

```

>> % MATLAB Recitation Demo for Monday, September 29.
>> % File: rdemo4
>> %
>> % *** Computing bases for the 4 fundamental subspaces
>> % *** of the matrix A.
>> %
>> % *** Reminder: From the Athena Dash menu, start MATLAB using
>> % *** Courseware / 18 Mathematics / 18.06 / 18.06 MATLAB
>> % *** Otherwise, MATLAB will not be able to find the new
>> % *** command "nullbasis" - which is used below.
>> %
>> % The MATLAB command basis(A) computes a matrix whose
>> % columns are a basis for the column space of A.
>> % The MATLAB command nullbasis(A) computes a matrix whose
>> % columns are a basis for the nullspace of A.
>> % The PA = LU factorization is used to obtain the row space of A
>> % via the pivot rows of U.
>> %
>> diary rdemo4
>>
>> % Let's enter a matrix with 3 rows and 5 columns, and compute
>> % bases for its column space, nullspace, row space and left
>> % nullspace.
>> %
>> A = [-1  3  8  -2  1;
        -1  3  9  -1  3;
         1 -3 -9   1 -3]
A =
    -1     3     8    -2     1
    -1     3     9    -1     3
     1    -3    -9     1    -3

>> [m, n] = size(A)
m =
     3
n =
     5

>> r = rank(A)
r =
     2

>> help plu
PLU    Pivoting, rectangular, LU factorization.

```

$[P, L, U] = \text{PLU}(A)$, for a rectangular matrix A , uses Gaussian elimination to compute a permutation matrix P , a lower triangular matrix L and an upper trapezoidal matrix U so that $L*U = P*A$.
 U is the same size as A . P and L are square, with as many rows as A .
See also `SLU`, `LU`, `REF`, `SOLVE`, `NULL`, `BASIS`.

```
>> [P, L, U] = plu(A)
Pivots in columns:
     1     3
No pivots in columns:
     2     4     5
Pivots in rows:
     1     2
P =
     1     0     0
     0     1     0
     0     0     1
L =
     1     0     0
     1     1     0
    -1    -1     1
U =
    -1     3     8    -2     1
     0     0     1     1     2
     0     0     0     0     0

>> colspace = basis(A)
rank =
     2
colspace =
    -1     8
    -1     9
     1    -9

>> nullspace = nullbasis(A)
nullspace =
     3    -10    -15
     1     0     0
     0     -1     -2
     0     1     0
     0     0     1

>> % The pivot rows of U are a basis for
```

```
>> % the row space of A.  
>> %  
>> rowspace = [U(1,:) U(2,:)']  
rowspace =  
    -1     0  
     3     0  
     8     1  
    -2     1  
     1     2  
  
>> leftnull = nullbasis(A')  
leftnull =  
     0  
     1  
     1  
  
>> diary off
```