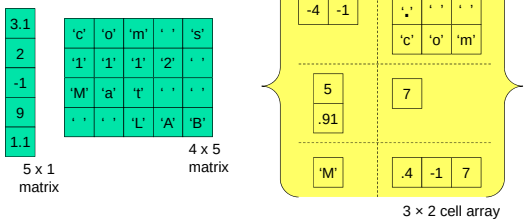
- Previous Lecture:
  - Intro to cell arrays
  - File input/output
- Today's Lecture:
  - More on cell arrays
  - Detailed file I/O example
- Announcements:
  - Project 5 due Thursday at 11pm
  - Prelim 2 on Nov 6th (Tues) at 7:30pm
  - Review questions will be posted and there'll be a review session Sunday Nov 4th 1-2:30pm in HLS B14

Matrix vs. Cell Array

Vectors and matrices store values of the same type in all components

A cell array is a special array whose individual components may contain different types of data



5 x 1 matrix

4 x 5 matrix

3 × 2 cell array

Example: Represent a deck of cards with a cell array

```
D{1} = 'A Hearts';
D{2} = '2 Hearts';
          :
D{13} = 'K Hearts';
D{14} = 'A Clubs';
          :
D{52} = 'K Diamonds';
```

But we don't want to have to type all combinations of suits and ranks in creating the deck... How to proceed?

Make use of a suit array and a rank array …

```
suit = {'Hearts', 'Clubs', …
        'Spades', 'Diamonds'};

rank = {'A','2','3','4','5','6',…
    '7','8','9','10','J','Q','K'};
```

Then concatenate to get a card. E.g.,

```
str = [rank{3} ' ' suit{2} ];
D{16} = str;
```

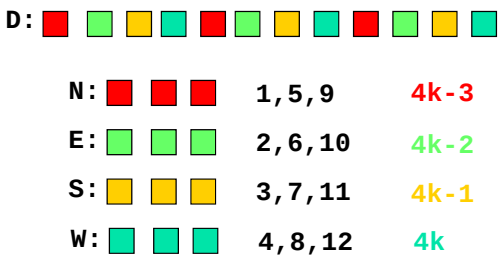
So **D{16}** stores **'3 Clubs'**

To get all combinations, use nested loops

```
i = 1;  % index of next card

for k= 1:4
   % Set up the cards in suit k
   for j= 1:13
      D{i} = [ rank{j} ' ' suit{k} ];
      i = i+1;
   end
end
```

See function **CardDeck**

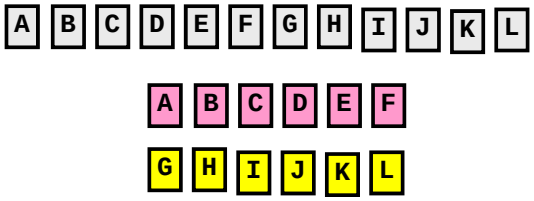
Example: deal a 12-card deck



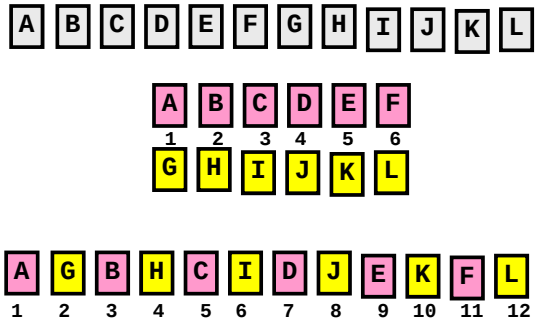
```
% Deal a 52-card deck
N = cell(1,13); E = cell(1,13);
S = cell(1,13); W = cell(1,13);

for k=1:13
   N{k} = D{4*k-3};
   E{k} = D{4*k-2};
   S{k} = D{4*k-1};
   W{k} = D{4*k};
end
```

See function **Deal**

Perfect Shuffle, Step 1: cut the deck



Perfect Shuffle, Step 2: Alternate



Example: Build a cell array of Roman numerals for 1 to 3999

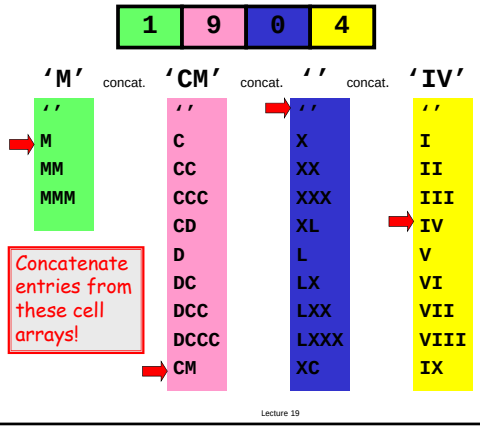
```
C{1} = 'I'
C{2} = 'II'
C{3} = 'III'
   :
C{2007} = 'MMVII'
   :
C{3999} = 'MMMXMXCIX'
```


Example

1904 = 1*1000 + 9*100 + 0*10 + 4*1

= M CM IV

= MCMIV



Ones-Place Conversion

```
function r = Ones2R(x)
% x is an integer that satisfies
%      0 <= x <= 9
% r is the Roman numeral with value x.

Ones = {'I', 'II', 'III', 'IV', ...
        'V', 'VI','VII', 'VIII', 'IX'};

if x==0
     r = '';
else
     r = Ones{x};
end
```


Similarly, we can implement these functions:

```
function r = Tens2R(x)
% x is an integer that satisfies
%      0 <= x <= 9
% r is the Roman numeral with value 10*x.
```

```
function r = Hund2R(x)
% x is an integer that satisfies
%      0 <= x <= 9
% r is the Roman numeral with value 100*x
```

```
function r = Thou2R(x)
% x is an integer that satisfies
%      0 <= x <=3
% r is the Roman numeral with value 1000*x
```


Now we can build the Roman numeral cell array for 1,…,3999

```
for a = 0:3  % possible values in thous place
  for b = 0:9  % values in hundreds place
    for c = 0:9  % values in tens place
      for d = 0:9  % values in ones place
        n = a*1000 + b*100 + c*10 + d;
        if n>0
          C{n} = [Thou2R(a) Hund2R(b)...
                  Tens2R(c) Ones2R(d)];
        end
      end
    end
  end
end
```

Four strings concatenated together

The n^{th} component of cell array C

The reverse conversion problem

Given a Roman Numeral, compute its value.
Assume cell array `C(3999,1)` available where:

```
C{1} = 'I'
C{2} = 'II'
   :
C{3999} = 'MMMCMXCIX'
```



```
function k = RN2Int(r)
% r is a string that represents
%      Roman numeral (<=3999)
% k is its value

C = RomanNum();
k = 1;
while ~strcmp(r,C{k})
   k=k+1;
end
```

See **RN2Int.m**

Example: subset of clicker IDs

IDs

```
['d091314'; ...
 'h134d83'; ...
 'h4567s2'; ...
 'fr83209']
```

Find subset that begins with 'h'

L

```
{'h134d83', ...
 'h4567s2'}
```

```
L= {};
k= 0;
for r=1:size(IDs,1)
  if IDs(r,1)=='h'
    k= k+1;
    L{k }= IDs(r,:);
  end
end
```

Directly assign into a particular cell—good!

```
L= {};

for r=1:size(ID,1)
  if IDs(r,1)=='h'

    L= [L, IDs(r,:)];
  end
end
```

Concatenate cells or cell arrays—prone to problems!

A detailed sort-a-file example

Suppose each line in the file

`statePop.txt`

is structured as follows:

Cols 1-14: State name
Cols 16-24: Population (millions)

The states appear in alphabetical order.

A detailed sort-a-file example

Create a new file

`statePopSm2Lg.txt`

that is structured the same as **`statePop.txt`** except that *the states are ordered from smallest to largest according to population.*

```
Alabama          4557808
Alaska            663661
Arizona          5939292
Arkansas         2779154
California      36132147
Colorado         4665177
   :                :
   :                :
```

- Need the pop as *numbers* for sorting.
- Can't just sort the pop— have to maintain association with the state names.

First, get the populations into an array

```
C = file2cellArray('StatePop');
n = length(C);
pop = zeros(n,1);
for i=1:n
  S = C{i};
  pop(i) = str2double(S(16:24));
end
```

Converts a string representing a numeric value (digits & decimal point) to the numeric value → scalar of type double. E.g., `x=str2double('3.24')` assigns to variable `x` the numeric value 3.24

Built-In function `sort`

Syntax: `[y,idx] = sort(x)`

x:	10	20	5	90	15
y:	5	10	15	20	90
idx:	3	1	5	2	4

`y(1) = x(3) = x(idx(1))`

Built-In function `sort`

Syntax: `[y,idx] = sort(x)`

x:	10	20	5	90	15
y:	5	10	15	20	90
idx:	3	1	5	2	4

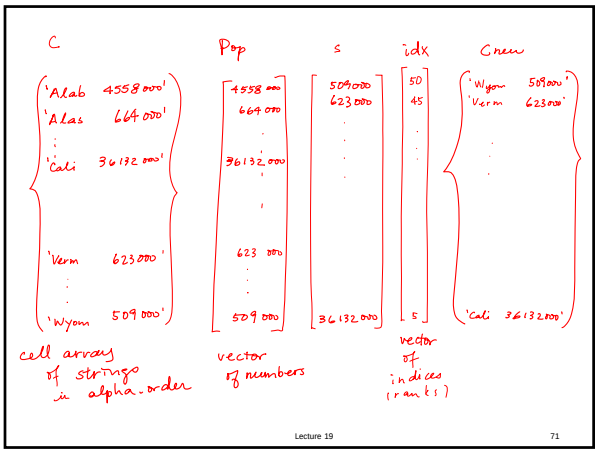
`y(2) = x(1) = x(idx(2))`

Built-In function `sort`

Syntax: `[y,idx] = sort(x)`

x:	10	20	5	90	15
y:	5	10	15	20	90
idx:	3	1	5	2	4

`y(k) = x(idx(k))`



Sort from little to big

```
% C is cell array read from statePop.txt
% pop is vector of state pop (numbers)
[s,idx] = sort(pop);
Cnew = cell(n,1);
for i=1:length(C)
    ithSmallest = idx(i);
    Cnew{i} = C{ithSmallest};
end

cellArray2file(Cnew,'statePopSm2Lg')
```