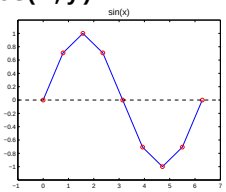
- Previous class:
  - User-defined function
  - Nested loops
- Now:
  - Working with colors
  - 1-dimensional array—vector
  - Algorithm for finding the best item in a set

## Generating tables and plots

| x | sin(x) |
|---|---|
| 0.000 | 0.000 |
| 0.784 | 0.707 |
| 1.571 | 1.000 |
| 2.357 | 0.707 |
| 3.142 | 0.000 |
| 3.927 | -0.707 |
| 4.712 | -1.000 |
| 5.498 | -0.707 |
| 6.283 | 0.000 |

`x`, `y` are vectors. A vector is a 1-dimensional list of values

```
x= linspace(0,2*pi,9);
y= sin(x);
plot(x,y)
```




Note: x, y are shown above as columns due to screen space; they are rows.

## Built-in function `linspace`

```
x= linspace(1,3,5)
```

| x | 1.0 | 1.5 | 2.0 | 2.5 | 3.0 |
|---|---|---|---|---|---|

```
x= linspace(0,1,101)
```

| x | 0.00 | 0.01 | 0.02 | ... | 0.99 | 1.00 |
|---|---|---|---|---|---|---|

1st value in vector

Last value in vector

Number of points

5

## How did we get all the sine values?

| x | sin(x) |
|---|---|
| 0.00 | 0.0 |
| 1.57 | 1.0 |
| 3.14 | 0.0 |
| 4.71 | -1.0 |
| 6.28 | 0.0 |

Built-in functions accept arrays

| 0.00 | 1.57 | 3.14 | 4.71 | 6.28 |
|---|---|---|---|---|

sin

and return arrays

| 0.00 | 1.00 | 0.00 | -1.00 | 0.00 |
|---|---|---|---|---|

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## Vectorized addition

| | | | | | |
|---|---|---|---|---|---|
| | x | 2 | 1 | .5 | 8 |
| + | y | 1 | 2 | 0 | 1 |
| = | z | 3 | 3 | .5 | 9 |

Matlab code: `z= x + y`

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## Vectorized multiplication

| | | | | | |
|---|---|---|---|---|---|
| | a | 2 | 1 | .5 | 8 |
| × | b | 1 | 2 | 0 | 1 |
| = | c | 2 | 2 | 0 | 8 |

Matlab code: `c= a .* b`

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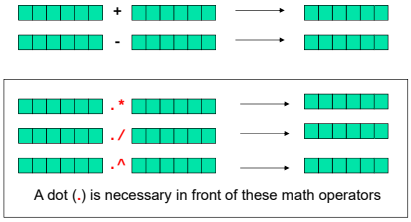
## Vectorized
element-by-element arithmetic operations on arrays

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## Shift

| | | | | | |
|---|---|---|---|---|---|
| | x | 3 | | | |
| + | y | 2 | 1 | .5 | 8 |
| = | z | 5 | 4 | 3.5 | 11 |

Matlab code: `z= x + y`

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## Reciprocate

| | | | | | |
|---|---|---|---|---|---|
| | x | 1 | | | |
| / | y | 2 | 1 | .5 | 8 |
| = | z | .5 | 1 | 2 | .125 |

Matlab code: `z= x ./ y`

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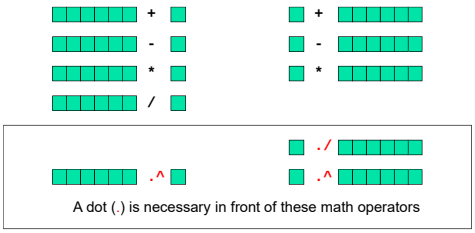
## Vectorized
element-by-element arithmetic operations between an array and a scalar




The dot in .*, .*, ./ not necessary but OK

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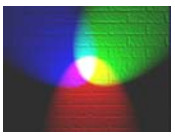
## Color is a 3-vector, sometimes called the RGB values

- Any color is a mix of red, green, and blue
- Example:

```
colr= [0.4  0.6  0]
```

- Each component is a real value in [0,1]
- [0 0 0] is black
- [1 1 1] is white
- [.2 .2 .2] is dark gray
- [.4 .6 .1] is a colorized hue



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## Mix two colors

Implement this function:

```
function newc = mixEqual(c1,c2)
% Average colors c1 and c2.
% c1, c2, and newc are vectors
%   representing colors.
% Display the three colors.
```

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## 1-d array: **vector**

- An array is a named collection of like data organized into rows or columns
- A 1-d array is a row or a column, called a *vector*
- An *index* identifies the position of a value in a vector

| score | 93 | 92 | 87 | 0 | 90 | 82 |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |

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## Array index starts at 1

| x | 5 | .4 | .91 | -4 | -1 | 7 |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |

Let k be the index of vector x, then

- k must be a positive integer
- 1<= k <= length(x)
- To access the $k^{th}$ element: x(k)

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## Accessing values in a vector

| score | 93 | 99 | 87 | 80 | 85 | 82 |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |

Given the vector **score** …

```
score(4)= 80;
score(5)= (score(4)+score(5))/2;
k= 1;
score(k+1)= 99;
```

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## A few different ways to create a vector (More later!)

```
count= zeros(1,6)
```

| count | 0 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|

```
x= linspace(10,30,5)
```

| x | 10 | 15 | 20 | 25 | 30 |
|---|---|---|---|---|---|

```
y= [3 7 2 1]
```

| y | 3 | 7 | 2 | 1 |
|---|---|---|---|---|

```
Z= [3; 7; 2]
```

| z |
|---|
| 3 |
| 7 |
| 2 |

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## Drawing a single line segment

```
a= 0;  % x-coord of pt 1
b= 1;  % y-coord of pt 1
c= 5;  % x-coord of pt 2
d= 3;  % y-coord of pt 2
plot([a c], [b d], '-*')
```

Line/marker format

x-values (a vector)

y-values (a vector)

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## Drawing a polygon (multiple line segments)

```
% Draw a rectangle with the lower-left
% corner at (a,b), width w, height h.
x= [                    ];  % x data
y= [                    ];  % y data
plot(x, y)
```

Fill in the missing vector values!

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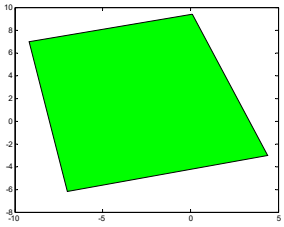
```
x= [0.1 -9.2  -7  4.4];
y= [9.4  7   -6.2  -3];
fill(x,y,'g')
```



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## Example

- Write a program fragment that calculates the cumulative sums of a given vector **v**.
- The cumulative sums should be stored in a vector of the same length as **v**.

1, 3, 5, 0 **v**

1, 4, 9, 9 cumulative sums of **v**

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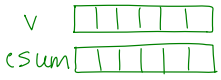


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## Common loop pattern to process a vector

```
% v is a given vector
for  k = 1:length(v)
    % work with v(k)


end
```

## A twinkling constellation

- Write a script that generates 9 random positions—the configuration of my constellation
- Simulate 10 rounds of twinkling
  - In each round, each star is equally likely to be lit or black
- Can you add some random adjustment to the color of the star?

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Algorithm: Finding the best in a set

```
Init bestSoFar
Loop over set
   if current is better than bestSoFar
      bestSoFar ← current
   end
end
```

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