Introduction

Sampling

Which of the following statements is true?

1. Aliasing is the distortion of information due to high-frequency sampling.
2. Aliasing can be avoided by filtering out high-frequencies before sampling.
3. By sampling at frequency f, we can recover frequencies up to f/2.

only 1

only 2

only 3

Correct Answer

2 and 3

Applications of the Signal Processing Chain

Which of the following statements is FALSE:

Correct Answer

A Denoising algorithm can be seen as a Machine Learning application on the Feature Extraction block of the Signal Processing Chain

A Dimensionality reduction method can be seen as a Machine Learning Application on the Feature Extraction block of the Signal Processing Chain

A Compression Algorithm can be seen as a Machine Learning Application on the Channel block of the Signal Processing Chain

A Classification Algorithm can be seen as a Machine Learning Application on the Modeling block of the Signal Processing Chain

MRI

MRI is different from other methods of capturing signals discussed in class because,

The resolution quality in an MRI image is the lowest

Correct Answer

Signals are captured in the frequency domain

Aliasing cannot occur in MRI images

It is the only way to sense the human body

Quantization Schemes

An audio signal is captured most faithfully when a quantization scheme considers which of the following alternatives:

Correct Answer

Larger number of discrete values for amplitude

Smaller number of discrete values for amplitude

A fixed and signal independent number of discrete values

None of the options listed here.

Senses

Which of the following statements is FALSE:

Correct Answer

Using Red, Green and Blue we can represent all the colors that humans can sense

Different combination of wavelengths can produce same perception of color

Sound is captured through the motion of a diaphragm which is converted to continuous variations of an electrical signal

A specific color sensor in the human eye responds to a range of frequencies.

Sampling in Time

To convert a continuous signal, f, to a digital form, sampling in time is called:

Correct Answer

Sampling

Quantization

Signaling

Digitizing

Discretizing Amplitude

To convert continuous signal LaTeX: ff to digital form, discretizing the amplitude is called:

Correct Answer

Quantization

Sampling

Signaling

Amplifying

Signal Processing Chain

Which of the following alternatives is the best representation for the Signal Processing Chain:

Correct Answer

Signal Capture -> Channel -> Feature Extraction -> Modeling

Signal Capture -> Feature Extraction -> Channel -> Modeling

Feature Extraction -> Signal Capture -> Modeling -> Channel

Feature Extraction -> Channel -> Signal Capture -> Modeling

Storing an Image

How many bits of storage does a LaTeX: 128 \times 128128 × 128 image with 64 gray levels need?

Correct Answer

98,304

4,096

8,192

12,288

Linear Algebra 1 Pick 5 questions, 1 pts per questionCollapse Group Add Question to this Group Edit Group Details Delete Group

Spectra and Similarity

Suppose we have spectra of three different sounds LaTeX: A, B, A , B , and LaTeX: C, C , in which LaTeX: A = \left[\begin{array}{c}4\\ 4\\ 0\\ 0\end{array} \right], B = \left[ \begin{array}{c}2\\ 4\\ 2\sqrt{2}\\ 2\end{array} \right], \textrm{and } C = \left[\begin{array}{c}0\\ 4\\ 4\\ 0\end{array} \right].A = [ 4 4 0 0 ] , B = [ 2 4 2 2 2 ] , and C = [ 0 4 4 0 ] . Which two sounds are the most similar?

Correct Answer

Sound B and Sound C

Sound A and Sound B

Sound C and Sound A

From the given information, it is impossible to determine.

Modulating Notes

We are given spectra of five different notes, represented by the LaTeX: 1\times 51 × 5 row vectors, LaTeX: A, \, B, \, C, \, D, \,EA , B , C , D , E, and given five different modulations represented by the LaTeX: 1 \times 51 × 5 row vectors, LaTeX: a, \, b,\, c,\, d,\, ea , b , c , d , e. We want to use the matrix multiplication method to modulate the five notes independently. Which of the following correctly represents this operation?

For example, the note LaTeX: AA should be modulated only by LaTeX: aa, the note LaTeX: BB should be modulated only by LaTeX: bb, etc.

Correct Answer

LaTeX: \left[ \begin{array}{ccccc} A^\top & B^\top & C^\top & D^\top & E^\top \end{array} \right] \cdot \left[\begin{array}{c}a\\ b\\ c\\ d\\ e\end{array}\right][ A ⊤ B ⊤ C ⊤ D ⊤ E ⊤ ] ⋅ [ a b c d e ]

LaTeX: \left[ \begin{array}{ccccc} A^\top & B^\top & C^\top & D^\top & E^\top \end{array} \right] \cdot \left[ \begin{array}{ccccc} a^\top & b^\top & c^\top & d^\top & e^\top \end{array} \right][ A ⊤ B ⊤ C ⊤ D ⊤ E ⊤ ] ⋅ [ a ⊤ b ⊤ c ⊤ d ⊤ e ⊤ ]

LaTeX: \left[ \begin{array}{c} A \\ B \\ C \\ D \\ E \end{array} \right] \cdot \left[ \begin{array}{ccccc} a^\top & b^\top & c^\top & d^\top & e^\top \end{array} \right][ A B C D E ] ⋅ [ a ⊤ b ⊤ c ⊤ d ⊤ e ⊤ ]

LaTeX: \left[ \begin{array}{c} A \\ B \\ C \\ D \\ E \end{array} \right] \cdot\left[\begin{array}{c}a\\ b\\ c\\ d\\ e\end{array}\right][ A B C D E ] ⋅ [ a b c d e ]

Entries in a Matrix

If LaTeX: A = \left[ \begin{array}{cc}3&4\\1&1 \end{array} \right]A = [ 3 4 1 1 ] and LaTeX: AB = \left[ \begin{array}{rrrr}1&0&-2&5\\4&-1&0&3\end{array} \right]A B = [ 1 0 − 2 5 4 − 1 0 3 ], find LaTeX: b\_{2,4}b 2 , 4, the (2,4)-entry of LaTeX: BB.

Correct Answer

-4

8

-2

3

11

Volumes

Which of following is the volume of the parallelepiped with one vertex at the origin and the adjacent vertices at LaTeX: (2,\, 9,\, 1)( 2 , 9 , 1 ), LaTeX: (3, \,12,\, 2)( 3 , 12 , 2 ), and LaTeX: (1,\, 3, \, 8)( 1 , 3 , 8 )?

Correct Answer

21

12

-12

-21

Transforming a Sphere

A full-bodied unit sphere of five dimensions is transformed by the following matrix: LaTeX: \left[ \begin{array}{rrrr} 2 & 1 & 3 & -1 \\ 3 & -1 & 2 & 0\\ 1 & 3 & 4 & -2 \\ 4 & -3 & 1 & 1 \\ 2 & 8 & -3 & 5

\end{array} \right][ 2 1 3 − 1 3 − 1 2 0 1 3 4 − 2 4 − 3 1 1 2 8 − 3 5 ]. How many dimensions does the object that results from the transformation have?

Correct Answer

3

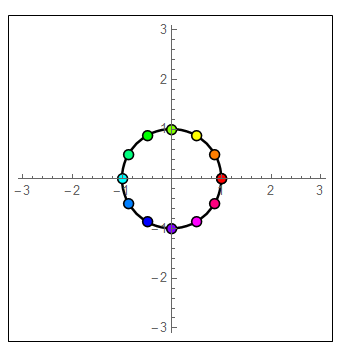
2

4

5

Linear Transforms and Dots

Consider the colored points, in the figure below, represented on a 2-dimensional plane LaTeX: [x\_1\,x\_2]^\top[ x 1 x 2 ] ⊤, where LaTeX: x\_1x 1 is the the horizontal axis and LaTeX: x\_2x 2 is the vertical axis. Which of the following figures best corresponds to result obtained after applying the transform LaTeX: T = \left[ \begin{array}{cc}1&0\\1&1 \end{array} \right]T = [ 1 0 1 1 ]?



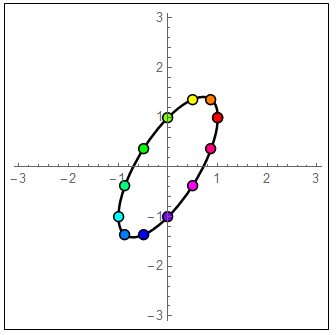
If images aren't the most accessible way for you to answer this question, please don't hesitate to reach out to the course staff so we can work with you.

Dots.a.png

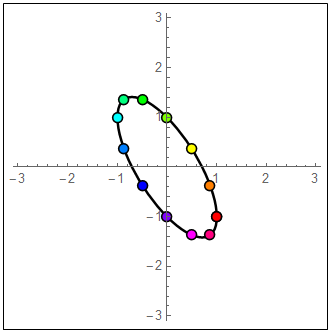
Chart, line chart

Description automatically generated

Dots.b.png



Dots.c.png



Correct Answer

dots.d.png

Chart

Description automatically generated

Rotation Matrices

Which of the following is strictly a rotation matrix, that is, a matrix which only rotates the space without scaling, stretching, flipping, or permuting it?

Correct Answer

LaTeX: \left[ \begin{array}{cc} 0.5 & -\frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & 0.5 \end{array} \right][ 0.5 − 3 2 3 2 0.5 ]

LaTeX: \left[ \begin{array}{cc} 0.1 & 0.3 \\ 0.2 & 0.3 \end{array} \right][ 0.1 0.3 0.2 0.3 ]

LaTeX: \left[ \begin{array}{lll} 0 & -1 & 0 \\1 & 0 & 0 \\ 0 & 0 & 0 \end{array} \right][ 0 − 1 0 1 0 0 0 0 0 ]

LaTeX: \left[ \begin{array}{cc} 0.5 & \frac{\sqrt{3}}{2} \\ \frac{\sqrt{3}}{2} & 0.5 \end{array} \right][ 0.5 3 2 3 2 0.5 ]

Subspaces

Let LaTeX: VV and LaTeX: WW be 6-dimensional subspaces of a 11-dimensional vector space LaTeX: XX. Which of the following CANNOT be the dimension of the subspace LaTeX: V \cap WV ∩ W?

Correct Answer

0

1

2

3

Products of Matrices

Consider the product between LaTeX: AA and LaTeX: BB where

LaTeX: A = \left[ \begin{array}{rrrrrr} -2 & 0 & -3 & 2 & -2 & 3\\1 & -2 & -2 & -2 & 3 & -3 \\2 & 2 & 1 & 0 & -3 & 1\\3 & 3 & -1 & 2 & 1 & 2 \end{array} \right]A = [ − 2 0 − 3 2 − 2 3 1 − 2 − 2 − 2 3 − 3 2 2 1 0 − 3 1 3 3 − 1 2 1 2 ] and LaTeX: B = \left[ \begin{array}{rrrr}0 & 0 & 0 & -2\\-3& -1 & -3 & -3 \\-1 & 3 & -1 & -2\\1 & 3 & 2 & -2\\-3 & -2 & -3 & 0\\-2 & -2 & -2 & -3 \end{array} \right]B = [ 0 0 0 − 2 − 3 − 1 − 3 − 3 − 1 3 − 1 − 2 1 3 2 − 2 − 3 − 2 − 3 0 − 2 − 2 − 2 − 3 ]. The value of the entry LaTeX: (2,4)( 2 , 4 ) in LaTeX: ABA B is:

Correct Answer

21

2

-12

-22

Fill in the Blank

Let LaTeX: {\bf v}\_1 = \left[\begin{array}{c}0\\0\\1\\2 \end{array}\right]v 1 = [ 0 0 1 2 ], LaTeX: {\bf v}\_2 = \left[ \begin{array}{r} 2\\3\\1\\-2 \end{array} \right]v 2 = [ 2 3 1 − 2 ], and LaTeX: {\bf v\_3} = \left[ \begin{array}{r}1\\0\\-1\\2 \end{array} \right]v 3 = [ 1 0 − 1 2 ]. What is the value of LaTeX: hh such that LaTeX: {\bf w} = \left[ \begin{array}{c} 4\\3\\h\\0\end{array} \right]w = [ 4 3 h 0 ] is a linear combination of LaTeX: {\bf v}\_1v 1, LaTeX: {\bf v\_2}v 2, and LaTeX: {\bf v}\_3v 3?

Correct Answer

-2

1

3

-5

Matrices and Operations

If LaTeX: A = \left[ \begin{array}{rr} 3 & 2\\ -1 &-2 \end{array} \right]A = [ 3 2 − 1 − 2 ]and LaTeX: B = \left[ \begin{array}{rr} 0 & -2 \\ -1 & 0 \end{array}\right]B = [ 0 − 2 − 1 0 ], which of the following statements is FALSE?

LaTeX: A + B = \left[ \begin{array}{rr} 3 & 0\\ -2 & -2 \end{array} \right]A + B = [ 3 0 − 2 − 2 ]

LaTeX: A - 2B = \left[ \begin{array}{rr}3 & 6\\ 1 & -2 \end{array} \right]A − 2 B = [ 3 6 1 − 2 ]

LaTeX: A^\top -B = \left[ \begin{array}{rr}3 & 1\\ 3 & -2 \end{array} \right]A ⊤ − B = [ 3 1 3 − 2 ]

Correct Answer

LaTeX: AB = \left[ \begin{array}{rr}0 & -4\\ 1 & 0 \end{array} \right]A B = [ 0 − 4 1 0 ]

Three Interpretations of Matrices

Which of the following statements is FALSE:

Correct Answer

A matrix can be seen as a transform because its columns are transformed when we multiply it by another matrix

A matrix can be seen as a data container because its columns can store information

A matrix can be seen as a space constructor because when we multiply it by a vector it is equivalent to getting a linear combination of its columns

A matrix can be seen as a data container because its rows can store information