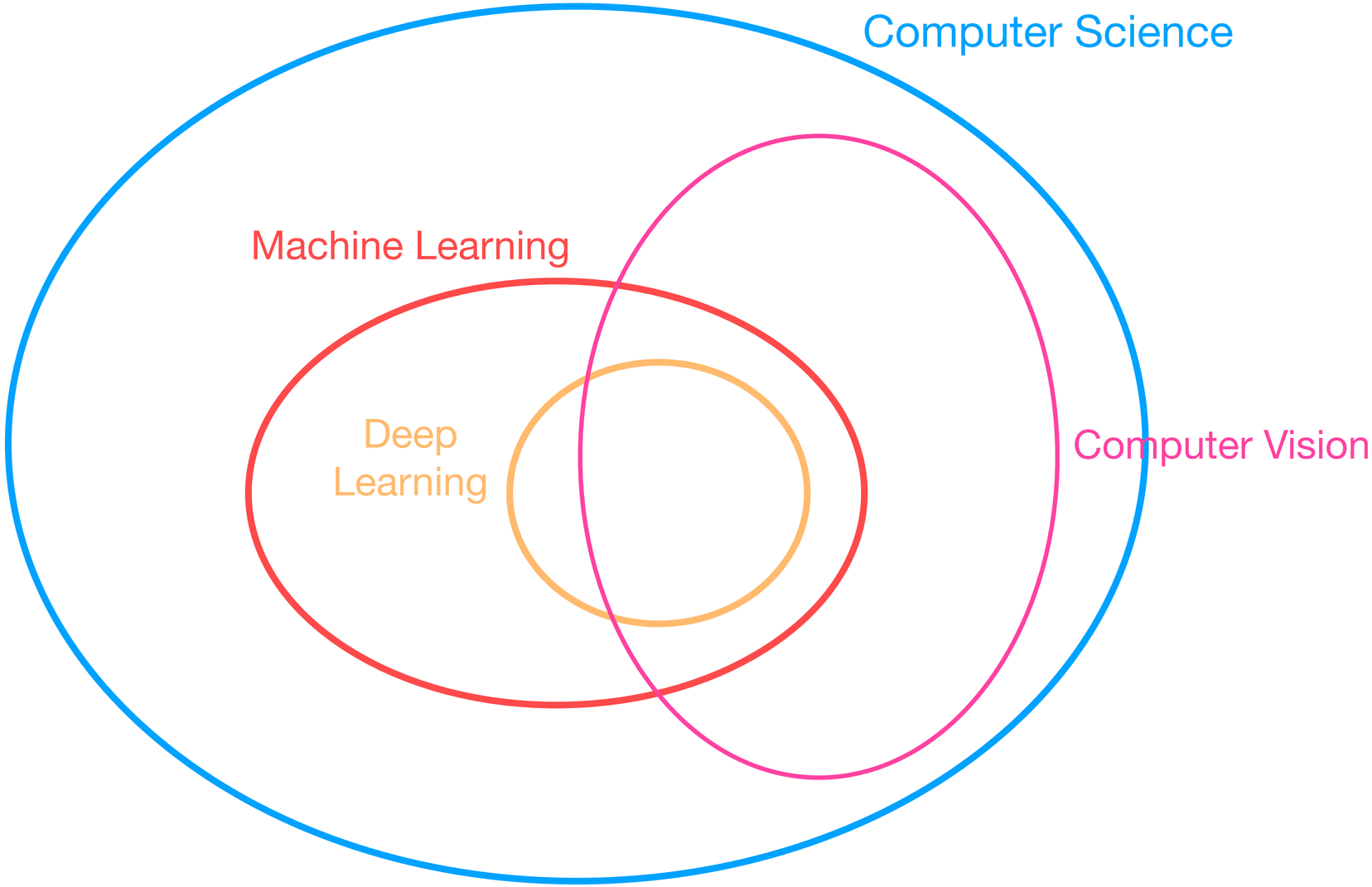
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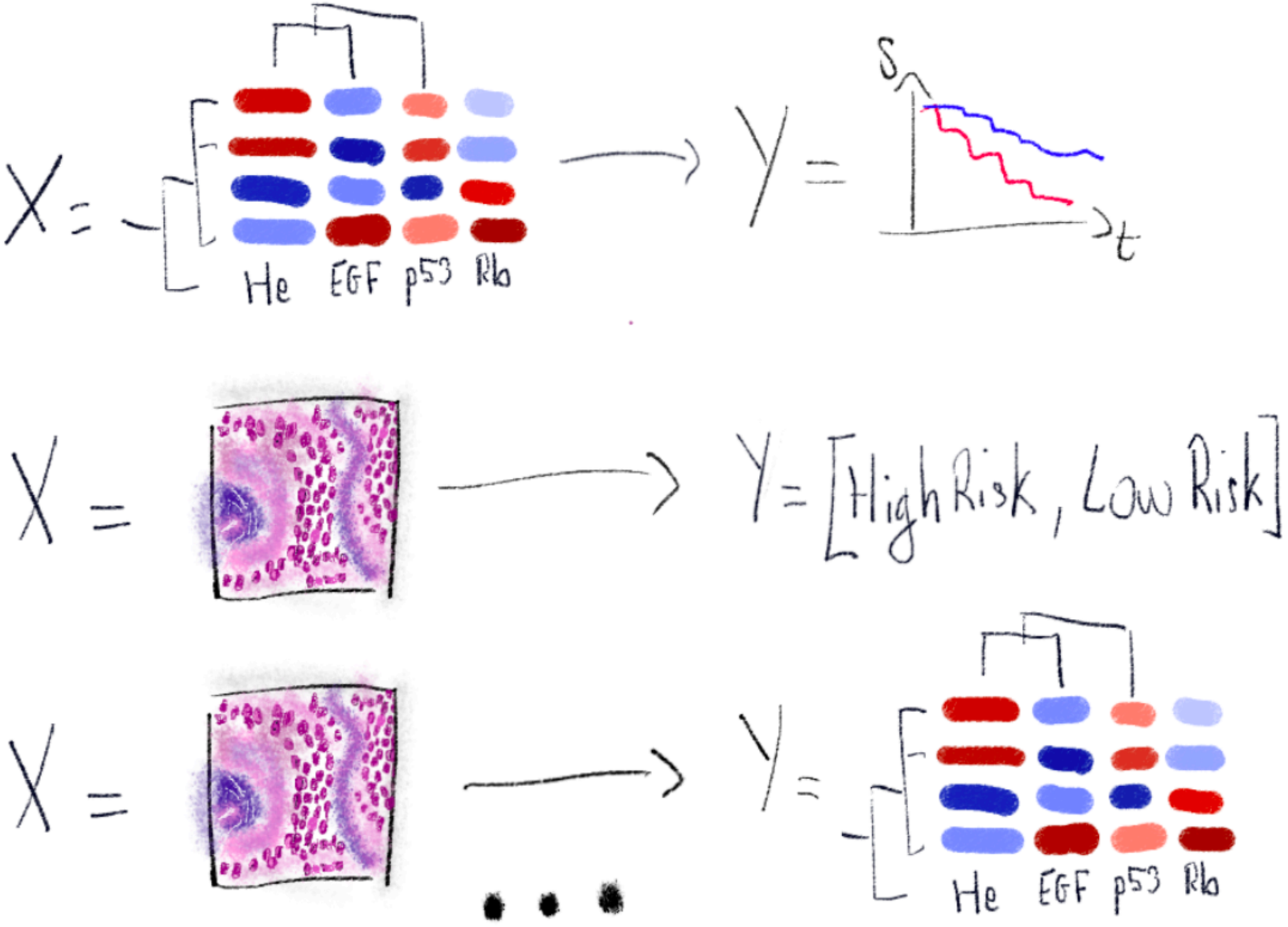
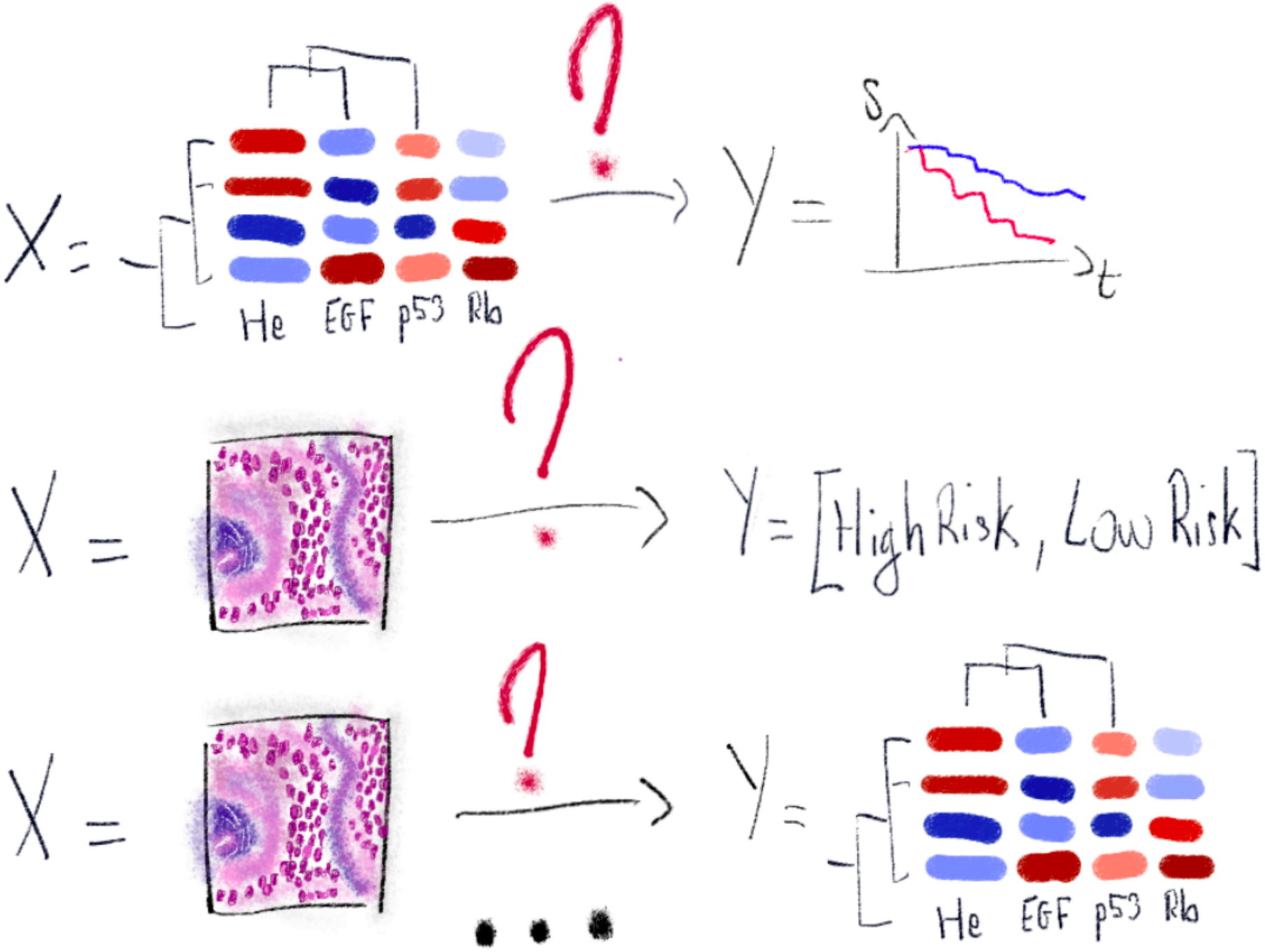
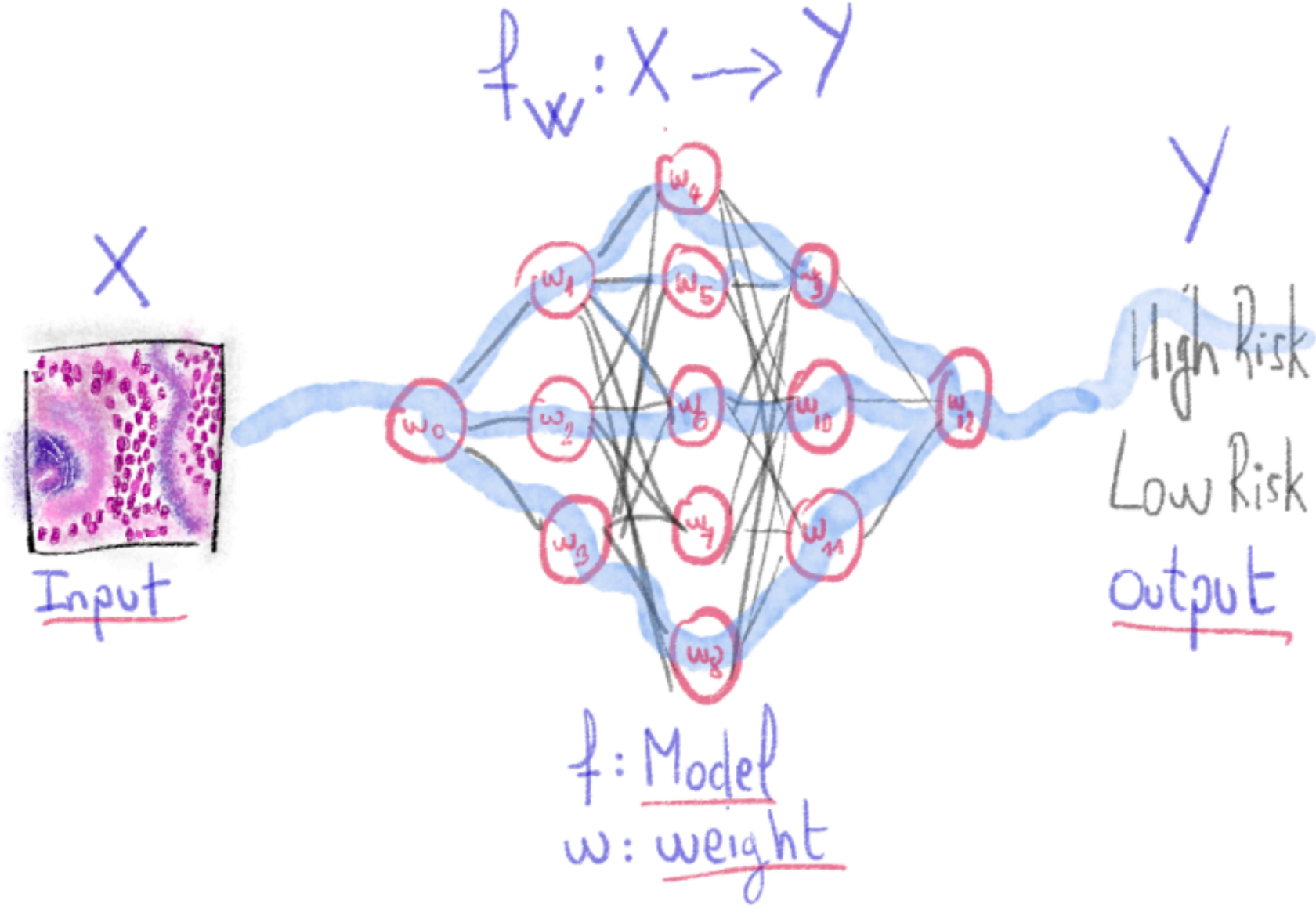
What do you have ? What do you want to do ?



How ?

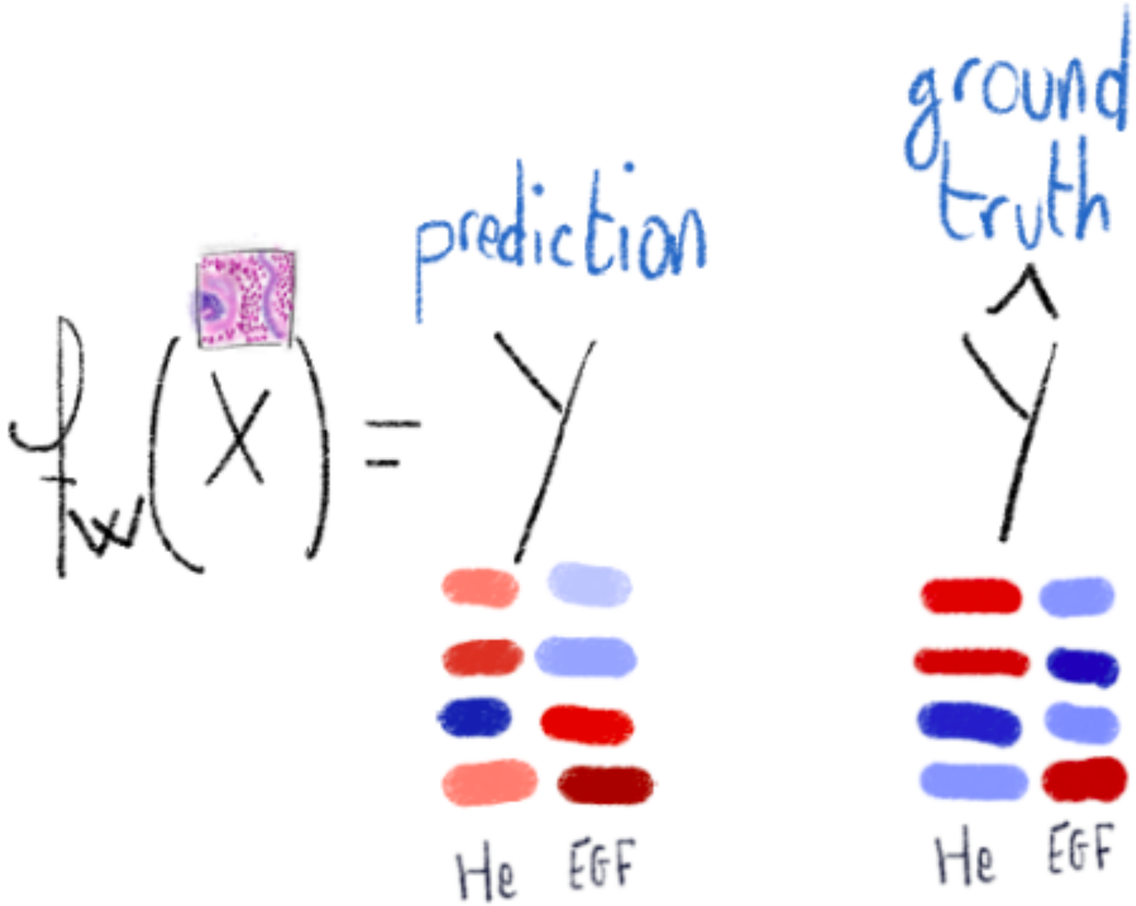


Define a model that you can train

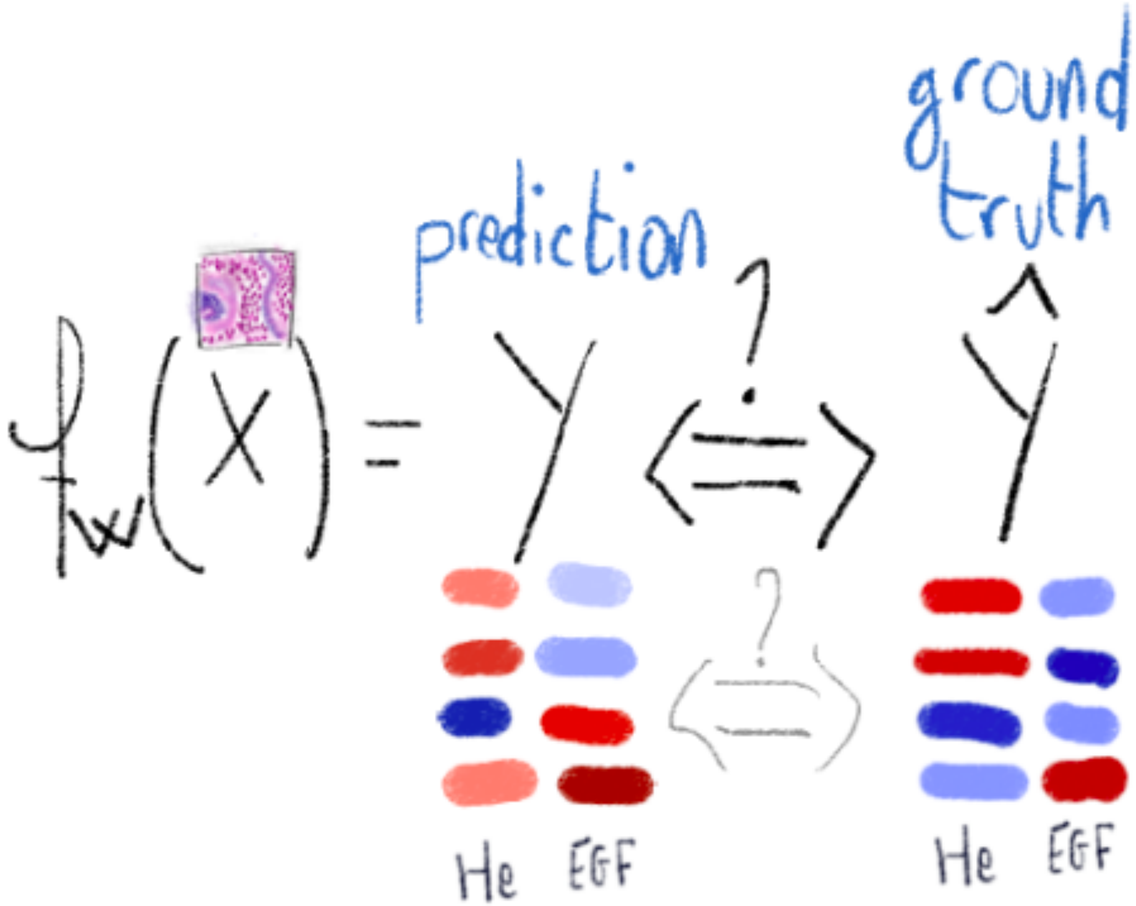


Training means that you need to have some known labels

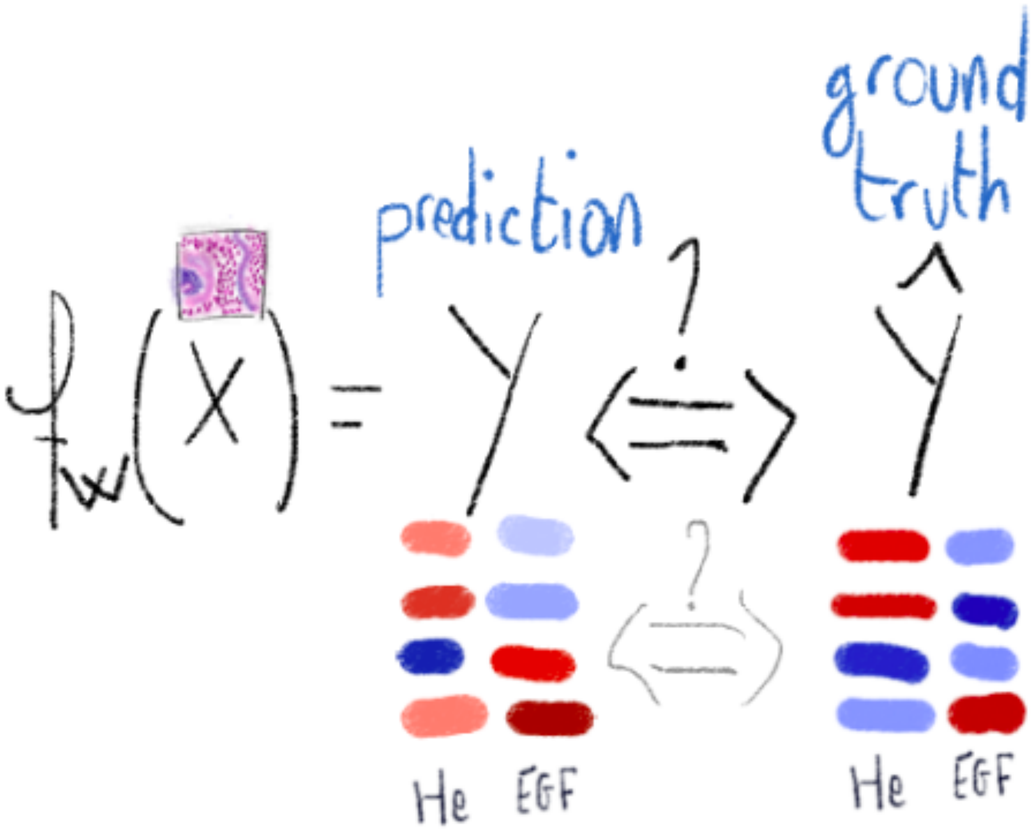
With wich you’re able to compare your model’s prediction



How ?

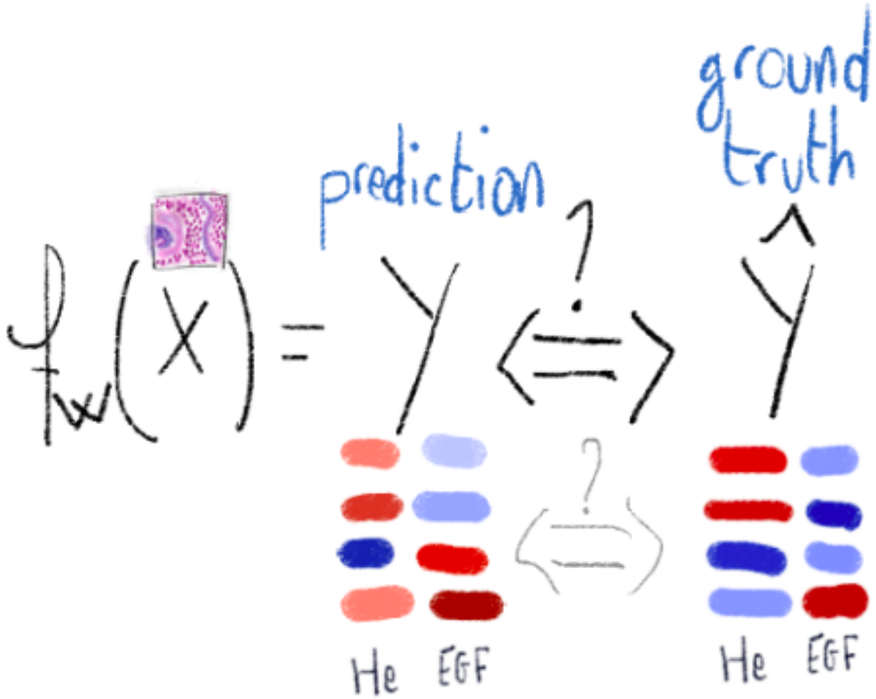


By defining an error function, or objective function, or **Loss**



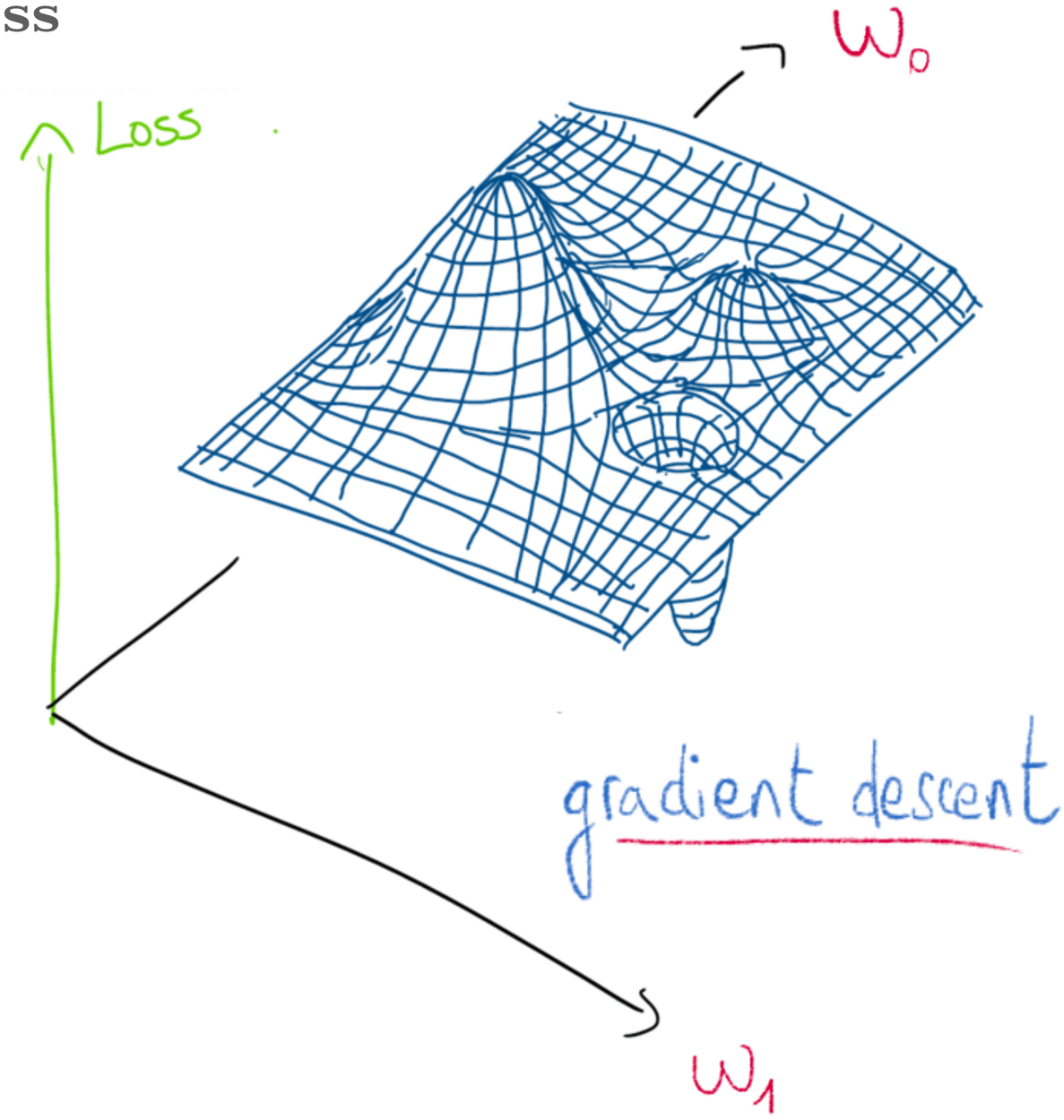
$$\underset{\text{Loss}}{\mathcal{L}} = |Y - \hat{Y}|$$

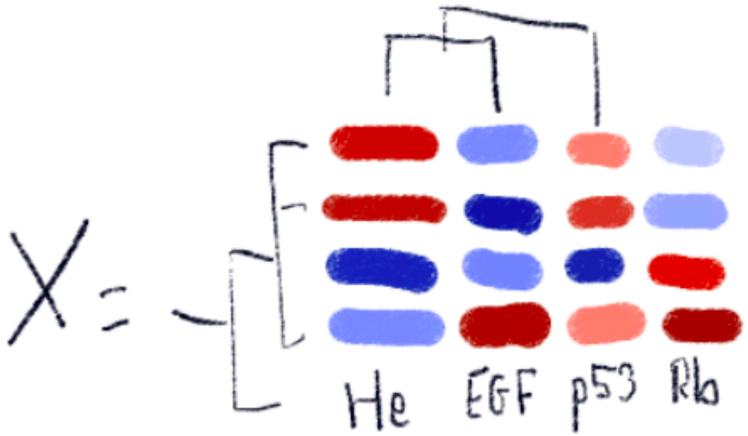
With this, you're going to be able to adapt your model such that it learns how to decreases the Loss



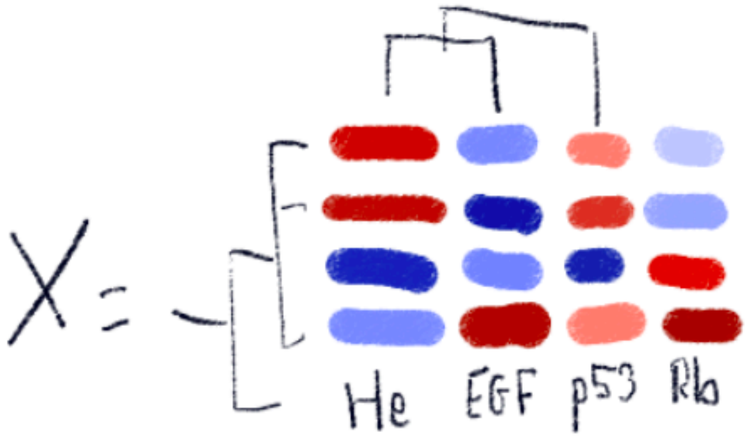
$$\mathcal{L} = |Y - \hat{Y}|$$

Loss

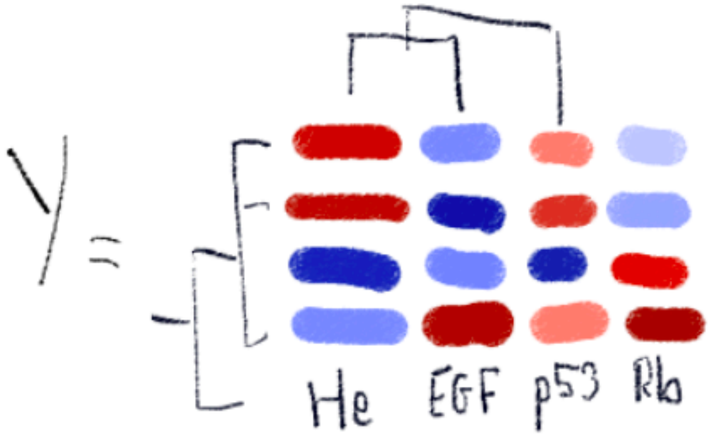




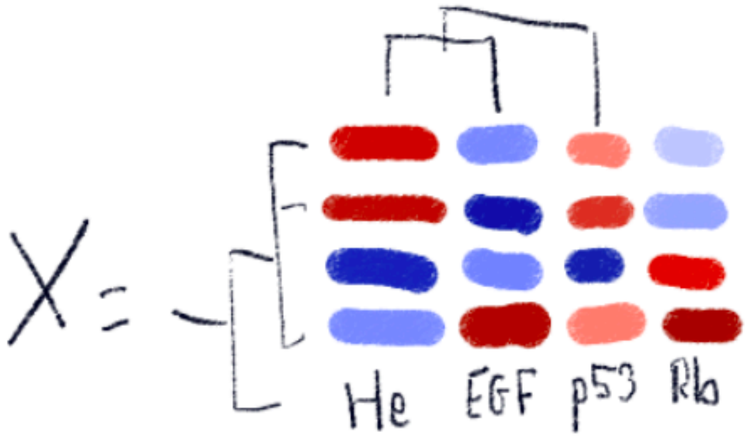
Input Data



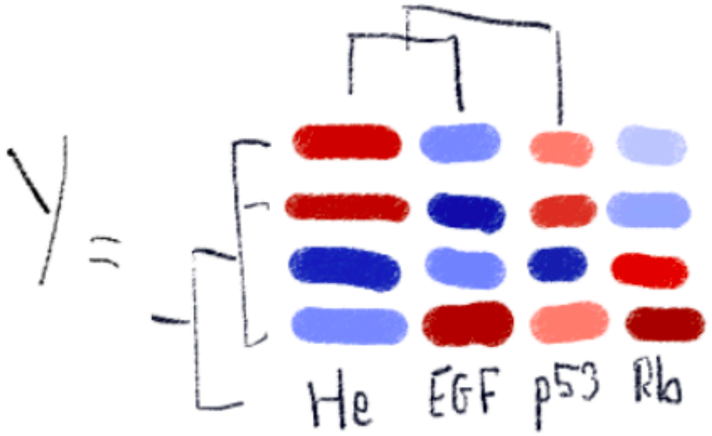
Input Data



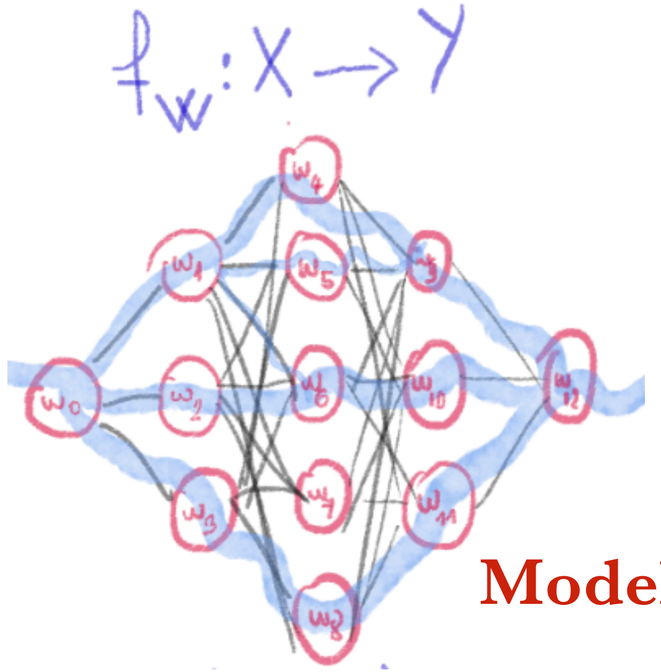
Ground Truth



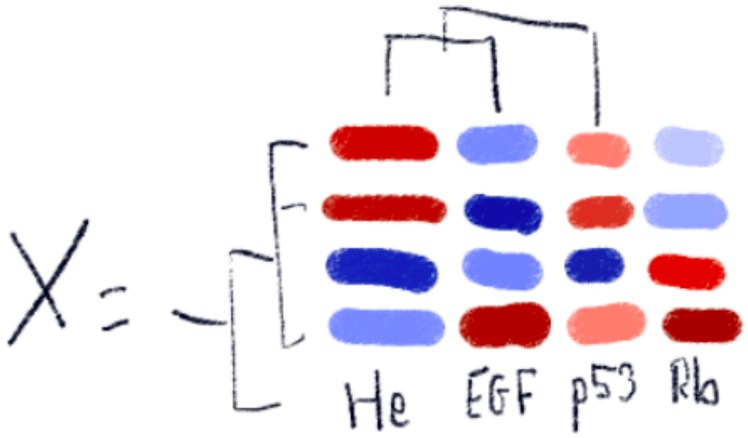
Input Data



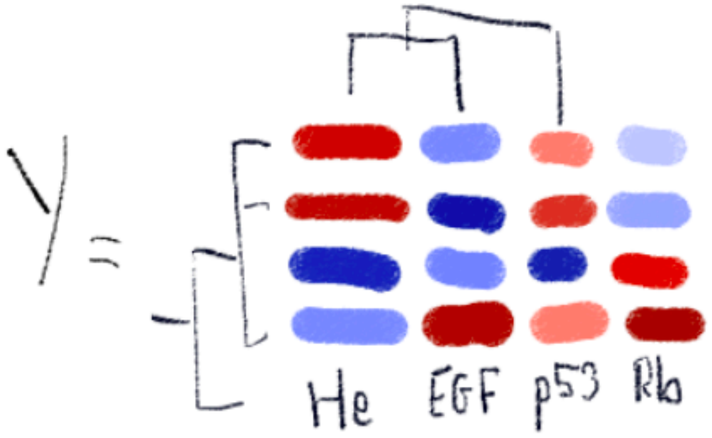
Ground Truth



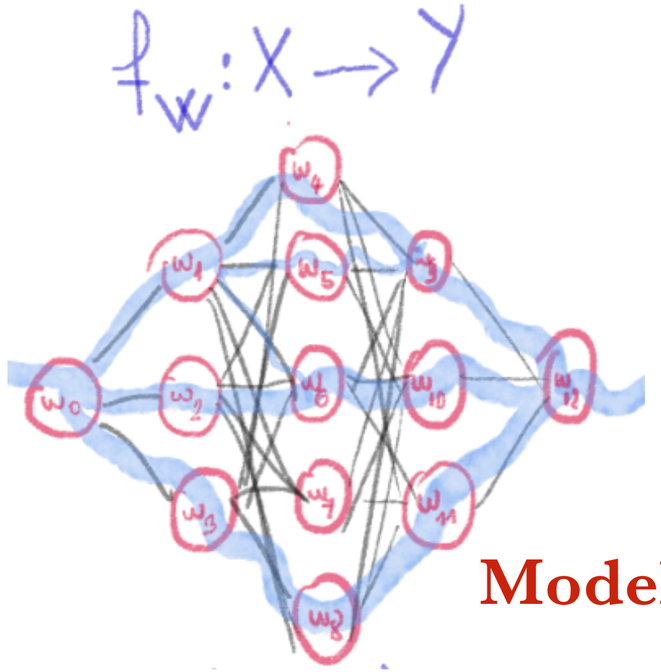
Model



Input Data



Ground Truth

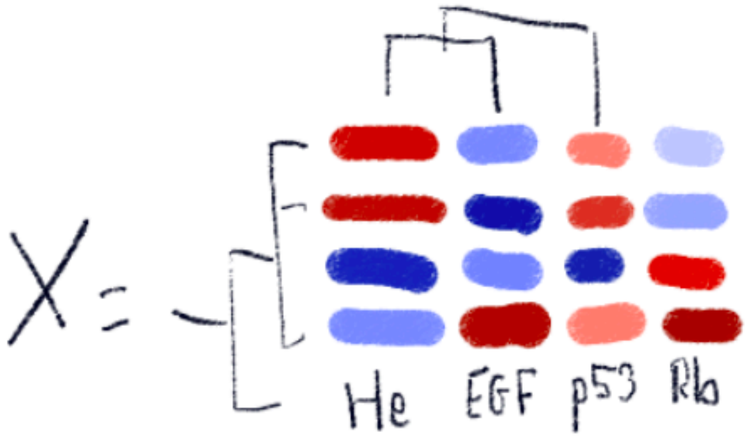


Model

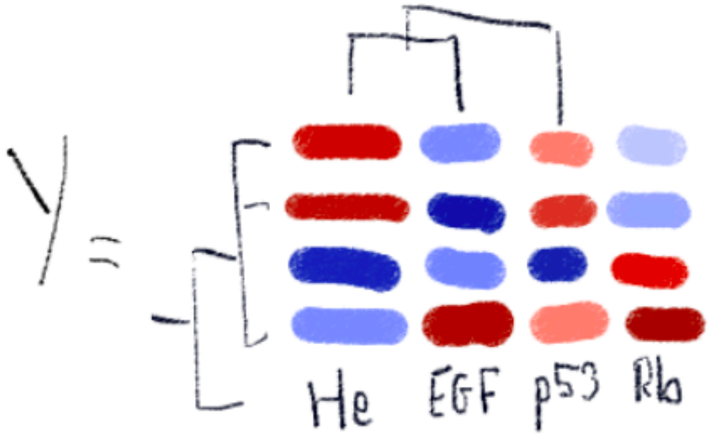
$$\mathcal{L} = |Y - \hat{Y}|$$

Loss

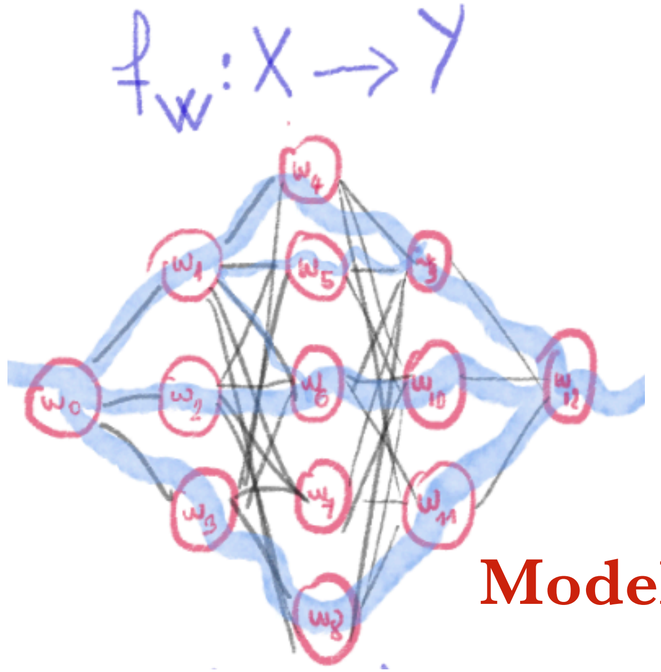
Loss Function



Input Data



Ground Truth



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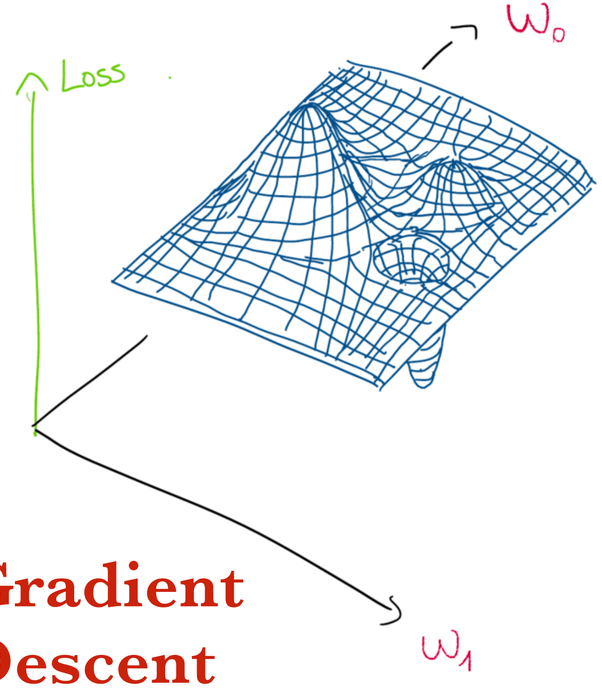
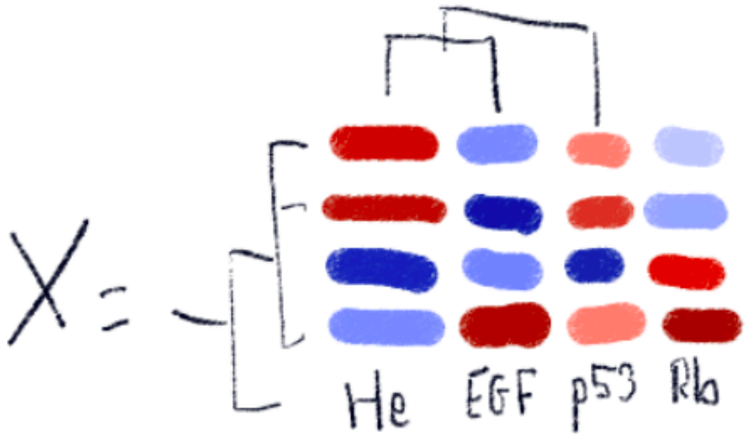
Loss

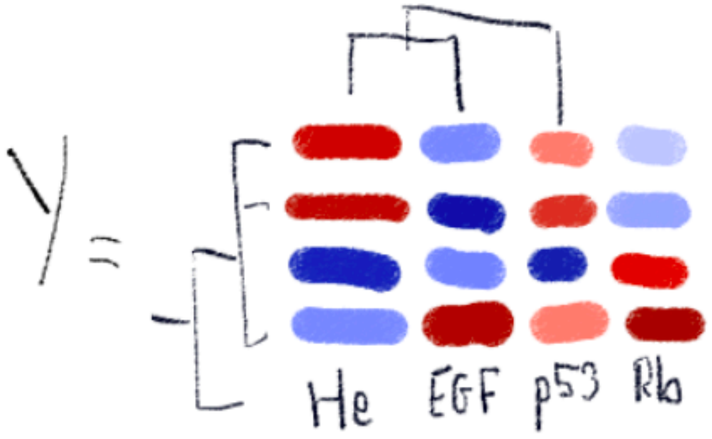
Loss Function



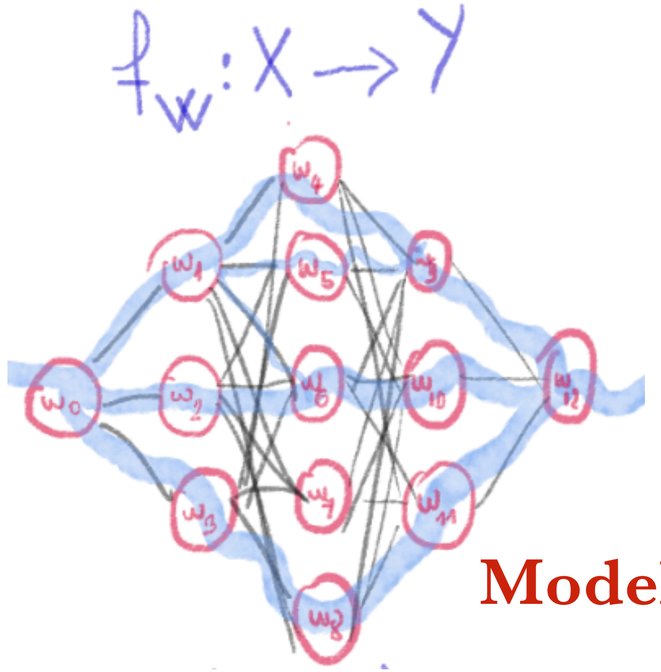
Gradient Descent



Input Data



Ground Truth

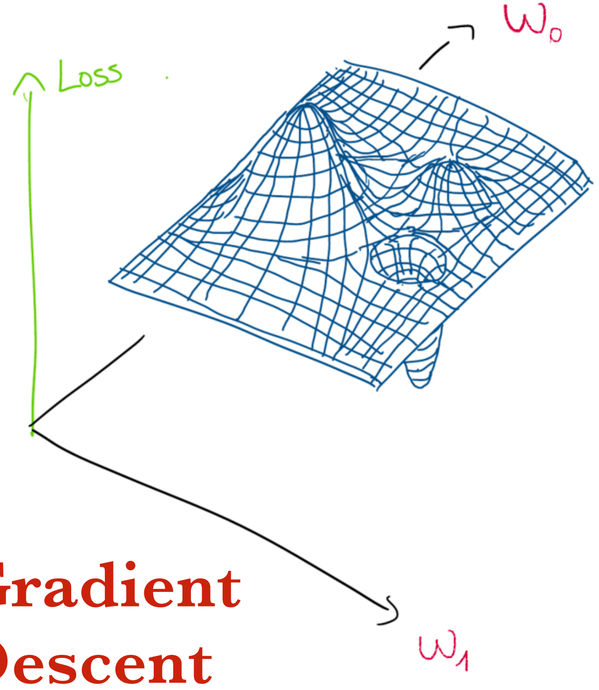


Model

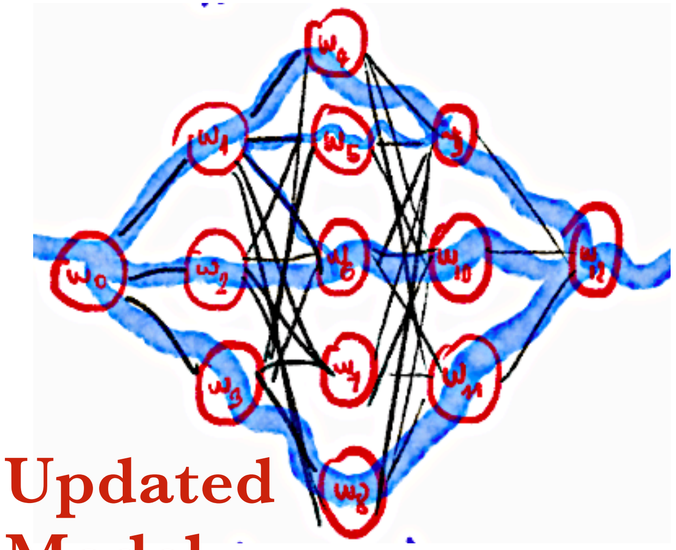
$$\mathcal{L} = |Y - \hat{Y}|$$

Loss

Loss Function



Gradient Descent



Updated Model

➡ Define your **dataset**, input X, ground truth/labels Y

➡ Define your **architecture/model**, $f_{\mathscr{W}} : x \rightarrow \hat{y}$

➡ Define the **loss** of your model: $\mathscr{L} = \hat{y} - y$

Hyper-parameters definition

➡ **Predict** a batch of data: $\hat{y} = f(x)$

➡ Compute the **loss** on the batch

➡ Use **stochastic gradient descent** to update your weights:

➡ Repeat until **convergence**

Training

➡ Test the **accuracy** on some test data

Testing

➡ Define your **dataset**, input X, ground truth/labels Y

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Hyper-parameters definition

➡ **Predict** a batch of data: $\hat{y} = f(x)$

➡ Compute the **loss** on the batch

➡ Use **stochastic gradient descent** to update your weights: $\mathscr{W}_{t+1} = \mathscr{W}_t + \lambda \frac{\partial \mathscr{L}}{\partial \mathscr{W}_t}$

➡ Repeat until **convergence**

Training

➡ Test the **accuracy** on some test data

Testing

➡ Define your **dataset**, input X, ground truth/labels Y

➡ Define your **architecture/model**, $f_{\mathscr{W}} : x \rightarrow \hat{y}$

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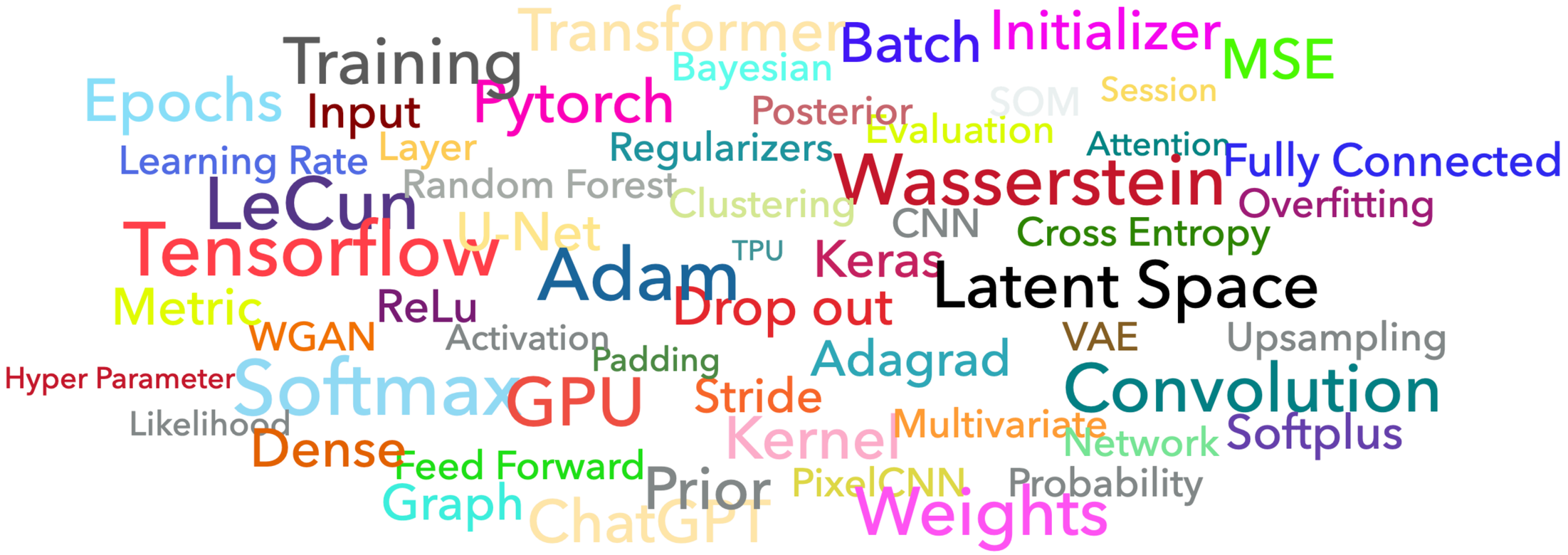
Training

➡ Test the **accuracy** on some test data

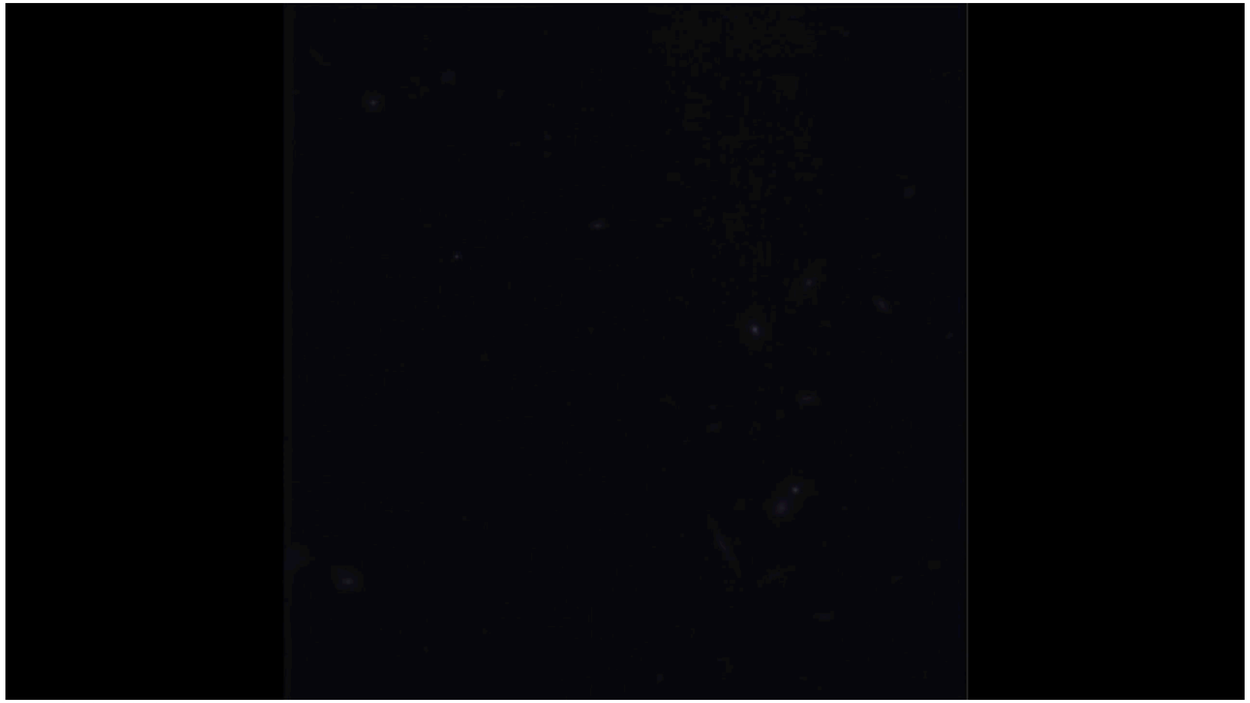
Testing

From here, you have basically all the steps to build models such as Chat-GPT…

What you'll have to do, is to increase the complexity of each of the steps. Let's explore some of them.

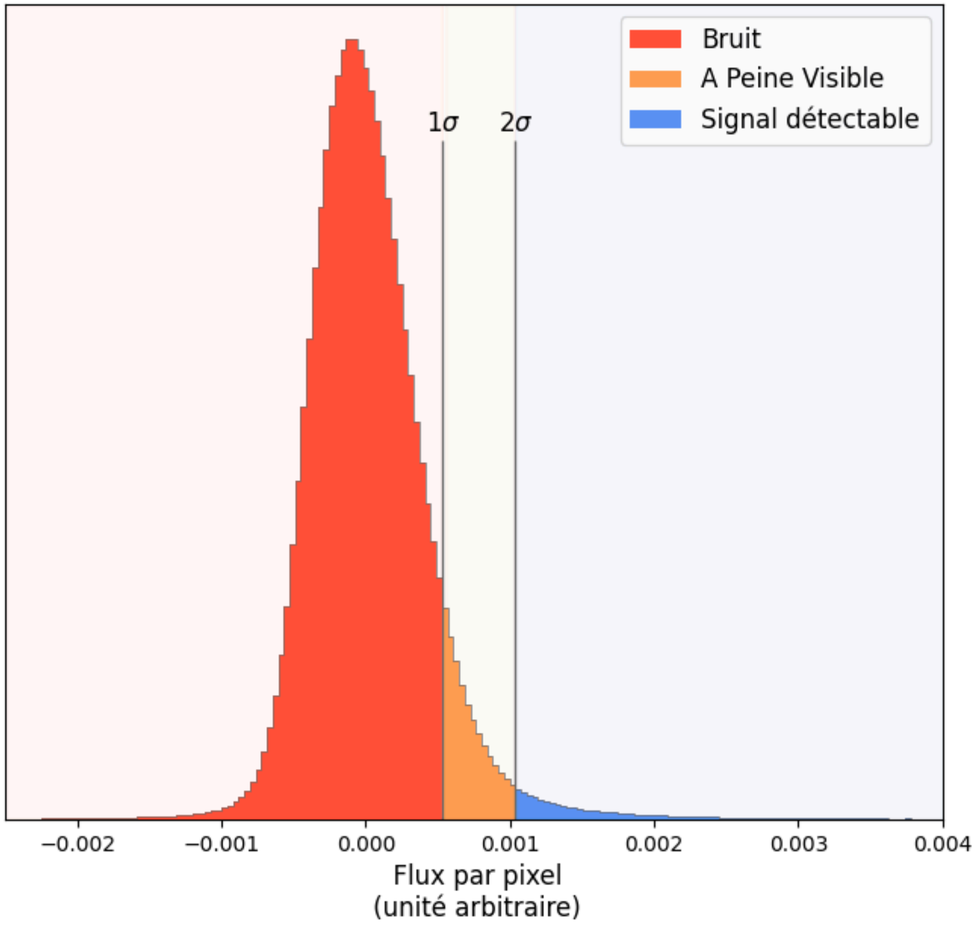


1- Your Data



sorry for the galaxies…

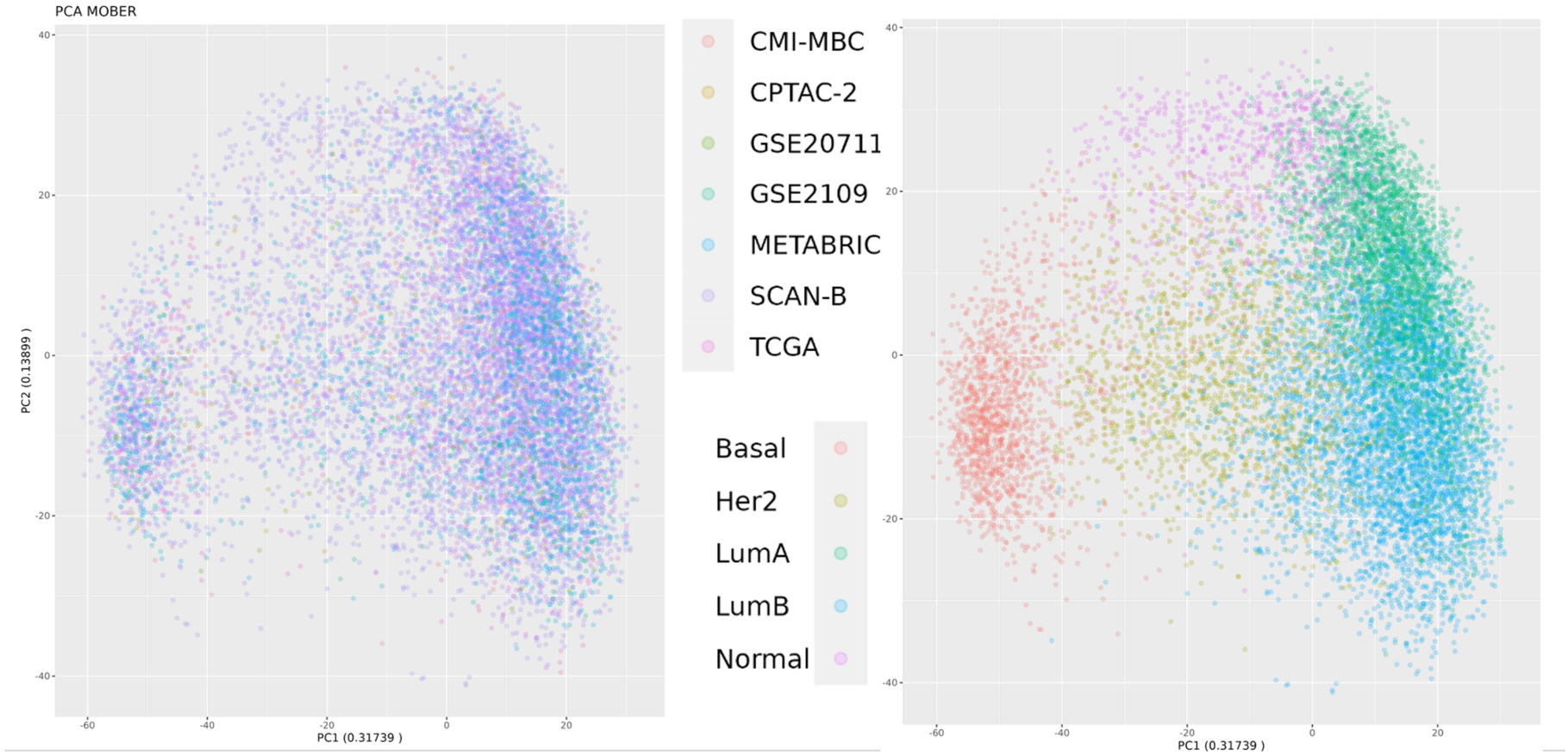
pardon my french…



Normalisation / dynamic range / cleaning / gold sample…

1- Your Data

Courtesy to Arnau

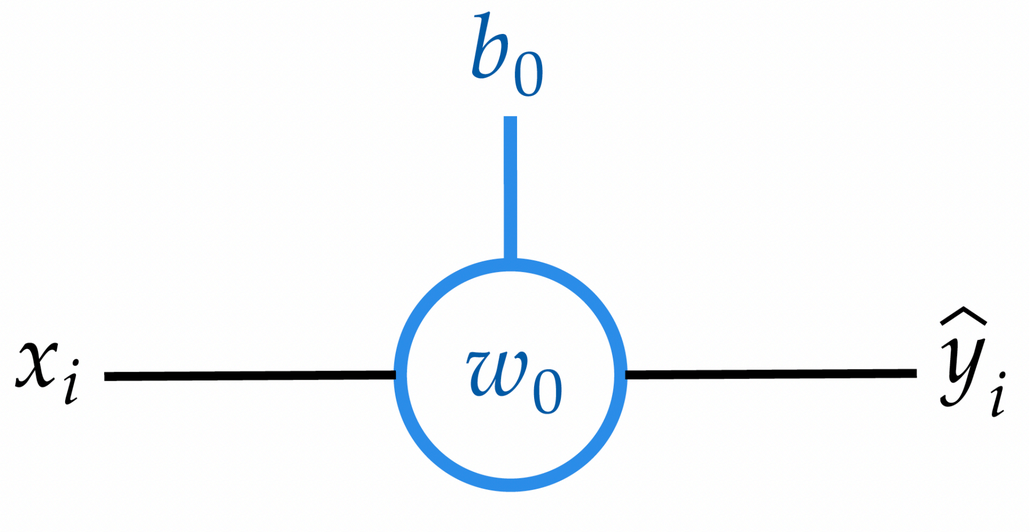


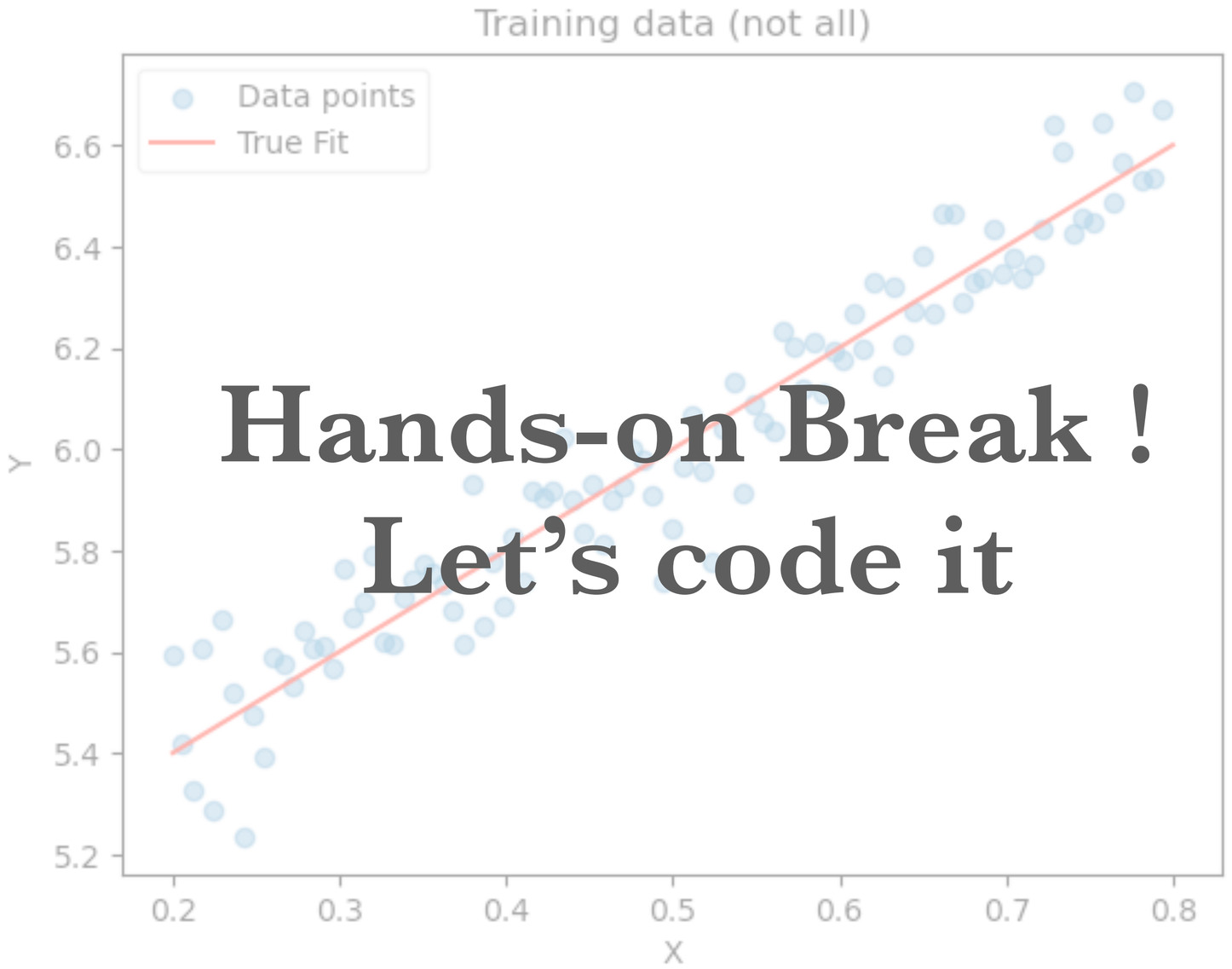
Batch effect / Normalisation / dynamic range / cleaning / gold sample…

2- Your Model

$$f(x) = w_0 x + b_0$$

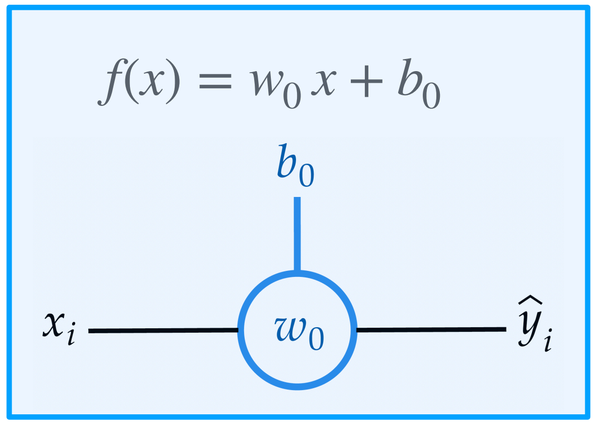
Neuron (almost)



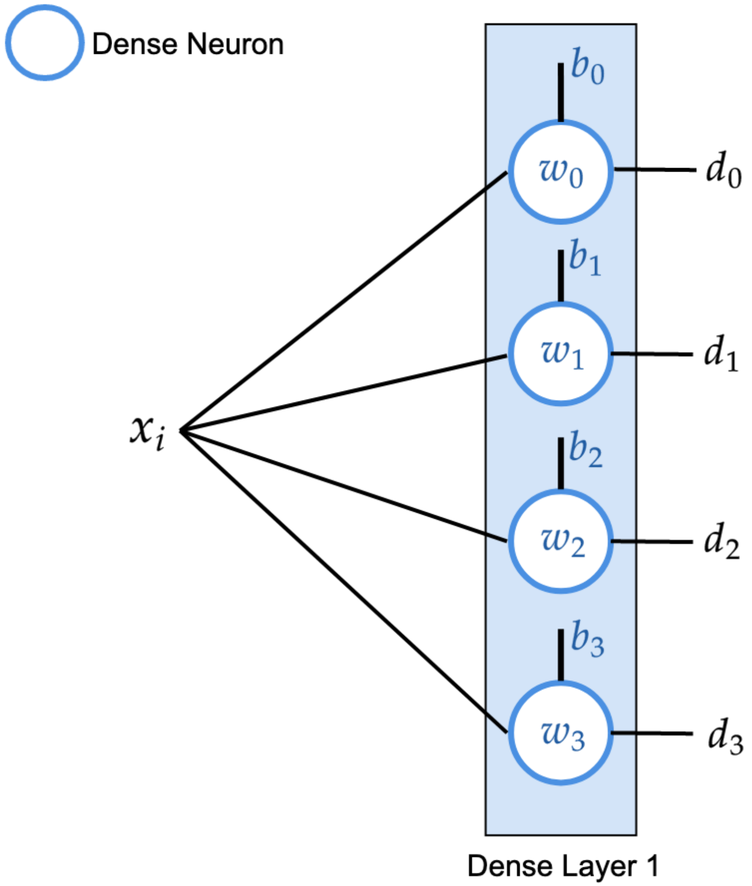


Hands-on Break !
Let’s code it

2- Your Model

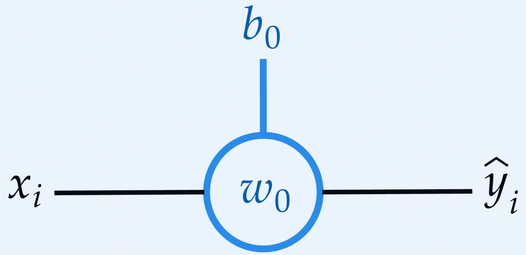


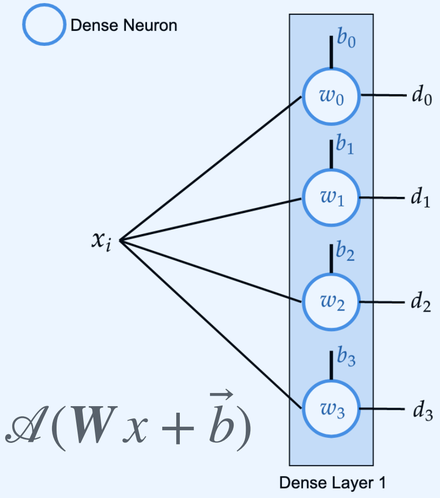
$$f(x) = \mathscr{A}(\boldsymbol{W}\,x + \vec{b})$$



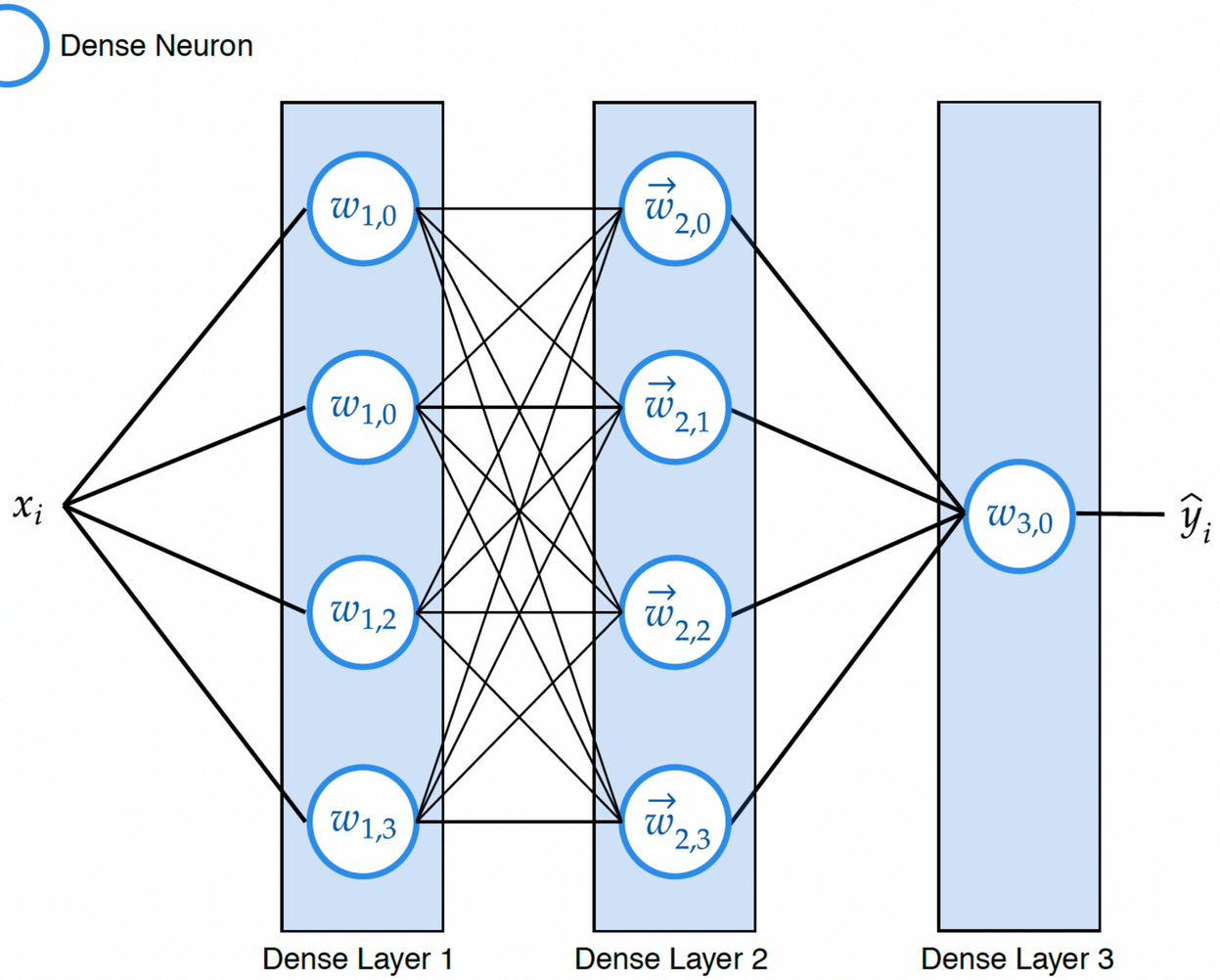
2- Your Model

$$f(x) = w_0\, x + b_0$$



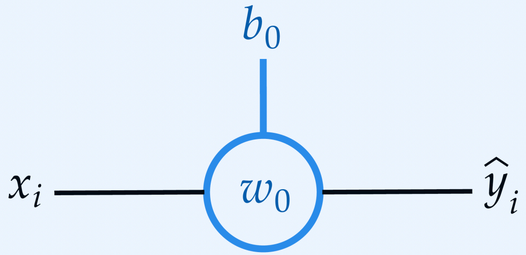


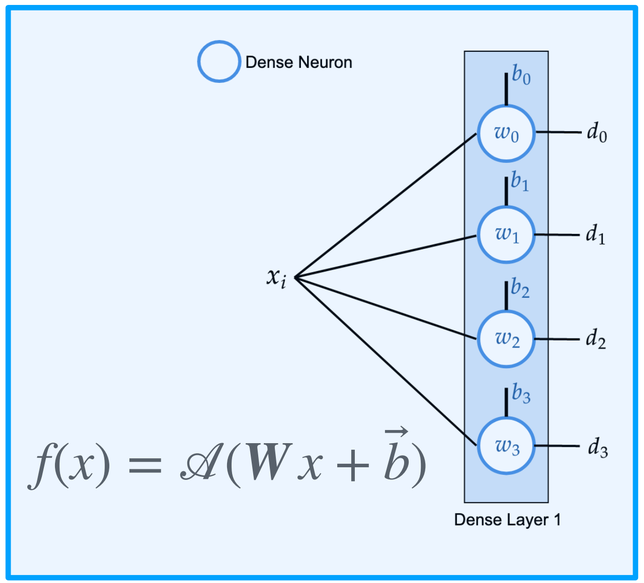
$$f(x) = \mathcal{A}(W\, x + \vec{b})$$

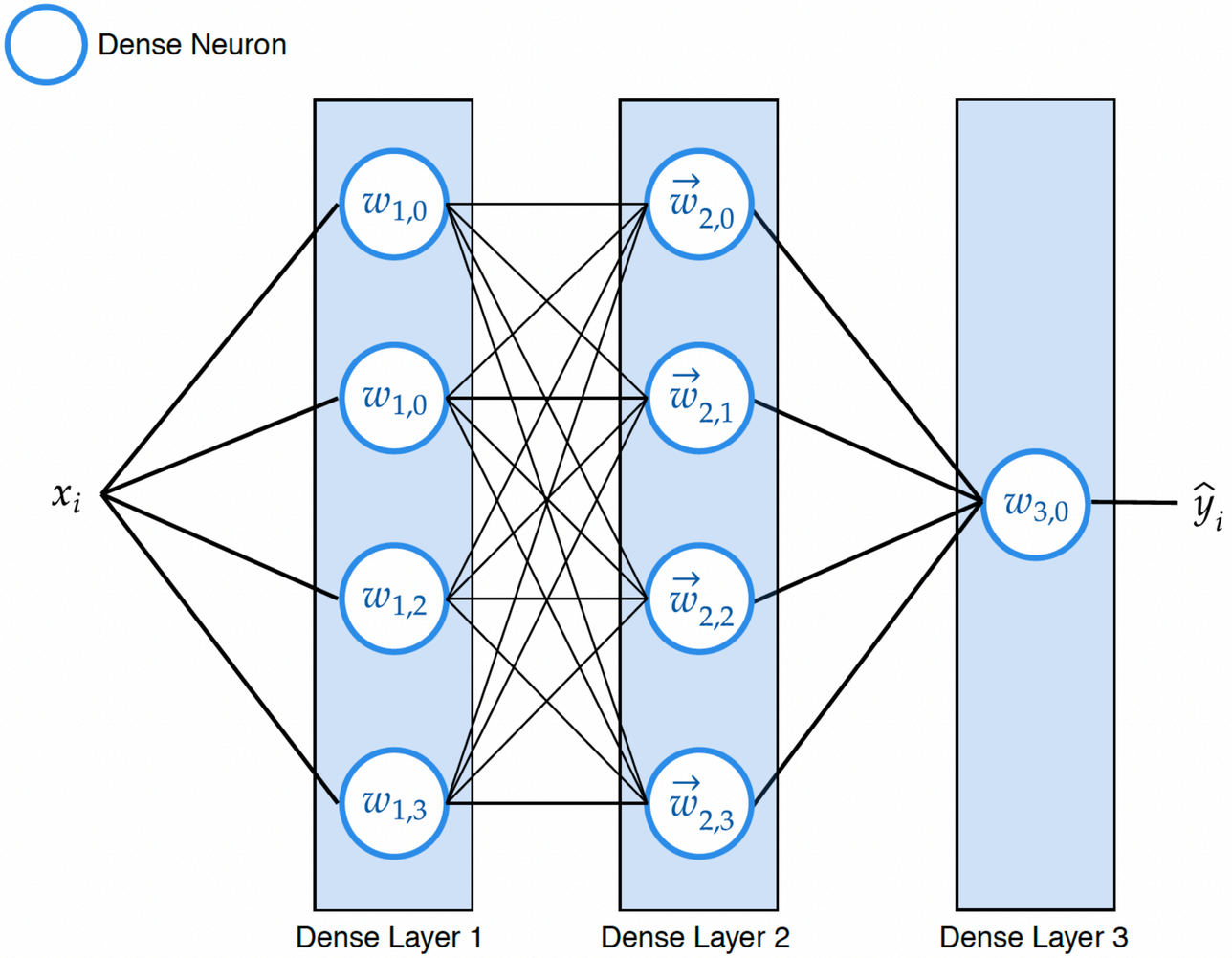


2- Your Model

$$f(x) = w_0\, x + b_0$$



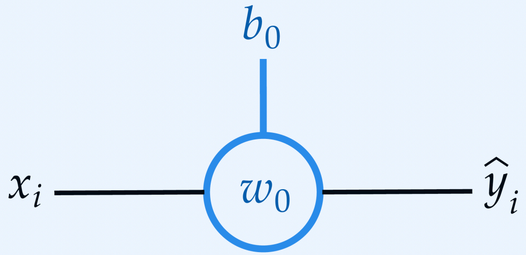


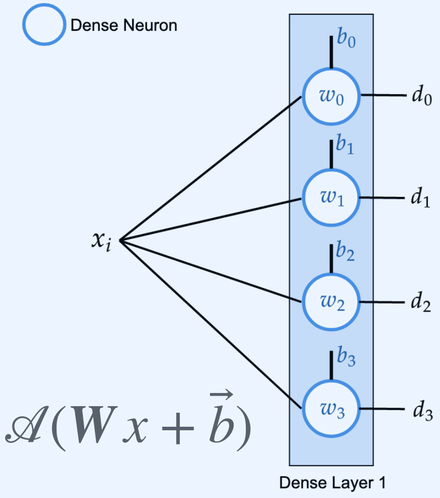


$$f(x) = \mathcal{A}\left(\boldsymbol{W_1}\,\mathcal{A}\left(\boldsymbol{W_1}\,\mathcal{A}(\boldsymbol{W_0} + \vec{b_0}) + \vec{b_1}\right) + \vec{b_2}\right)$$

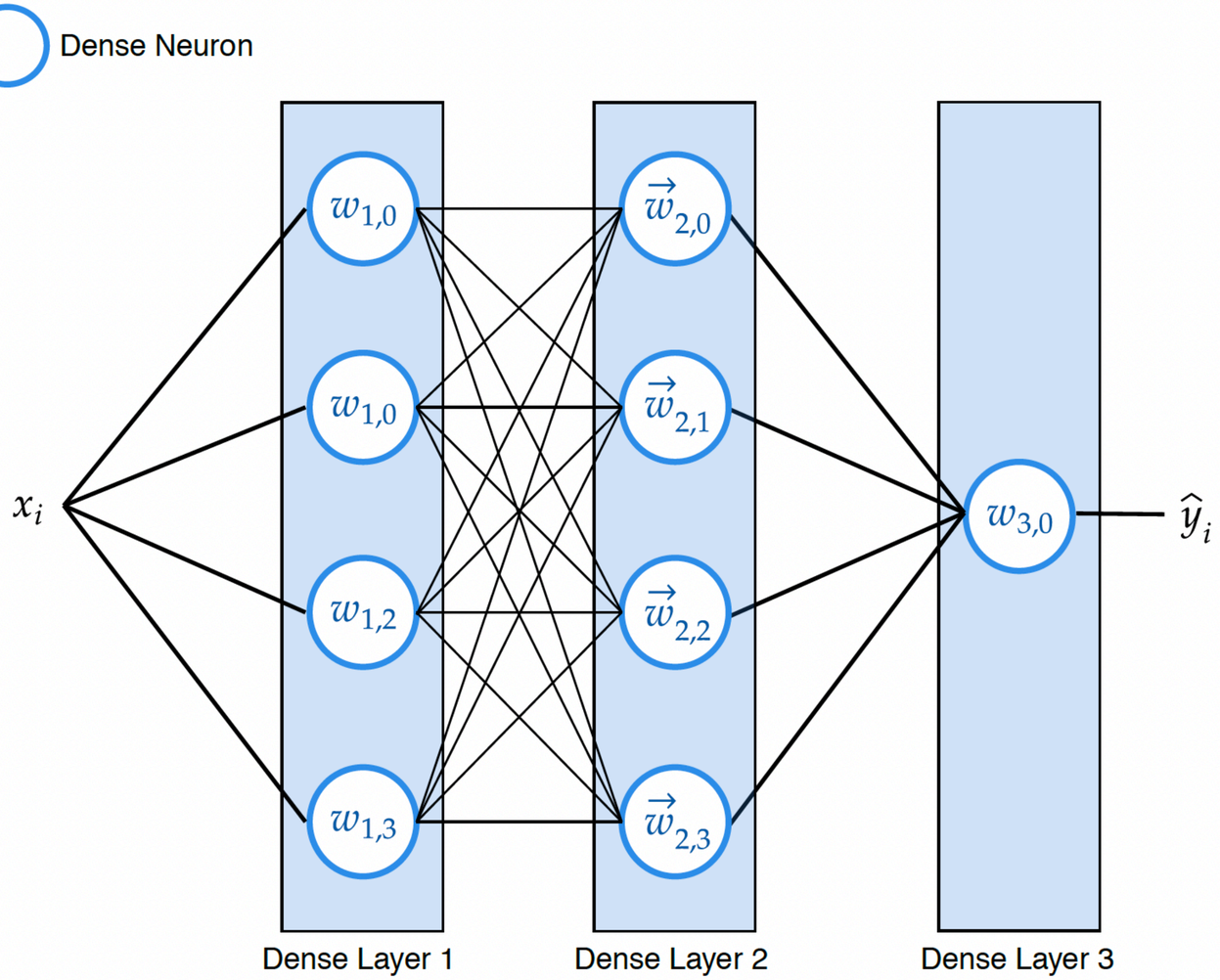
2- Your Model

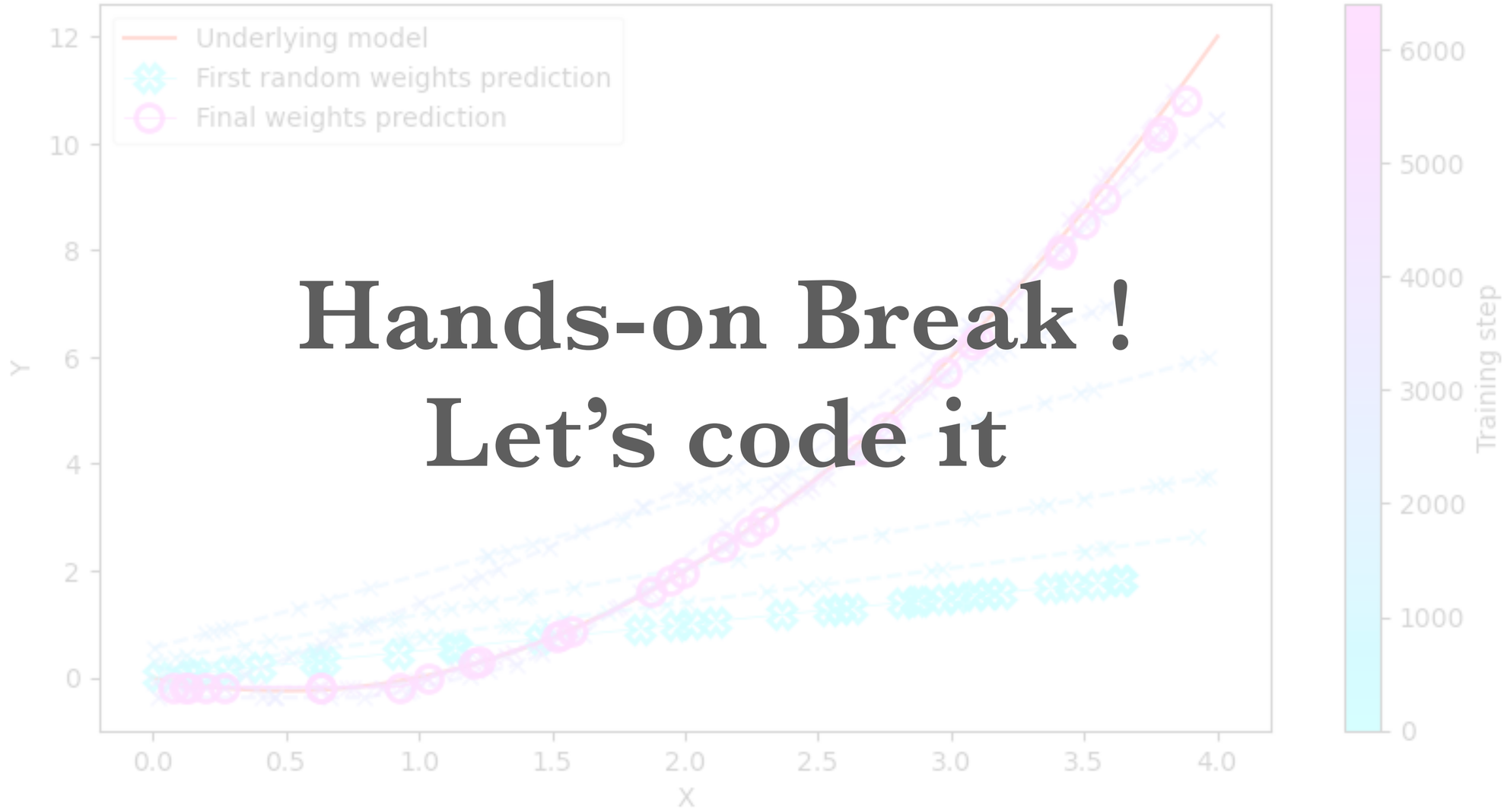
$$f(x) = w_0\, x + b_0$$





$$f(x) = \mathcal{A}(W\, x + \vec{b})$$





Hands-on Break !
Let’s code it

2- Your Model

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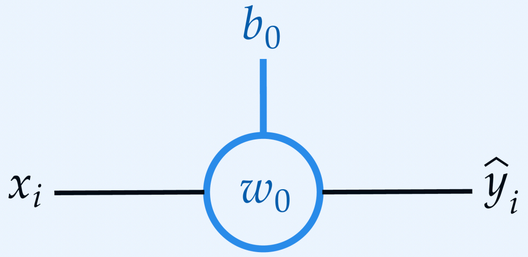

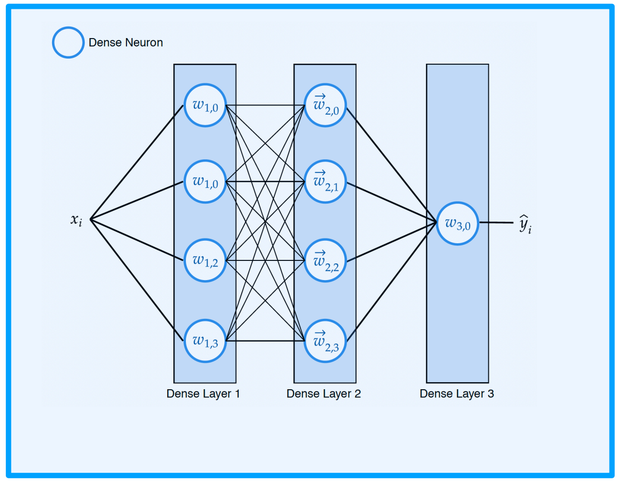

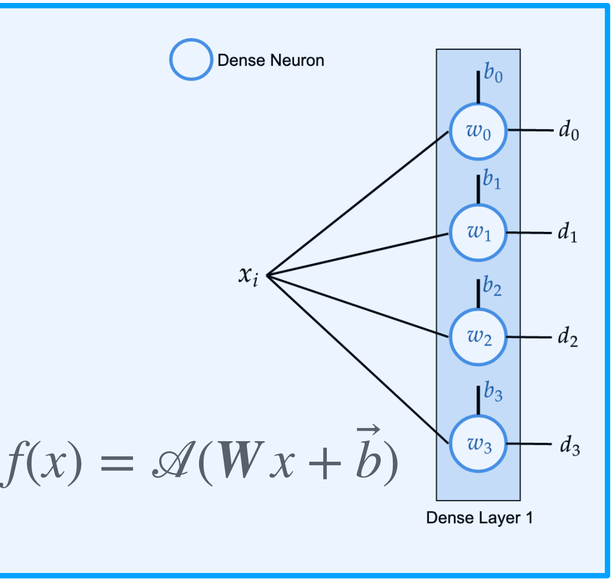

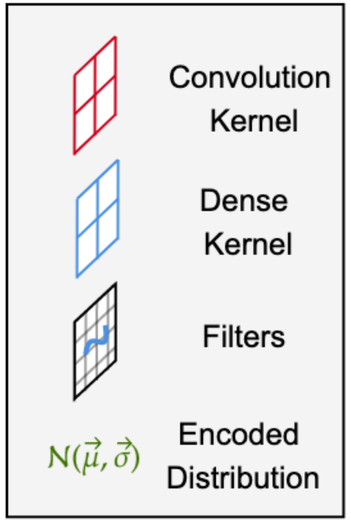

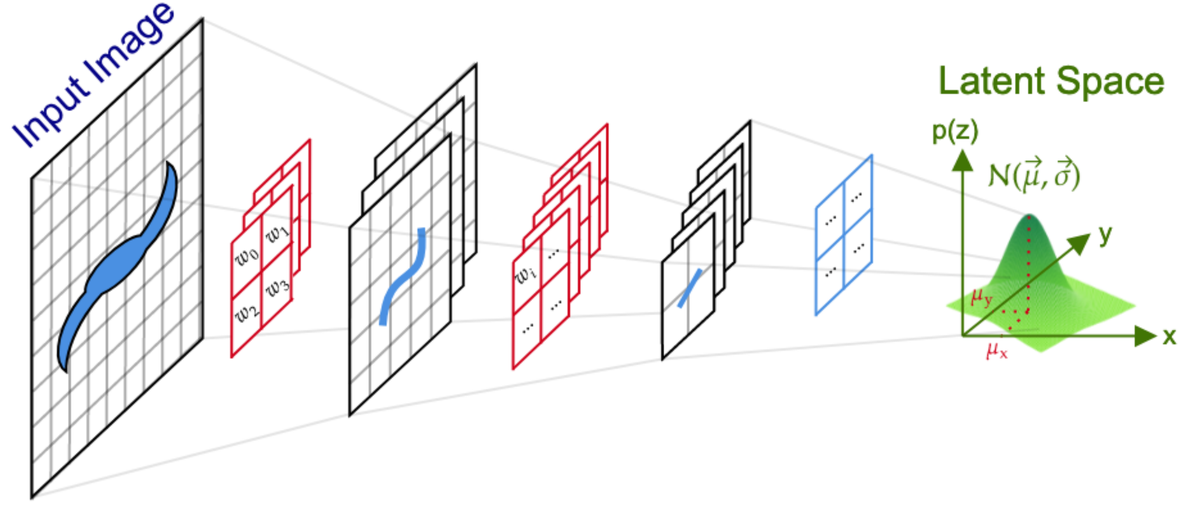

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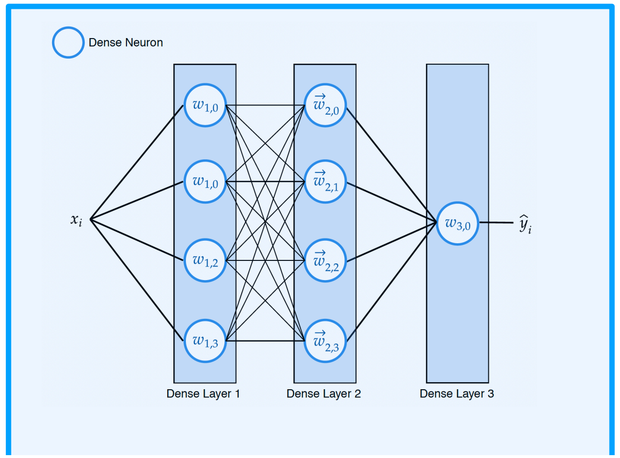
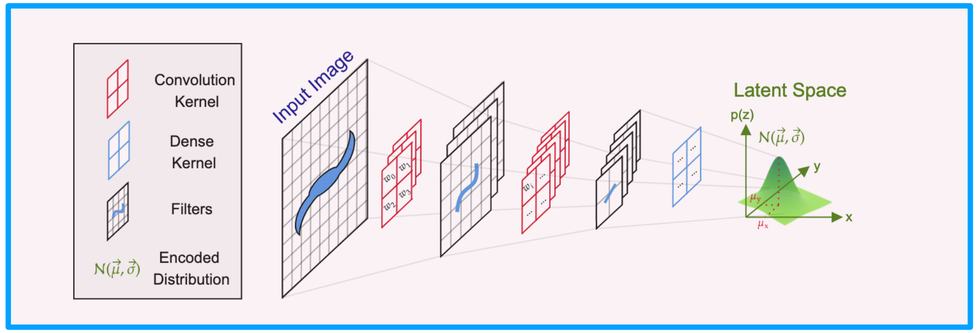
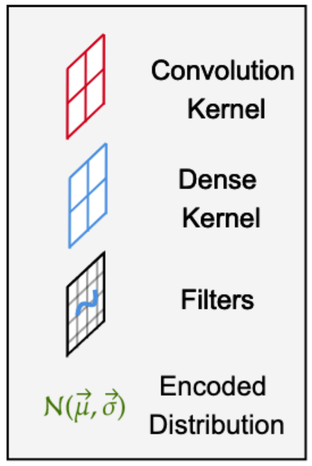
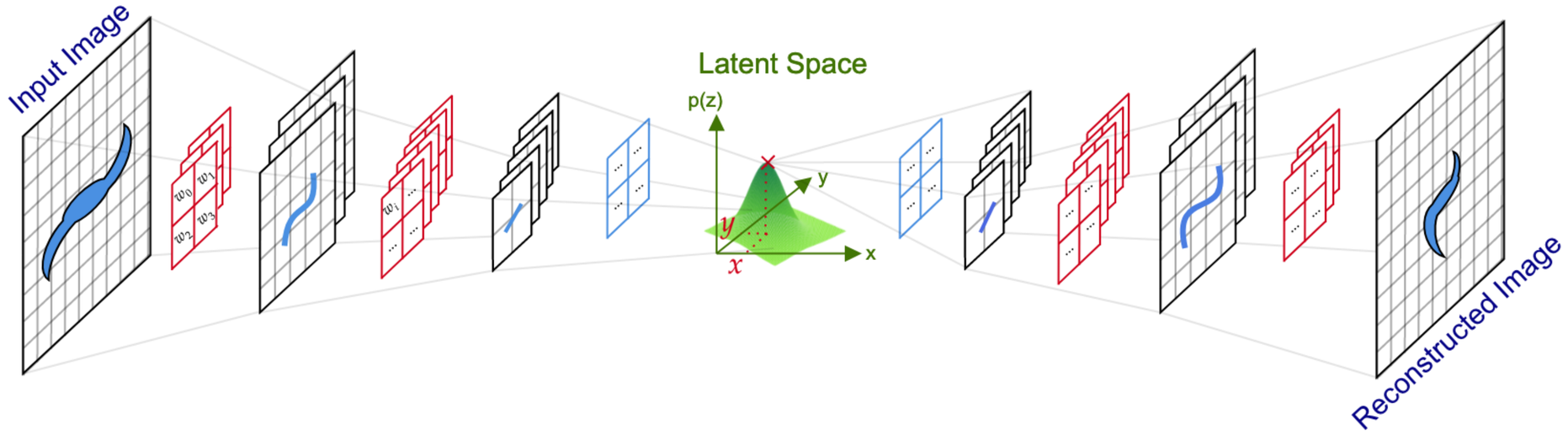
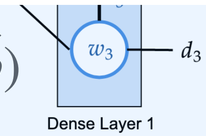








$$f(x) = \mathcal{A}(W\, x + \vec{b})$$



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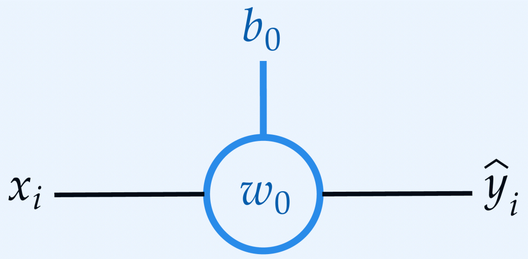

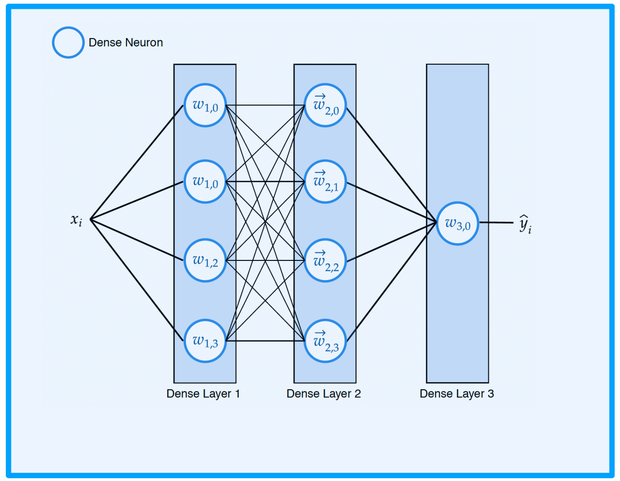

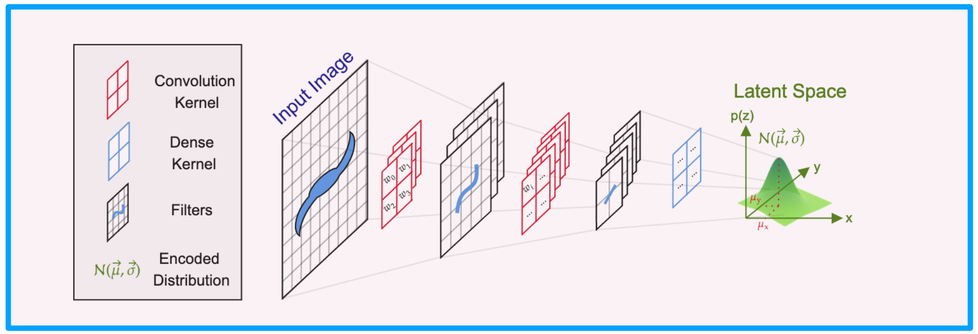

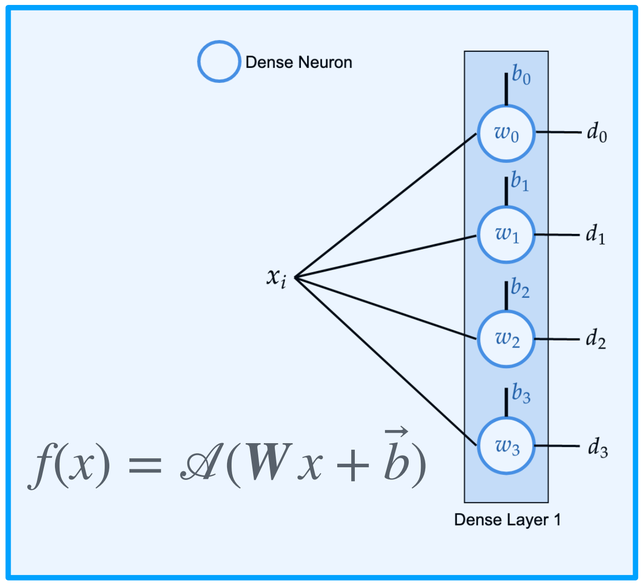

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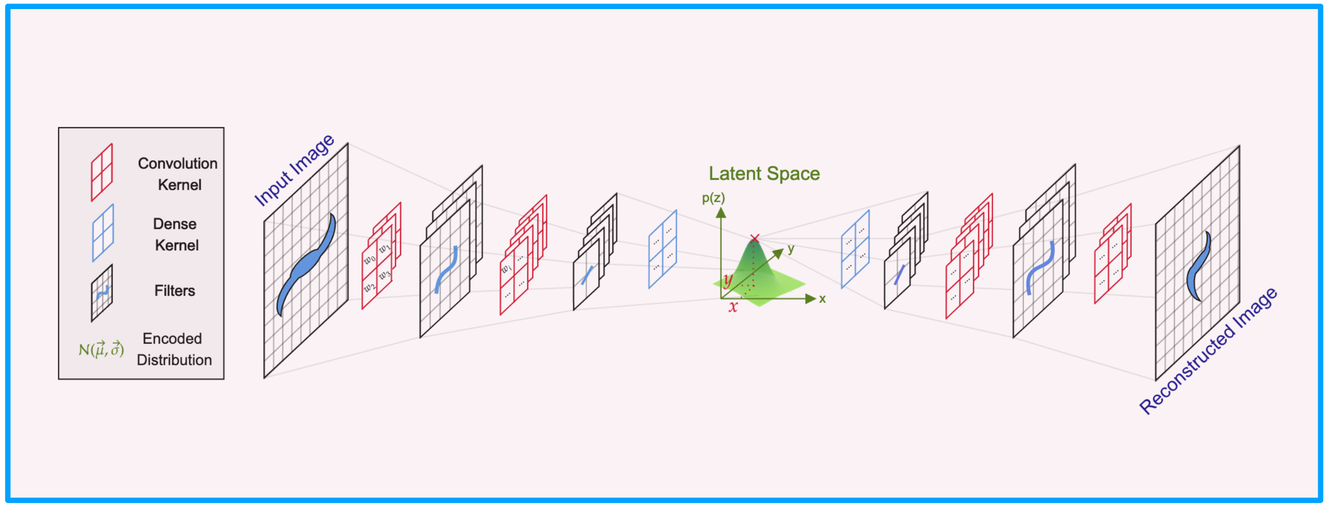

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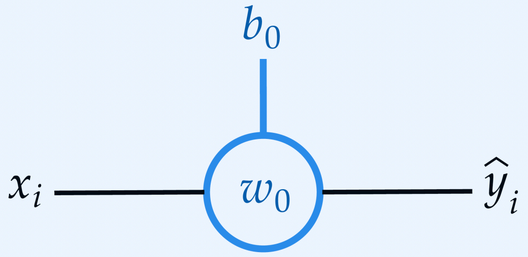

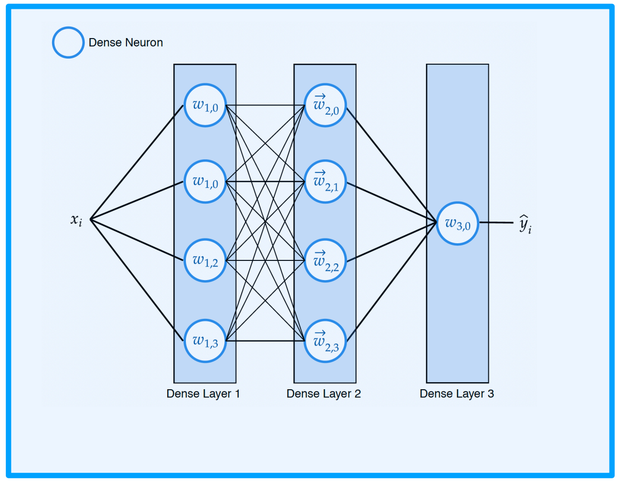

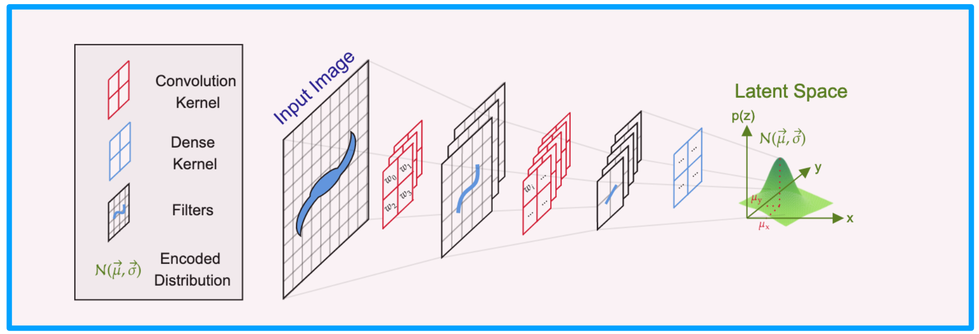

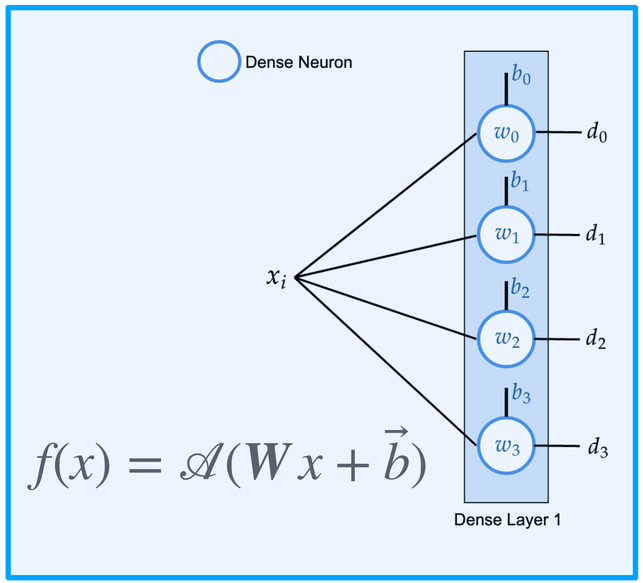

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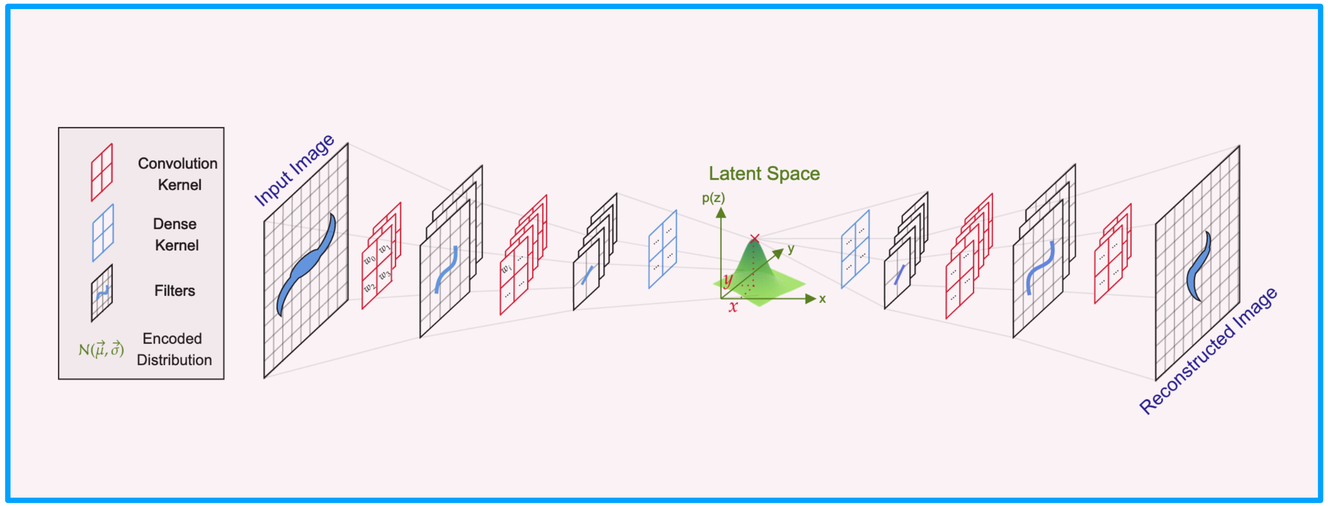

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3- Your Loss

Add more examples

$$\mathscr{L} = Y - \hat{Y}$$

3- Your Loss

$$\mathscr{L} = Y - \hat{Y}$$

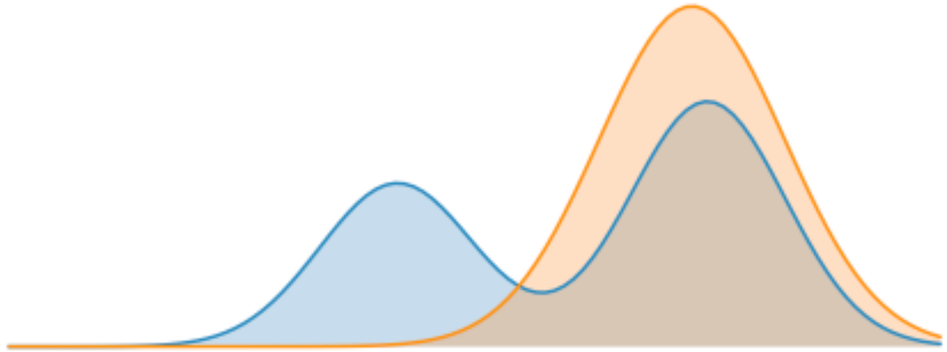
$$\mathscr{L} = |Y - \hat{Y}|^2$$

3- Your Loss

$$\mathscr{L} = Y - \hat{Y}$$

$$\mathscr{L} = |Y - \hat{Y}|^2$$

$$\mathscr{L} = \mathscr{P}(\hat{Y})$$

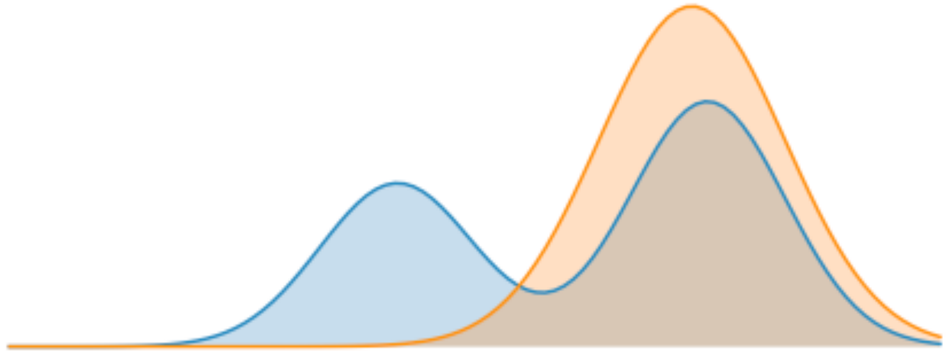


3- Your Loss

$$\mathscr{L} = Y - \hat{Y}$$

$$\mathscr{L} = |Y - \hat{Y}|^2$$

$$\mathscr{L} = \mathscr{P}(\hat{Y})$$



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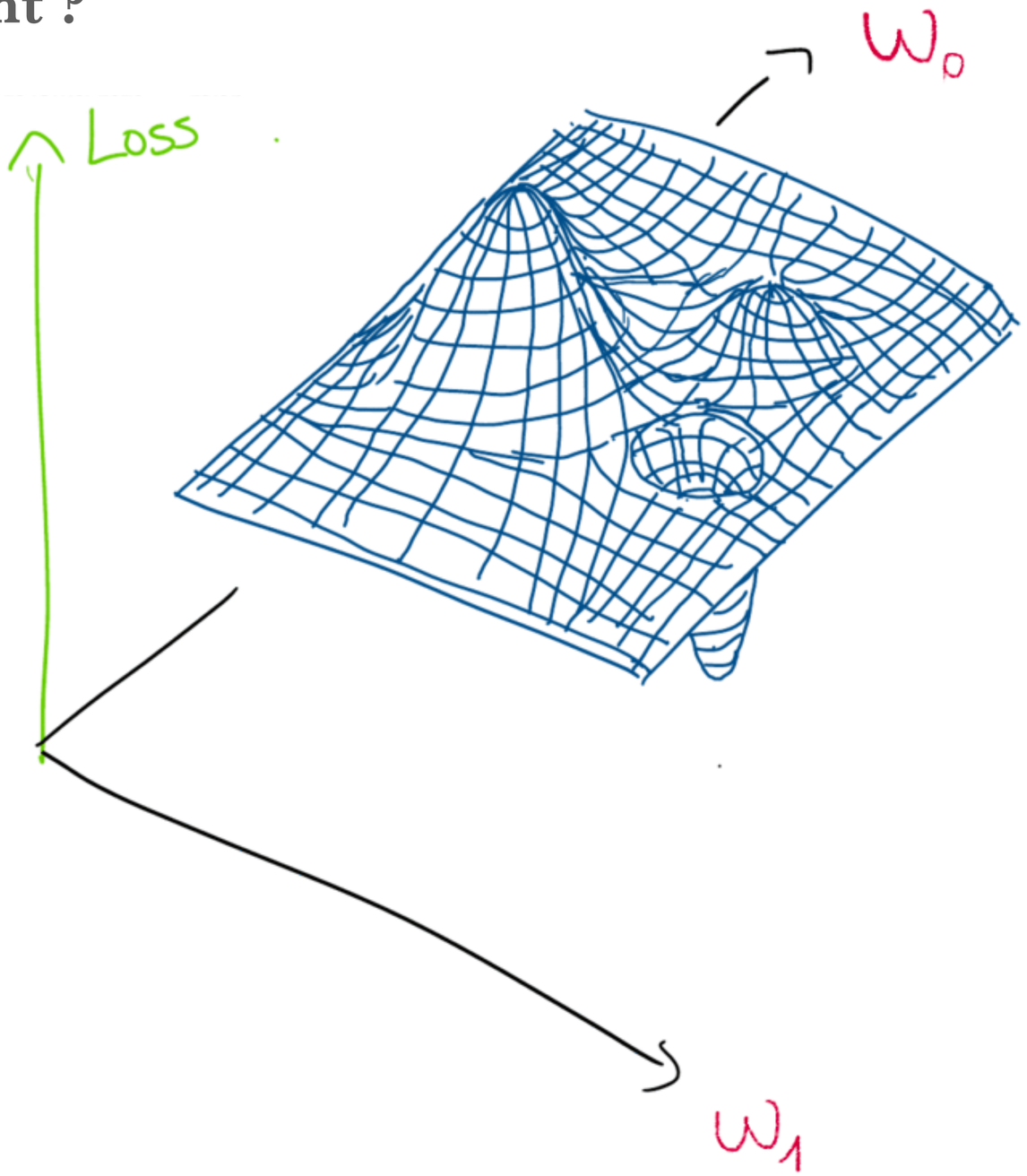
4- Gradient Descent ?



How I see the use of DL in academic science…

- Do you really need it ?
- Don’t randomly use a model found in the net.
- We are scientists, not pure data scientists: use your knowledge to inform your model: input, loss, tests…
- Check 10 times your results, with tests, robustness, interpretation…
- Be carefull on how you present your methods: clarity, trust, pedagogy…