Matrix Algebra: Takeaways

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Syntax

- Using NumPy to multiply a matrix and a vector:

```
matrix_a = np.asarray([
[0.7, 3, 9],
[1.7, 2, 9],
[0.7, 9, 2]
], dtype=np.float32)
vector_b = np.asarray([
[1], [2], [1]
], dtype=np.float32)
ab_product = np.dot(matrix_a, vector_b)
```

- Using NumPy to compute the transpose of a matrix:

```
matrix_b = np.asarray([
[113, 3, 10],
[1, 0, 1],
], dtype=np.float32)
transpose_b = np.transpose(matrix_b)
```

- Using NumPy to create an identity matrix:

```
np.identity(3) # creates the 3x3 identity matrix
```

- Using NumPy to compute the inverse of a matrix:

```
matrix_c = np.asarray([
[30, -1],
[50, -1]
])
matrix_c_inverse = np.linalg.inv(matrix_c)
```

- Using NumPy to compute the determinant of a matrix:

```
matrix_22 = np.asarray([
[8, 4],
[4, 2]
])
det_22 = np.linalg.det(matrix_22)
```

Concepts

- Many operations that can be performed on vectors can also be performed on matrices. With matrices, we can perform the following operations:
    - Add and subtract matrices containing the same number of rows and columns.
    - Multiply a matrix by a scaler value.

    - Multiply a matrix with a vector and other matrices. To multiply a matrix by a vector or another matrix, the number of columns must match up with the number of rows in the vector or matrix. The order of multiplication does matter when multiplying matrices and vectors.
- Taking the transpose of a matrix switches the rows and columns of a matrix. Mathematically, we use the notation A^T to specify the transpose operation.
- The identity matrix contains 1 along the diagonal and 0 elsewhere. The identity matrix is often represented using I_n where n is the number of rows and columns.
- When we multiply with any vector containing two elements, the resulting vector matches the original vector exactly.
- To transform A into the identity matrix I in $A\vec{x} = \vec{b}$, we multiply each side by the inverse of matrix A.
- The inverse of a $2x2$ matrix can be found using the following:
    - If $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$, then $A^{-1} = \frac{1}{ad-bc}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$
- If the determinant of a $2x2$ matrix or $ad - bc$ is equal to 0, the matrix is **not** invertible. We can compute the determinant and matrix inverse only for matrices that have the same number of rows in columns. These matrices are known as square matrices.
- To compute the determinant of a matrix other than a $2x2$ matrix, we can break down the full matrix into minor matrices.

Resources

- Documentation for the dot product of two arrays
- Identity matrix
- Documentation for the transpose of an array

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