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In [2]:
```
import numpy as np
```

Question 1: Find the Manhattan norm of the vector v= (2,3,4,5)

In [4]:
```
v = np.array([2,3,4,5])
man_norm = np.linalg.norm(v, ord=1)
man_norm
```

Out[4]:
```
14.0
```

Question 2: Compute the distance between the two points a=(1,2,3) and b=(-1,-1,0)

In [13]:
```
a = np.array([1,2,3])
b = np.array([-1,-1,0])

dist = np.linalg.norm(a-b)
dist
```

Out[13]:
```
4.69041575982343
```

Question 3: Compute the angle between the two vectors v=(1,2) and w=(-1,-1)

In [19]:
```
v = np.array([1,2])
w = np.array([-1,-1])

#Calcs the dot product of vectors
dot_product = np.sum(v * w)

#Clacs the magnitude
magnitude_v = np.linalg.norm(v)
magnitude_w = np.linalg.norm(w)

#Calcs the cosine
cos = dot_product / (magnitude_v * magnitude_w)

#Uses arccos to find the angle in radians then convert to degrees
angle_radians = np.arccos(cos)
angle_degrees = np.degrees(angle_radians)


print(f"Dot Product: {dot_product}")
print(f"Angle: {angle_degrees}")
```

```
Dot Product: -3
Angle: 161.565051177078
```

Question 4: Show that these two vectors are orthogonal v=(4,-2,3,5) and w = (-1,1,2,0)

In [27]:
```
v = np.array([4,-2,3,5])
w = ([-1,1,2,0])

dot_proudct = np.dot(v, w)
print(f"Dot Product: {dot_proudct}")
if dot_proudct == 0:
    print(f"Therefore the two vectors are orthogonal")
```

```
else:
    print(f"Therefore the two vectors are NOT orthogonal")
```

```
Dot Product: 0
Therefore the two vectors are orthogonal
```

Question 5: Find any unit vector orthogonal to v=(2,3,4)

In [42]:
```
v = np.array([2,3,4])
#reshape into column
v = v[:, np.newaxis]

#SVD to find an orthonormal basis
u, _, _ = np.linalg.svd(v, full_matrices=True)

#Extract a vector orthogonal to v
orthogonal_vector = u[:, 1]

#Normalize the orthogonal vector to make it a unit vector
unit_orthogonal_vector = orthogonal_vector / np.linalg.norm(orthogonal_vector)

print("Unit Orthogonal Vector:", unit_orthogonal_vector)

#Testing that its close to 0
print(np.dot(v.flatten(), unit_orthogonal_vector))
```

```
Unit Orthogonal Vector: [-0.55708601  0.77370064 -0.30173248]
2.220446049250313e-16
```

Question 6: Find the vector projection of a=(1,2,3) onto b = (3,-4,1)

In [46]:
```
a = np.array([1,2,3])
b = np.array([3,-4,1])

b_norm = np.sqrt(sum(b**2))

project_of_a_on_b = (np.dot(a, b)/b_norm**2)*b
project_of_a_on_b
```

Out[46]:
```
array([-0.23076923,  0.30769231, -0.07692308])
```

Question 7: Find the projection of the vector (1,1,1) onto the xy plane

In [54]:
```
v1 = np.ones(3)
n = np.array([0,0,1])

project_of_v_on_n = (np.dot(v1, n) / np.dot(n, n)) * n
project_of_v_on_n

ans = v1 - project_of_v_on_n
ans
```

Out[54]:
```
array([1., 1., 0.])
```

Question 8: Create 2 random vectors in R^4 and find the angle between them.

In [61]:
```
v1 = np.random.rand(4)
v2 = np.random.rand(4)

print(f"v1: {v1}\nv2:{v2}\n")
```

```python
dot_product = np.sum(v1 * v2)

magnitude_v1 = np.linalg.norm(v1)
magnitude_v2 = np.linalg.norm(v2)

cos = dot_product / (magnitude_v1 * magnitude_v2)

angle_radians = np.arccos(cos)
angle_degrees = np.degrees(angle_radians)

print(f"Dot Product: {dot_product}")
print(f"Angle: {angle_degrees}")
```

```
v1: [0.52112667 0.76843218 0.17947212 0.44167743]
v2:[0.42964886 0.52227694 0.2986239  0.75733376]

Dot Product: 1.0133277861251808
Angle: 23.45759568667726
```

Question 9: Find the distance between the point (1,-2,4) and the plane 3x + 2y+ 6z = 5

In [68]:

```python
v1 = np.array([1,-2,4])
plane_normal = np.array([3,2,6])
plane_const = 5

numerator = abs(np.dot(plane_normal, v1) - plane_const)

denominator = np.linalg.norm(plane_normal)

distance = numerator / denominator
distance
```

Out[68]:

```
2.5714285714285716
```

In [ ]:

```python

```