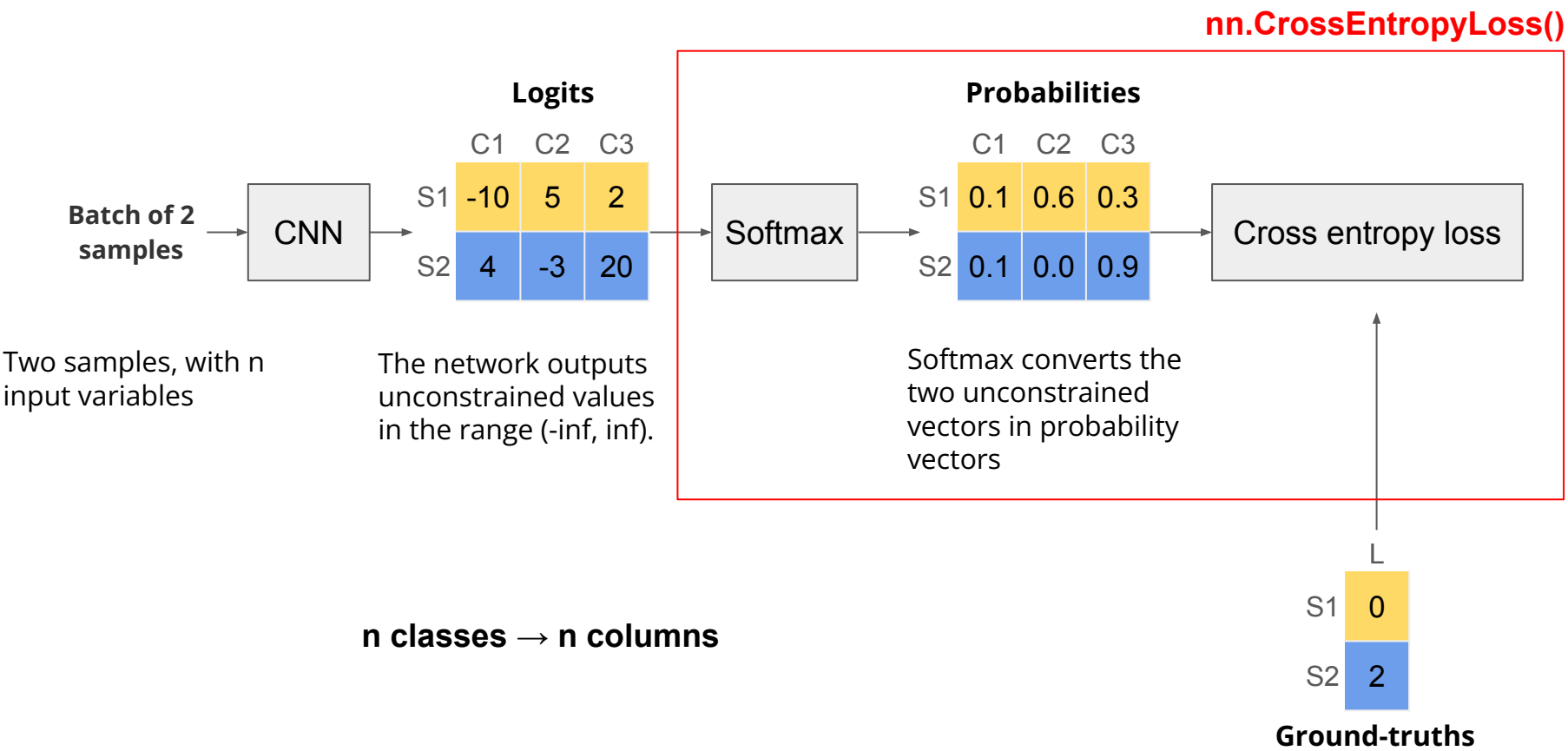


# Classification with 1D-CNNs + heartbeat signal

Prof. Flavio Piccoli - Dr. Mirko Paolo Barbato

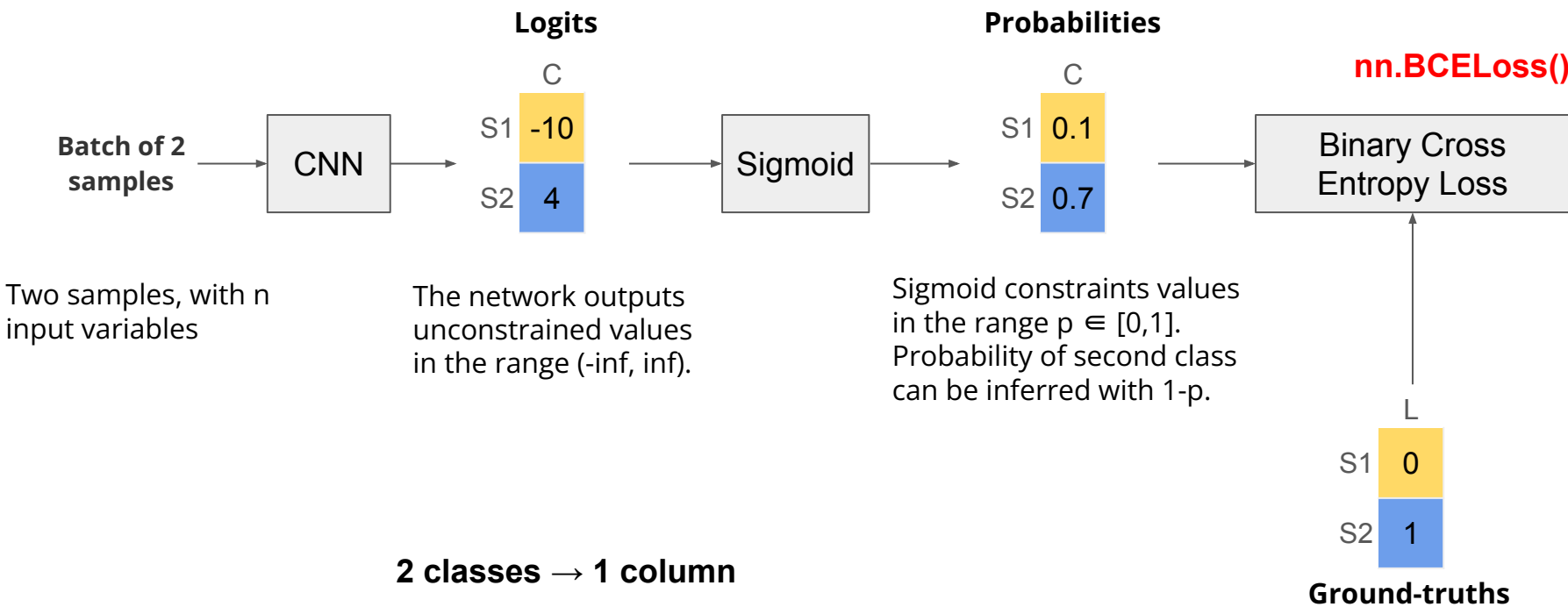
# Multiclass classification

In Pytorch, you can use directly `nn.CrossEntropyLoss` which combines softmax and cross entropy loss



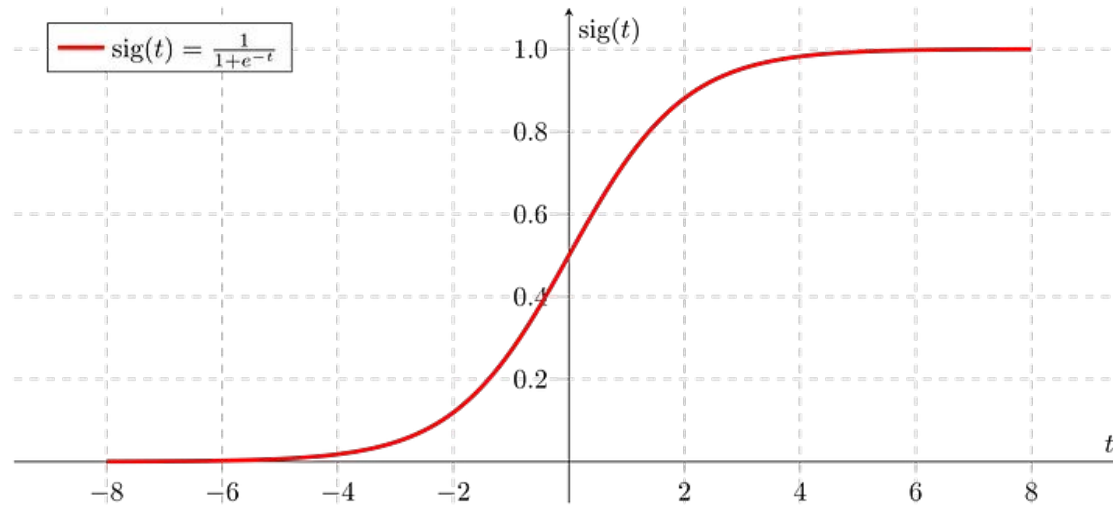
# Binary class classification

Binary classification in PyTorch requires that you constrain the network's output between 0 and 1.



# Sigmoid

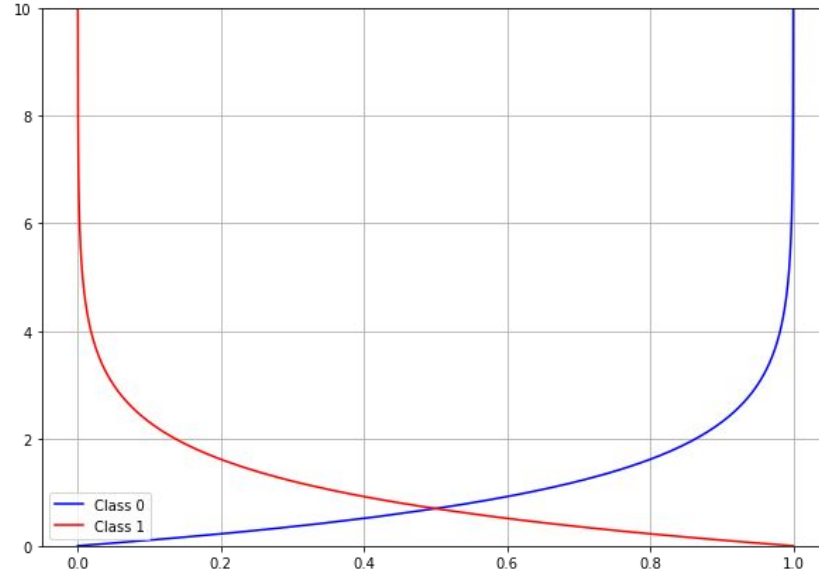
- The sigmoid function projects any value in the range  $[0,1]$
- Very useful in binary classification tasks



# Binary Cross-Entropy Loss

- In binary classification, the network outputs a single element **p**.
- To perform cross entropy, it's needed to slightly change the equation:

$$L_{BCE} = -\frac{1}{N} \sum_{i=1}^N \boxed{y_i \log(p(y_i))} + \boxed{(1 - y_i) \log(1 - p(y_i))}$$



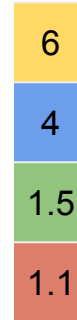
# Pooling

- Pooling computes the average/max of the features in a neighbourhood
- It is applied channel-by-channel
- Useful to decrease spatial dimension

## Current Activation

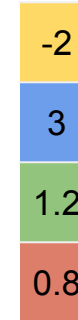


## Max Pooling



$$y_{ijk} = \max_{pq \in \Omega_{ij}} x_{pqk}$$

## Average Pooling



$$y_{ijk} = \text{avg}_{pq \in \Omega_{ij}} x_{pqk}$$

The background of the slide is a light gray-blue gradient. It features a series of thin, white, concentric circles that are centered on the left side of the frame. These circles create a sense of depth and focus. Scattered throughout the background are numerous out-of-focus blue circles of varying sizes, which appear as bokeh light effects. The overall aesthetic is clean, modern, and tech-oriented.

# The heartbeat signal



# The heart rate

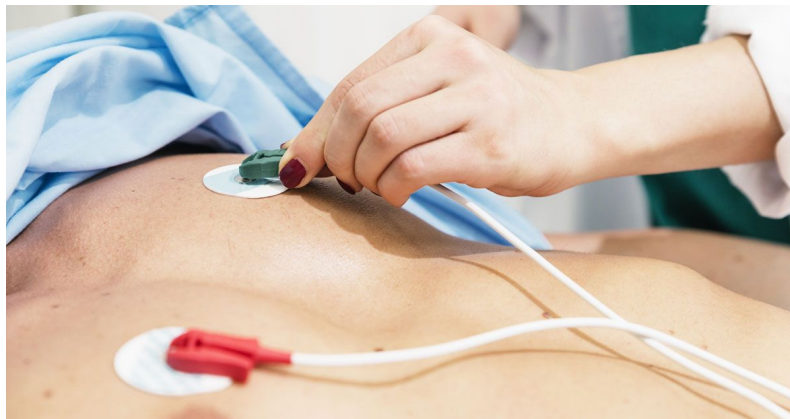


## Heart rate (or pulse rate)

is the frequency of the heartbeat measured by the number of contractions of the heart per minute (beats per minute, or bpm)

## Heart rate monitor

is the device used to measure the heart rate. Two different approaches:



**Electrical (electrocardiography):** Your heart generates a small electrical current with every heartbeat.



**Optical (photoplethysmography):** These devices use infrared light to see the expansion of your arteries as your heart pumps blood through them



# Arrhythmia (irregular heartbeat)



**DEF:** Arrhythmia, or irregular heartbeat, is a problem with the rate or rhythm of your heartbeat. Your heart may beat too quickly, too slowly, or with an irregular rhythm.



# Exercise 2 - Arrhythmia detection



Given a set of heart signals, determine whether the patient has arrhythmia or not.

- On e-learning you will find:
  - the csv dataset
  - few lines of code needed to load the data in a proper way