UNIT IV CORRELATION AND SPECTRAL DENSITIES

Auto correlation - Cross correlation - Properties – Power spectral density – Cross spectral density – Properties-Wiener-Khintchine relation.

Auto Correlation

Puzzle 1:

You record the temperature in your city every hour for a week. You notice that if it is hot at noon, it is usually hot at 1 PM too. What property of the temperature data does this observation illustrate?

Puzzle 2:

A music streaming service analyzes how similar a song is to itself if you listen to it with a delay of a few seconds. What kind of analysis are they performing?

Cross Correlation

Puzzle 3:

In a concert, two microphones are placed at different locations. Sometimes, both pick up the same sound at slightly different times. What method could you use to find out how much the signals from the two microphones are related, even if they are not perfectly synchronized[1]?

Puzzle 4:

Scientists study brain activity by comparing signals from two different sensors placed on a person's head. What does it mean if the signals from both sensors show similar patterns at the same times[2][1]?

Power Spectral Density

Puzzle 5:

An engineer wants to know how much of a random signal's energy is present at different frequencies. What tool or analysis should they use to see which frequencies are most powerful in the signal[3][4][5]?

Puzzle 6:

A radio station wants to ensure its broadcast is strongest at certain frequencies. Which measurement would help them visualize how their signal's strength varies with frequency[3][4]?

Cross Spectral Density

Puzzle 7:

In a wind farm, sensors on two different turbines record vibrations. Engineers want to find out if certain frequencies of vibration are present in both turbines at the same time, possibly indicating a shared disturbance. What analysis could they use[2][1]?

Puzzle 8:

Audio engineers want to clean up a recording by identifying which frequencies are common between two microphones and which are just noise. Which type of spectral analysis helps them do this[2][1]?

Properties and Relations

Puzzle 9:

You notice that the similarity between two signals is strongest at certain frequencies. What does this tell you about the relationship between the signals at those frequencies[2][1]?

Puzzle 10:

A seismologist deploys sensors at two locations to monitor earthquakes. By examining how the frequency components of the ground motion at both locations are related, what kind of insight can they gain about the propagation of seismic waves[2]?

Wiener-Khintchine Relation

Puzzle 11:

A scientist finds that the way a signal repeats itself over time is closely linked to how its energy is spread across different frequencies. What fundamental relationship does this observation highlight[5]?