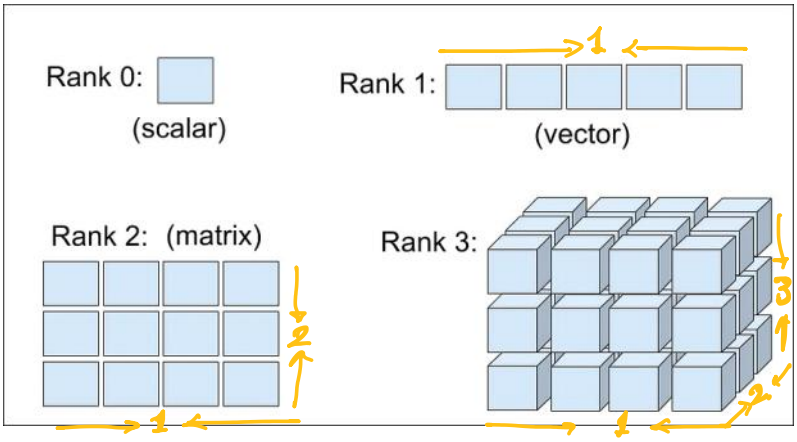
2.0 TENSORS IN PyTorch

24 August 2025 02:47 AM Avinash Yadav

A kind of data structure to hold, store and represent data.

Tensor is a specialized multi-dimensional array designed for mathematical and computational efficiency.

dimension of a tensor means: In how many direction the particular tensor is spanning



Real-World Examples

1. **Scalars: 0-dimensional tensors (a single number)**
   - Represents a single value, often used for simple metrics or constants.

It means that it is not spanned in any of the dimensions and this can only be one tensor called SCALAR

   - Example:

loss value = $[\hat{y} - y]$

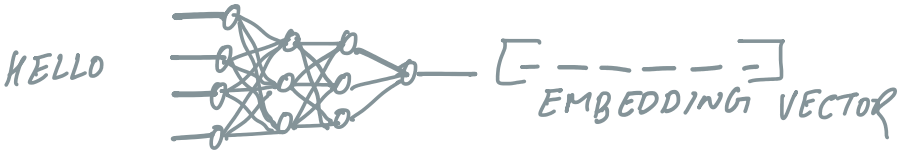
     - Loss value: After a forward pass, the loss function computes a single scalar value indicating the difference between the predicted and actual outputs.
     - Example: 5.0 or -3.14

1. **Vectors: 1-dimensional tensors (a list of numbers)**

i.e. A tensor spanned/spread in one direction. A well known example of 1-D tensor is VECTOR (array)

   - Represents a sequence or a collection of values.

   - Example:



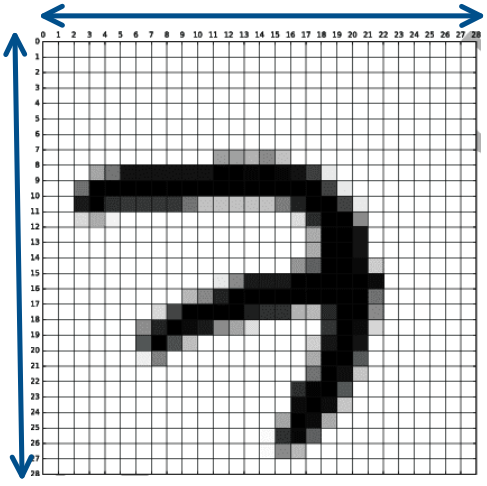
     - Feature vector: In natural language processing, each word in a sentence may be represented as a 1D vector using embeddings.
     - Example: [0.12, -0.84, 0.33] (a word embedding vector from a pre-trained model like Word2Vec or Glove).

1. **Matrices: 2-dimensional tensors (a 2D grid of numbers)**

A tensor spread in 2 direction. A well known example is image → Gray scale image

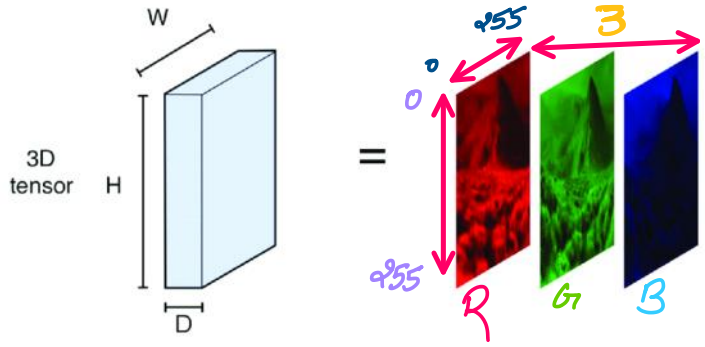
   - Represents tabular or grid-like data.

Numbers stored in both the directions



   - Example:
     - Grayscale images: A grayscale image can be represented as a 2D tensor, where each entry corresponds to the pixel intensity.
     - Example: [[0, 255, 128], [34, 90, 180]]

1. **3D Tensors: Coloured images**
   - Adds a third dimension, often used for stacking data.



   - Example:
     - RGB Images: A single RGB image is represented as a 3D tensor (width × height × channels).
     - Examples: RGB Image (e.g., 256x256): Shape [256, 256, 3]

1. **4D Tensors: Batches of RGB images**
   - Adds the batch size as an additional dimension to 3D data.

   - Example:
     - Batches of RGB Images: A dataset of coloured images is represented as a 4D tensor (batch size × width × height × channels).
     - Example: A batch of 32 images, each of size 128x128 with 3 colour channels (RGB), would have shape [32, 128, 128, 3].

1. **5D Tensors: Video data**
   - Adds a time dimension for data that changes over time (e.g., video frames).

   - Example:
     - Video Clips: Represented as a sequence of frames, where each frame is an RGB

image.

- Example: A batch of 10 video clips, each with 16 frames of size 64x64 and 3 channels (RGB), would have shape [10, 16, 64, 64, 3]