

THE COMPLETE SOLUTION TO $A\mathbf{x} = \mathbf{b}$ (PART I)

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OVERVIEW

The goal of this lab will be to implement an algorithm for finding the complete solution to $A\mathbf{x} = \mathbf{b}$ (if it has a solution). Comprehensive usage of the `for` and `if` structures are required. Several new MATLAB commands are introduced. One major goal is to convert pseudocode into formal MATLAB code.

ACTIVITIES

- Shortening vectors:

```
>> v = [-7 -2 -6 0 4]
>> v(1) = ''      % delete the 1st element of v
>> u = [3 3 -5 -3 -7]
>> u([1 2 5]) = '' % delete 1st, 2nd, and 5th elements of u
```

- Extending vectors:

```
>> v = []      % create a vacant vector
>> v = [v,3]
>> v = [v,[9 -4]]
```

- **fprintf(format string, data);** formats output, where *format string* describes the format of the output fields. Below `%d` denotes that we will input a variable of type double in that place. We then specify what that value is with commas after the line we are printing. `\n` will move down to the next line. For example, type

```
>> y = [-1 -3 -6 7];
>> fprintf('The second element in y is %d.\n',y(2));
>>bob_age=23;
>>sally_age=19;
>>fprintf('Bob is %d years old, and Sally is %d years young \n',
bob_age, sally_age);
```

Feel free to look up other ways to display things in MATLAB and other features of the display command, but these should suffice for this lab.

- Pseudocode is an informal description of an algorithm that uses a combination of a programming language and ordinary language. It is intended to be read by human beings as opposed to machines.

Goal: For a given matrix A , determine its reduced row echelon form and list its pivot and free variables.

Pseudo-code:

```
function csolve(A)    % actual MATLAB code
    obtain the size of A
    pivot = vacant vector    % initialize 'pivot'
    free = [1,2,..., # of columns of A]    % initialize 'free'
    rreform = rref(A);    % actual MATLAB code, rref(A) returns reduced row
    echlon form of A
    for i from 1 to # of rows of A    % visit every row
        for j from 1 to # of columns of A    % visit every column
            if(rreform(i,j) == 1)    % check for a leading 1
                pivot = [pivot,j];    % save the pivot column
                break;    % actual MATLAB code
            end
        end
    end
    remove all the elements in 'pivot' from 'free'
    output results    % rank(A) = the length of 'pivot'
end
```

Actual code:

```
function csolve(A)
    [m,n] = size(A);
    pivot = []; %set pivot as a vacant vector
    free = 1:n;
    rreform = rref(A);
    for i = 1:m
        for j = 1:n
            if(rreform(i,j)==1) %check for a pivot variable
                pivot=[pivot,j]; %update pivot with new pivot variable
                break;
            end
        end
    end
    free(pivot)=''; %remove the pivot variables from free
    %print the results
    fprintf('Rank of A is %i', length(pivot));
    fprintf('\nPivot variables :'); fprintf('x%d',pivot);
    fprintf('\nFree variables:'); fprintf('x%d',free);
    fprintf('\n');
end
```