Data Science Survival Skills

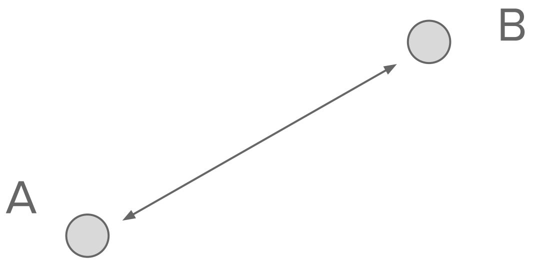
Exercise 6

Agenda

- Metrics (Distance + Evaluation)
- Audio signal processing ➜ Data Augmentation

Distance metrics

Computing a distance



Distance metrics

- **L1 Norm (Manhatten distance)**
  - Distance a taxi would travel along the grid-like streets of Manhattan from one point to another
  - Measures the absolute sum of the differences between corresponding coordinates of two vectors
  - Scale invariance: not affected by the magnitude of the vectors

$$\sum_{i=1}^{n} |x_i - y_i|$$

Distance metrics

- **L2 Norm (Euclidean distance)**
  - Measures the straight-line distance between two points in Euclidean space
  - Scale sensitivity: sensitive to the magnitude of the vectors ➔ takes into account both the direction and the magnitude of the differences between corresponding coordinates

$$\sqrt{\sum_{i=1}^{n}(x_i - y_i)^2}$$

Distance metrics

- **L∞ Norm (Chebyshev distance)**
  - Maximum absolute difference: focuses in the dimension with the maximum absolute difference between corresponding coordinates → measures the "worst-case" in terms of dissimilarity
  - Scale invariance

$$\max_i(|x_i - y_i|)$$

Distance metrics

- **Lp Norm (Minkowski distance)**
  - Generalization

$$\left(\sum_{i=1}^{n} |x_i - y_i|^p\right)^{\frac{1}{p}}$$

Distance metrics

- **Cosine similarity**
  - Scale invariance
  - High-dimensional data: concept of distance becomes less meaningful ➔ CS can be more effective in capturing the relationship between data points

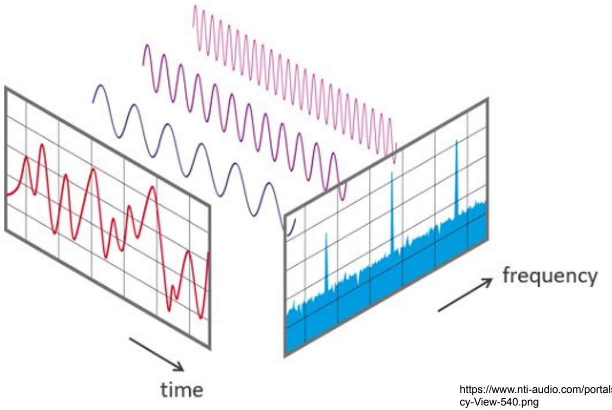
$$\cos(\theta) = \frac{\mathbf{a} \cdot \mathbf{b}}{\|\mathbf{a}\| \, \|\mathbf{b}\|} = \frac{\mathbf{a} \cdot \mathbf{b}}{\sqrt{\mathbf{a}^2 \cdot \mathbf{b}^2}} = \frac{\sum_{i=1}^{n} a_i \cdot b_i}{\sqrt{\sum_{i=1}^{n} (a_i)^2} \cdot \sqrt{\sum_{i=1}^{n} (b_i)^2}}$$

kNN - k-Nearest-Neighbors

https://www.ibm.com/de-de/topics/knn

Fourier transform

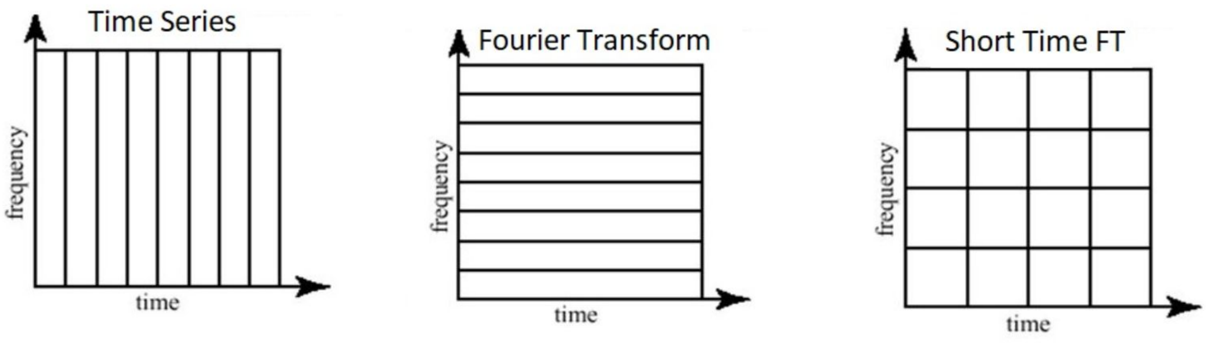
- Takes a function in the time (or spatial) domain and represents it in the frequency domain
- Result of the Fourier Transform provides information about the frequency components present in the original function
- Convolution Theorem: powerful property ➔ states that the convolution of two functions in the time domain is equivalent to the multiplication of their Fourier Transforms in the frequency domain
- Fast Fourier Transform (FFT): algorithm for efficiently computing the fourier transform



https://www.nti-audio.com/portals/0/pic/news/FFT-Time-Frequency-View-540.png

STFT - Short-term fourier transform

- Provides a time-dependent frequency analysis by dividing the signal into smaller, overlapping segments
- Time and Frequency Resolution: provides a time-varying frequency analysis, allowing for the examination of changes in frequency content over time ➔ time and frequency resolution can be adjusted by choosing different window sizes



https://ataspinar.com/2018/12/21/a-guide-for-using-the-wavelet-transform-in-machine-learning/