AI in Culture and Arts – Tech Crash Course

Introduction to Deep Learning

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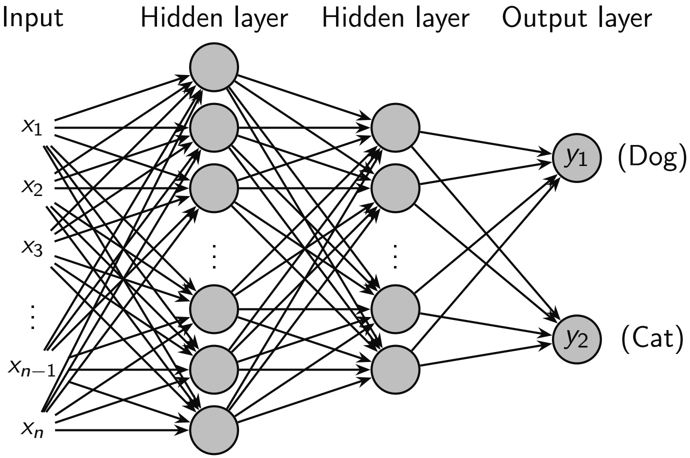
1. How Do Machines Learn?

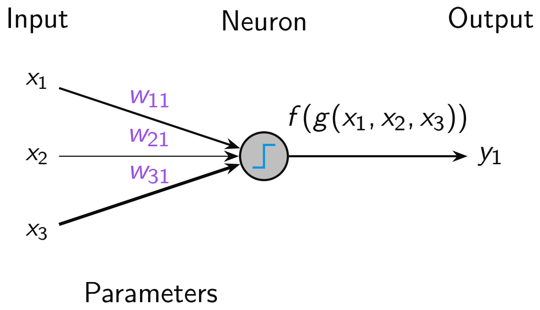
2. How Do Humans Train Machine?

3. Interactions with ML

Synaptic Plasticity



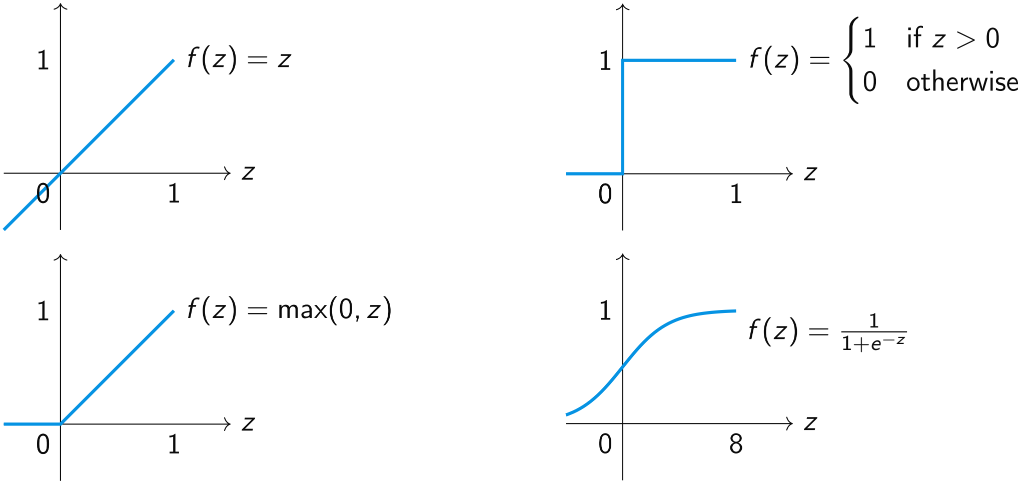
$h_\theta(\mathbf{x}) = \mathbf{y}$, where $\mathbf{x} = (x_1, \ldots x_n)$ and $\mathbf{y} = (y_1, \ldots, y_k)$

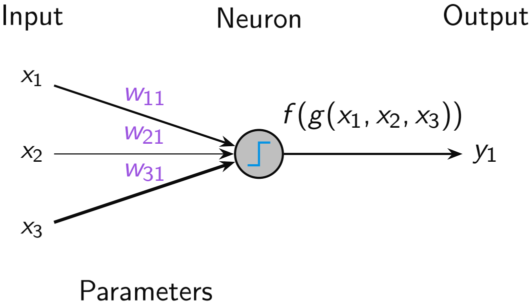


Parameters determine how strong neurons are wired together:

$$g(x_1, x_2, x_3) = x_1 \cdot w_{11} + x_2 \cdot w_{21} + x_3 \cdot w_{31}$$

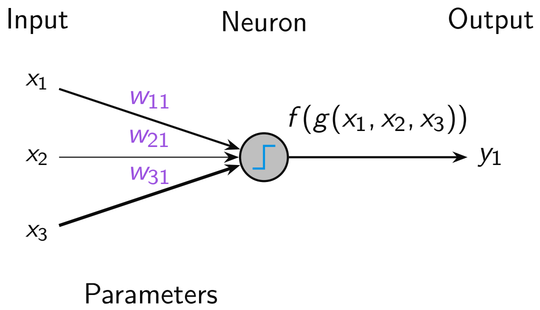
Activation Functions





"Neurons that fire together, wire together."

$$w_{ij} = w_{ij} - \eta \cdot x_i \cdot y_j$$



"Neurons that fire together, wire together."

$$\theta_{t+1} = \theta_t - \eta \cdot \nabla J(\theta_t)$$

In this case $\theta_t = (w_{11}, w_{21}, w_{31})$.

Mean Squared Error (MSE):

$$J(\theta) = \frac{1}{N} \sum_{i=1}^{N} \|\mathbf{y}_i - h_\theta(\mathbf{x}_i)\|^2$$

where $\mathbf{y}_i$ is the correct label of a data point $\mathbf{x}_i = (x_1, \ldots, x_n)$ in our training data.

Cost Function (Classification)

Idea: Let's say our preduction clasifies our i-th image, that is $\mathbf{x}_i$, as 0.3 dog and 0.7 cat:

$$h_\theta(\mathbf{x}_i) = (0.3, 0.7)$$

but it is most certainly a dog, that is, $(0.95, 0.05)$. A good error would be:

$$-\left[0.95 \cdot 0.3 \cdot (1 - 0.95) \cdot (1 - 0.3)\right] \cdot \left[0.05 \cdot 0.7 \cdot (1 - 0.05) \cdot (1 - 0.7)\right]$$

This term is minimal for $\mathbf{x}_i = (0.95, 0.05)$

Categorical Cross Entropy Cost:

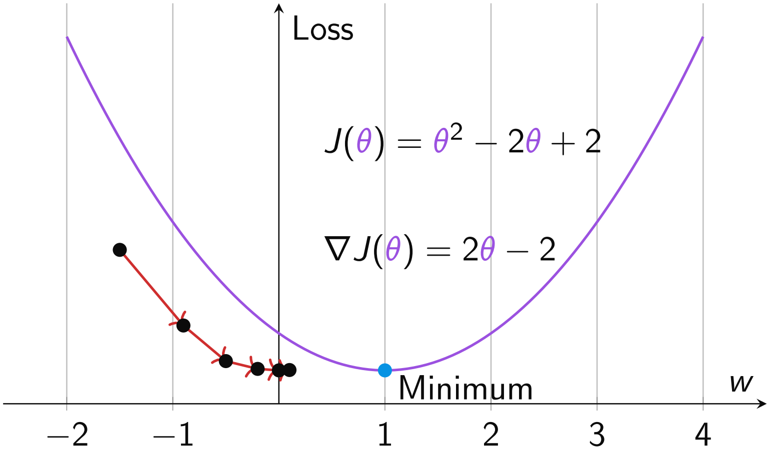
$$J(\theta) = \frac{1}{N} \sum_{i=1}^{N} [\mathbf{y}_i \cdot \log(h_\theta(\mathbf{x}_i)) + (\mathbf{1} - \mathbf{y}_i) \cdot (\mathbf{1} - \log(h_\theta(\mathbf{x}_i)))]$$

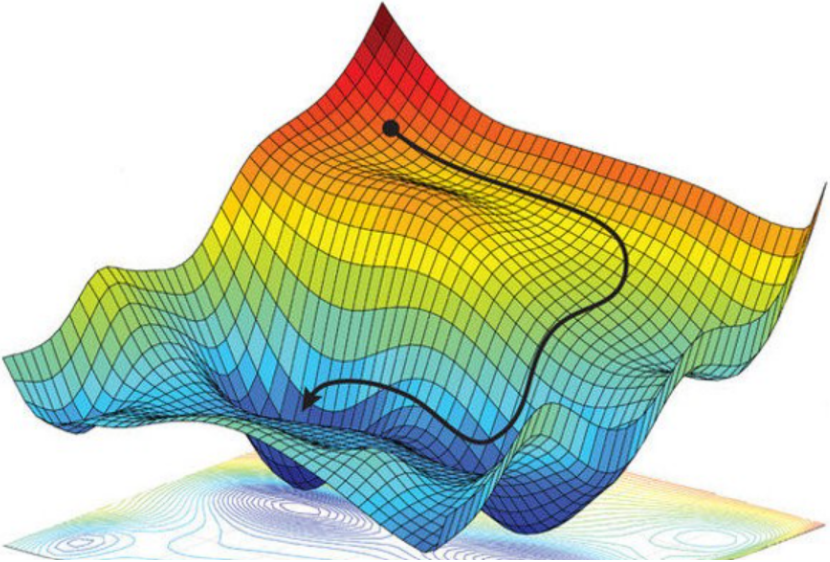
where $\mathbf{y}_i$ is interpreted as the probability distribution of categories for $\mathbf{x}_i = (x_1, \ldots, x_n)$, i. e. a data point.

Gradient Decent

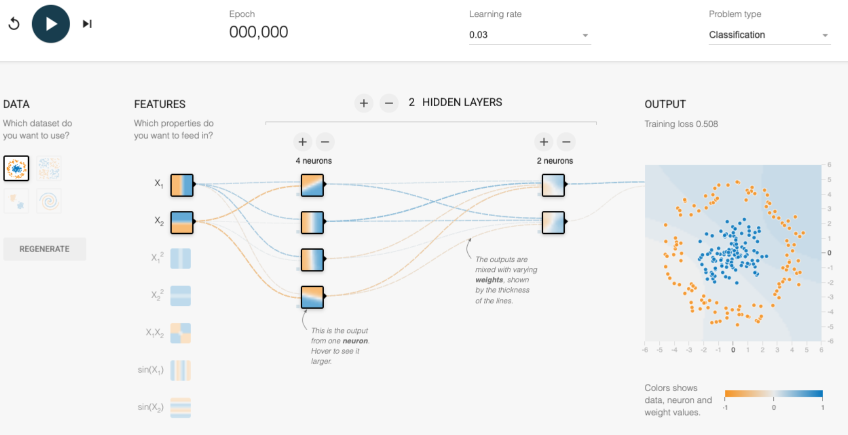
$$\theta_{t+1} = \theta_t - \eta \cdot \nabla J(\theta_t)$$

Interactive Tutorial


Loss
$J(\theta) = \theta^2 - 2\theta + 2$
$\nabla J(\theta) = 2\theta - 2$
Minimum
w
−2
−1
1
2
3
4



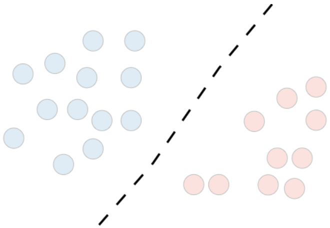
Design and Try Your Perceptron



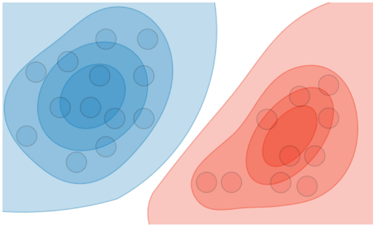
Simplified Tensorflow Playground

Extended Tensorflow Playground

- **Discriminative models:** Learn the boundaries of decisions.
- **Generative models:** Learn the whole distribution of the data.

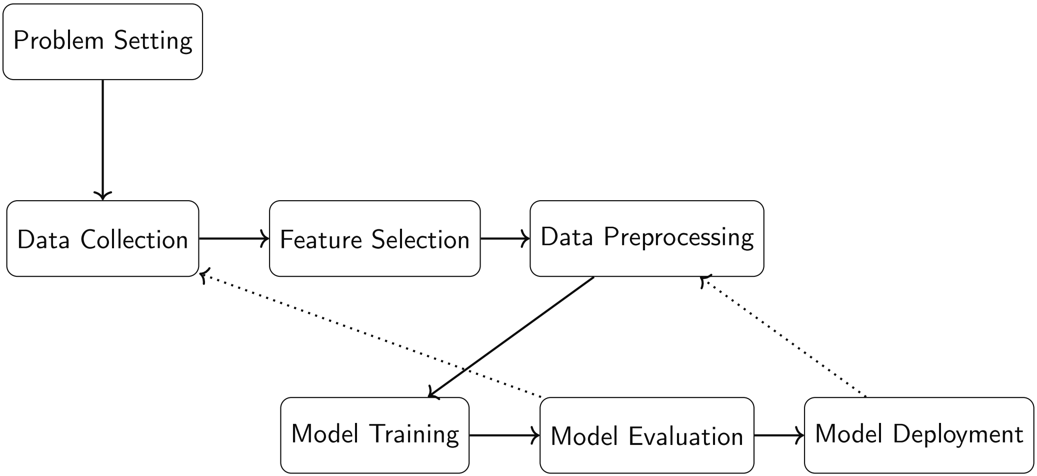


Discriminative modelling



Generative modelling

Development Cycle



Programming Libraries

```python
class fast_qlinear(torch.autograd.Function):
    def forward(ctx, a, b, scales, zeros):

        m, k = a.shape
        _, n = b.shape

        quant_groupsize = 128
        block_size_m = 16
        block_size_n = 32 # [N = 4096 // 32] = 128 blocks
        block_size_k = 256
        group_size_m = 8
        num_warps = 4
        num_stages = 8
        total_blocks_m = triton.cdiv(m, block_size_m)
        total_blocks_n = triton.cdiv(n, block_size_n)
```

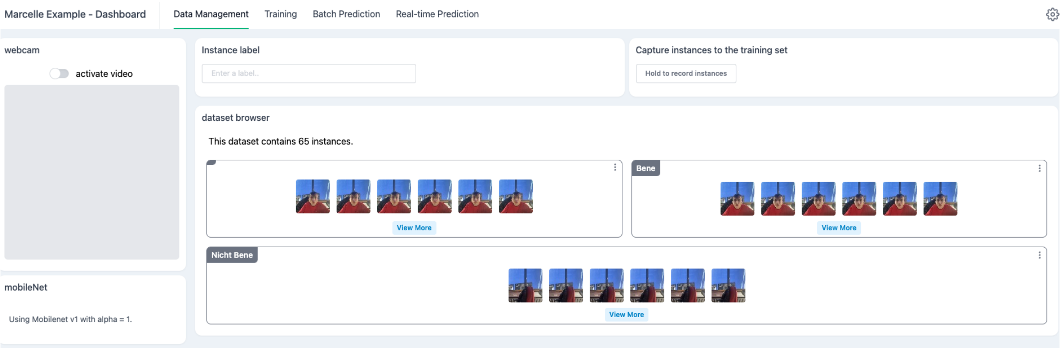
Python and ML libraries (PyTorch, tensorflow, JAX etc.)

Train a Model with Python

Marcelle: composing interactive machine learning workflows and interfaces (Françoise, Caramiaux, & Sanchez, 2021).

https://marcelle.dev/

The Marcelle Toolkit



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Any questions?

Françoise, J., Caramiaux, B., & Sanchez, T. (2021). Marcelle: Composing interactive machine learning workflows and interfaces. In *The 34th annual acm symposium on user interface software and technology* (pp. 39–53). New York, NY, USA: Association for Computing Machinery. Retrieved from https://doi.org/10.1145/3472749.3474734 doi: 10.1145/3472749.3474734