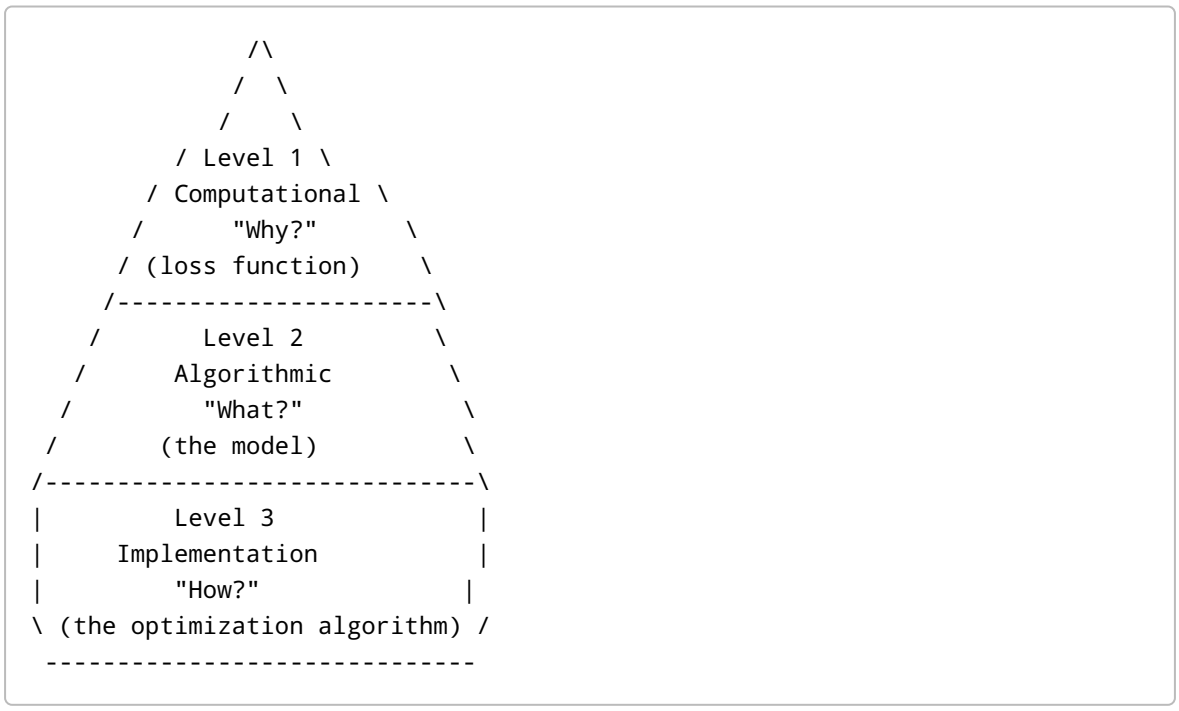
Aside: Marss's Levels of analysis

1. Computations "why?" eg loss fuction
2. Algorithmic "what?" eg the model
3. IMplemenation "whow?" eg the optimization alogo



How is dataset generated?

Let's say $(x, y) \sim p(x, y)$, where x and y is some data.

Training: $\mathcal{D} = \{(x, y) \ldots\}$

Assuming they are i.i.d.,

$$ p(\mathcal{D}) = \prod p(x, y) = \prod p(x)p(y \mid x) $$

We are trying to learn $p_\theta(y \mid x)$, basically it's a model of the true $p(y \mid x)$.

A good model should make the data look probable.

Therefore, we must choose θ such that:

$$ p(\mathcal{D}) = \prod p(x) p_\theta(y \mid x) $$

is maximized.

But the problem is that $p(x) \leq 1$, multiplying many such terms would make the result closer to zero.

Therefore, we take logarithm:

$$ \log p(\mathcal{D}) = \sum \log p(x_i) + \log p_\theta(y_i \mid x_i) $$

$$ = \sum \log p_\theta(y_i \mid x_i) + \text{const} \quad (p(x_i) \text{ doesn't depend on } \theta) $$

Then,

$$ \theta \leftarrow \arg\max \sum \log p_\theta(y_i \mid x_i) \quad \text{(MLE)} $$

$$ \theta \leftarrow \arg\min -\sum \log p_\theta(y_i \mid x_i) \quad \text{(NLL)} $$

Therefore, what is loss function?

The loss function quantifies how bad θ is. We want the least bad θ .