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# **l4mod**

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## L4MOD

This module implements Gaussian elimination<sup>1</sup> for `list of lists` objects, along with hand-written matrix multiplication.

See `l4mod.gauss()` and `l4mod.matmul()` for more information.

`l4mod.gauss(a, b)`

Given two matrices, *a* and *b*, with *a* square, the determinant of *a* (returned as *det*) and a matrix *x* (returned as *b*) such that  $a \cdot x = b$  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

### Returns

- **det** (*float*) – The determinant of *a*
- **b** (*np.array or list of lists*) – Solution of  $Ax=b$

### 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](https://en.wikipedia.org/wiki/Gaussian_elimination) for further details.

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

`l4mod.matmul(a, b)`

Given two matrices,  $a$  and  $b$ , the product of  $a$  and  $b$  is returned. If the number of columns of  $a$  is not equal to number of rows of  $b$ , a `ValueError` will be raised.

**Parameters**

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

**Returns** **c** – ‘n x l’ matrix which is the product of  $a$  and  $b$

**Return type** `np.array` or list of lists

**Examples**

```
>>> a = [[3, 1], [4, 2], [7, 5]]
>>> b = [[2], [1]]
>>> c = matmul(a, b)
>>> c
[[7], [10], [19]]
>>> m = [[1, 0, -1], [-2, 3, 0], [1, -3, 2], [3, 1, -2]]
>>> n = [[1, 3], [6, 5], [7, 8]]
>>> t = matmul(m, n)
>>> t
[[-6, -5], [16, 9], [-3, 4], [-5, -2]]
```

**Notes**

See [https://en.wikipedia.org/wiki/Matrix\\_multiplication](https://en.wikipedia.org/wiki/Matrix_multiplication) for details.

`l4mod.zeromat(p, q)`

Given two positive integers,  $p$  and  $q$ , a ‘p x q’ zero matrix is returned.

**Parameters**

- **p** (*int*) – Positive integer
- **q** (*int*) – Positive integer

**Returns** ‘p x q’ zero matrix

**Return type** list of lists

**Examples**

```
>>> p = 3
>>> q = 4
>>> x = zeromat(p, q)
>>> x
[[0, 0, 0, 0], [0, 0, 0, 0], [0, 0, 0, 0]]
>>> m = 3
>>> n = 2
>>> y = zeromat(m, n)
>>> y
[[0, 0], [0, 0], [0, 0]]
```

**Notes**

See [https://en.wikipedia.org/wiki/Zero\\_matrix](https://en.wikipedia.org/wiki/Zero_matrix) for further details.

**References**





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