
ACSE_la

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CONTENTS

1	A Gaussian Elimination routine	3
2	A determinant routine	5
3	Citation	7

`acse_la` is a linear algebra library that implements Gaussian Elimination, matrix multiplication and calculating the determinant.

A GAUSSIAN ELIMINATION ROUTINE

This package implements Gaussian elimination [1] for list of lists and `numpy.ndarray` objects, along with hand-written matrix multiplication.

See `acse_la.gauss()` and `acse_la.gauss.matmul()` for more information.

`acse_la.gauss.gauss(a, b)`

Given two matrices, a and b , with a square, the determinant of a and a matrix x such that $a*x = b$ are returned. If b is the identity, then x is the inverse of a .

Parameters

- **a** (*np.array or list of lists*) – ‘n x n’ array
- **b** (*np.array or list of lists*) – ‘m x n’ array

Examples

```
>>> a = [[2, 0, -1], [0, 5, 6], [0, -1, 1]]
>>> b = [[2], [1], [2]]
>>> det, x = gauss(a, b)
>>> det
22.0
>>> x
[[1.5], [-1.0], [1.0]]
>>> A = [[1, 0, -1], [-2, 3, 0], [1, -3, 2]]
>>> I = [[1, 0, 0], [0, 1, 0], [0, 0, 1]]
>>> Det, Ainv = gauss(A, I)
>>> Det
3.0
>>> Ainv
[[2.0, 1.0, 1.0],
 [1.3333333333333333, 1.0, 0.6666666666666666],
 [1.0, 1.0, 1.0]]
```

Notes

See https://en.wikipedia.org/wiki/Gaussian_elimination for further details.

`acse_la.gauss.matmul(a, b)`

Matrix product of matrix *a* and matrix *b*.

Parameters

- **a** (*np.array* or *list of lists*) – ‘n x m’ array
- **b** (*np.array* or *list of lists*) – ‘m x l’ array

Returns out – The matrix product of the inputs.

Return type list of lists

Raises ValueError – If the number of columns of *a* is not the same as the number of rows *b*.

Notes

The output dimension depends on the dimensions of the input.

- For input matrices *a* = n x m and *b* = m x l, the output matrix will have dimensions n x l.

Examples

For 2-D arrays:

```
>>> a = np.array([[1, 2],
...              [3, 4]])
>>> b = np.array([[5, 1],
...              [6, 2]])
>>> matmul(a, b)
[[17, 5], [39, 11]]
```

For a 2-D array and 1-D array: `>>> a = np.array([[1, 2], ... [3, 4]]) >>> b = np.array([5, 6]) >>> matmul(a, b)`
[[17, 39]]

`acse_la.gauss.zeromat(a, b)`

Returns an array with dimension shape, filled with zeros.

Parameters shape (*tuple*) – Shape of output matrix

Returns out – Matrix with dimension p x q

Return type list of lists

Examples

```
>>> zeromat(2, 3)
[[0, 0, 0], [0, 0, 0]]
>>> zeromat(1, 3)
[[0, 0, 0]]
>>> zeromat(2, 1)
[[0], [0]]
```


A DETERMINANT ROUTINE

`acse_la.det.det(A)`

Compute the determinant of a matrix.

Parameters *A* (*np.array* or *list of lists*) – ‘N x N’ matrix

Returns *out* – The determinant of the matrix.

Return type float

Raises **ValueError** – If input is not square matrix

Notes

- The determinant is computed with LU decomposition, using Crout’s method. For further details see: Propp, J. G., Wilson, D. B. ‘Numerical Recipes’, Cambridge University Press. (1996).
- Pivoting is not yet implemented. Matrices with zero entries along diagonal can have unstable behaviour.

Examples

```
>>> det([[2, 9, 4], [7, 5, 3], [6, 1, 8]])
-360.0
>>> det([[0.5, 1.5], [4.2, 3.9]])
-4.35
```


CITATION

[1] <https://mathworld.wolfram.com/GaussianElimination.html>

[2] Propp, J. G., Wilson, D. B. 'Numerical Recipes', Cambridge University Press. (1996)