Sure, here are the step-by-step instructions for finding LU factorization of a matrix with an example:

Step 1: Write down the matrix

Let's take the following matrix as an example:

```
A = [[4, -2, 1],
    [20, -7, 12],
    [-8, 13, 17]]
```

Step 2: Decompose the matrix into an upper and lower triangular matrix

To do this, we first find the lower triangular matrix `L` and the upper triangular matrix `U`. We start by assuming that the diagonal elements of `L` are all equal to 1. Then, we apply Gaussian elimination to `A` to get `U`.

```
A = [[4, -2, 1],
    [20, -7, 12],
    [-8, 13, 17]]
```

Step 3: Perform row operations on `A` to get `U`

We can use row operations to transform `A` into `U` by applying elementary matrices. The goal is to eliminate the entries below the diagonal of `A`. The elementary matrices are stored in `L`. We can start by subtracting 5 times the first row from the second row, and adding 2 times the first row to the third row:

```

A = [[4, -2, 1],
     [20, -7, 12],
     [-8, 13, 17]]

L1 = [[1, 0, 0],
      [-5, 1, 0],
      [2, 0, 1]]

A1 = L1 @ A

A1 = [[4, -2, 1],
      [0, 3, 7],
      [0, 9, 19]]

Step 4: Continue with row operations until `A` is transformed to `U`

We can continue the process by subtracting 3 times the second row from the third row, and applying the corresponding elementary matrix `L2` to `A1`:

```

A1 = [[4, -2, 1],
      [0, 3, 7],
      [0, 9, 19]]

L2 = [[1, 0, 0],
      [0, 1, 0],
      [0, -3, 1]]

U = L2 @ A1

U = [[4, -2, 1],
    [0, 3, 7],
    [0, 0, -4]]

Step 5: Write down the final `L` matrix

Now that we have `U`, we can write down `L` as the product of the elementary matrices `L1` and `L2`:

```
L = L2 @ L1

L = [[1, 0, 0],
    [5, 1, 0],
    [-2, 3, 1]]
```

Step 6: Check the result

To verify that we have correctly found the LU factorization, we can multiply `L` and `U` together and check that we get the original matrix `A`:

```
A = [[4, -2, 1],
    [20, -7, 12],
    [-8, 13, 17]]

L = [[1, 0, 0],
```

```
    [5, 1, 0],
    [-2, 3, 1]]

U = [[4, -2, 1],
    [0, 3, 7],
    [0, 0, -4]]

LU = L @ U

LU = [[4
```