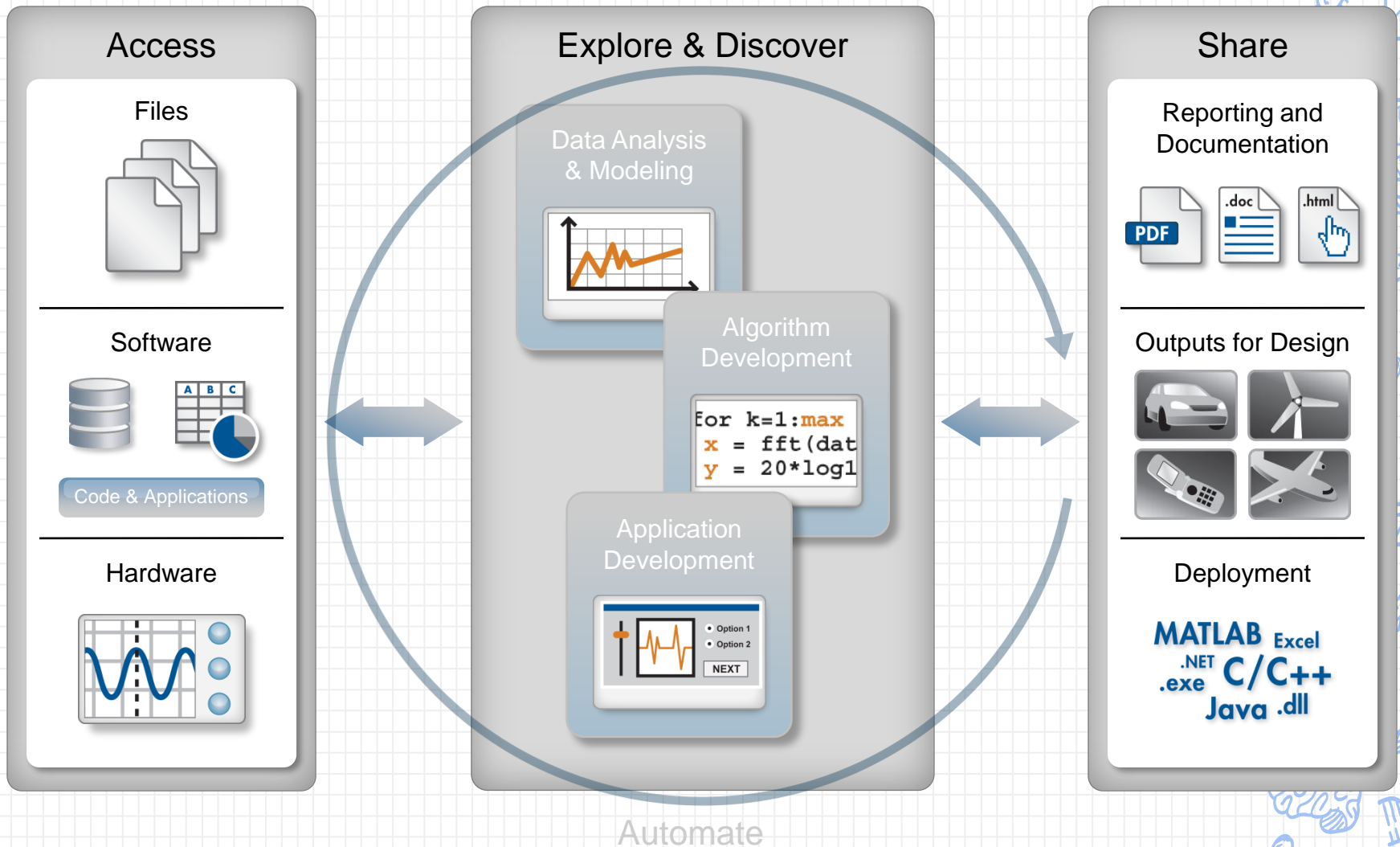


Analyzing Data with MATLAB

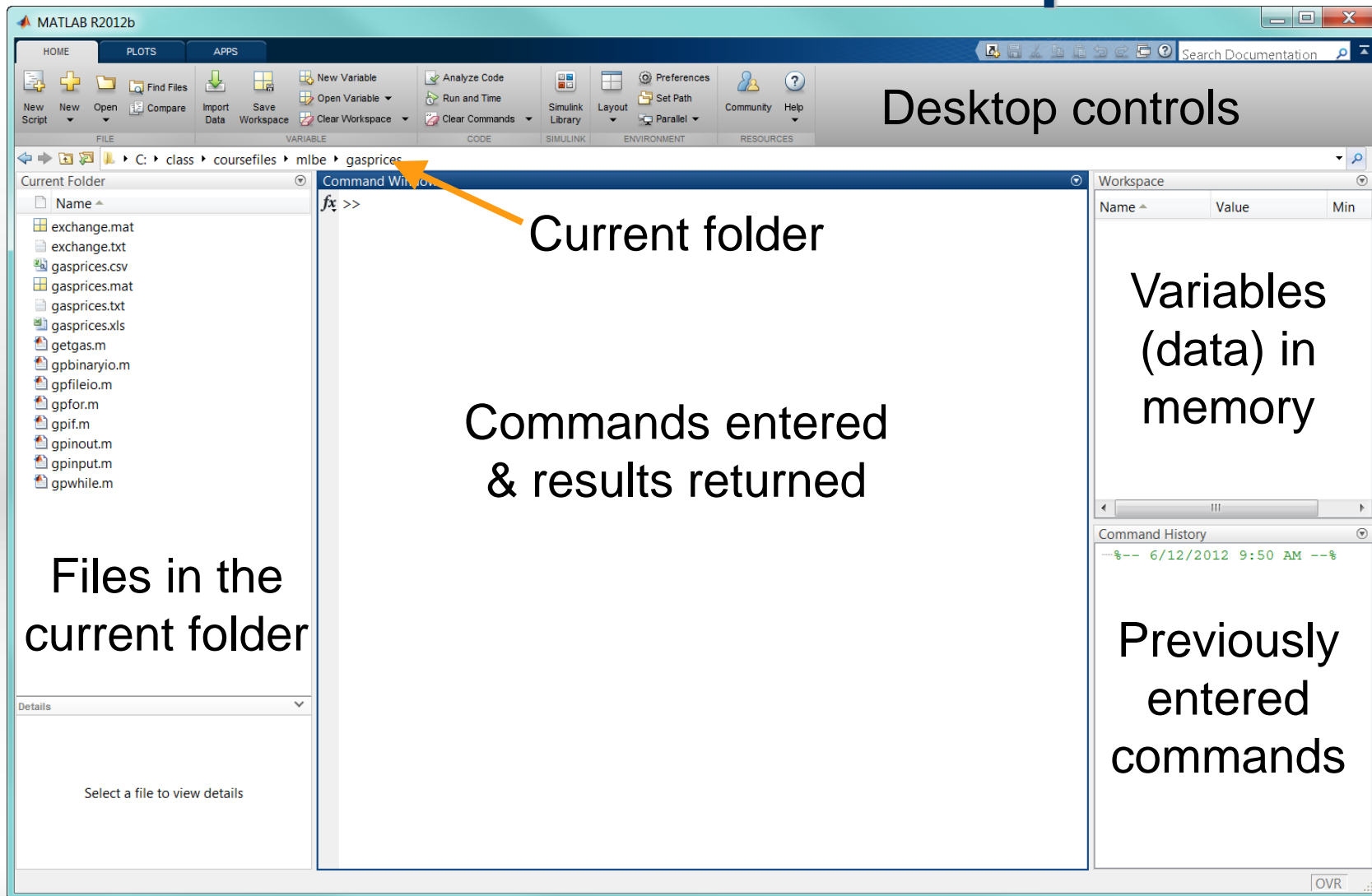


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Technical Computing Workflow



The MATLAB® Desktop



Desktop controls

Current folder

Files in the current folder

Commands entered & results returned

Variables (data) in memory

Previously entered commands

The screenshot shows the MATLAB R2012b Desktop environment. The top toolbar includes tabs for HOME, PLOTS, and APPS, with various icons for file operations, workspace management, and code execution. The main workspace is divided into four panes: Current Folder (left), Command Window (center), Workspace (right), and Command History (bottom right). The Current Folder pane shows a list of files in the 'C:\class\coursefiles\mlbe\gasprices' directory. The Command Window shows the prompt 'fx >>'. The Workspace pane shows a table with columns 'Name', 'Value', and 'Min'. The Command History pane shows a list of previously entered commands.

Assignment

```
>> no_of_penguins = x*sin(pi*t);
```

1. evaluate right-hand side

2. assign resulting value to variable on left-hand side

create new variable or
overwrite old one,
as appropriate



Creating Matrices

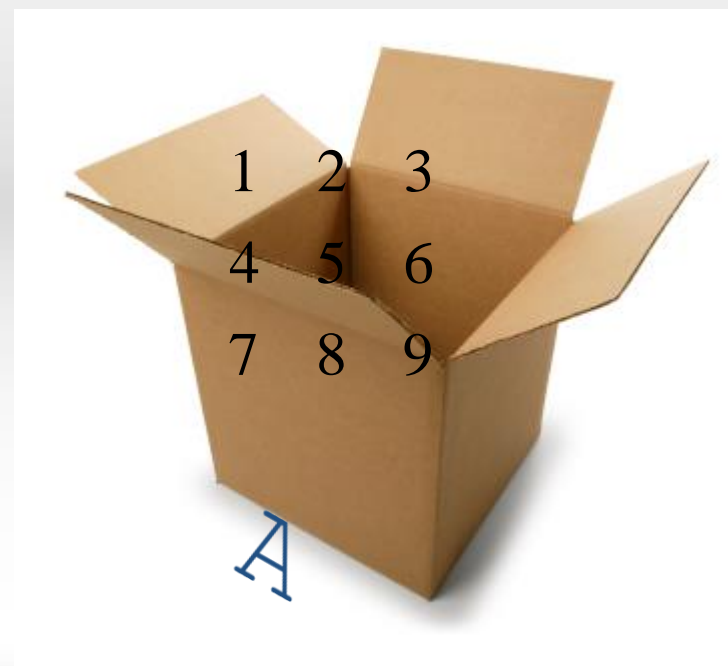
```
>> A = [1,2,3; 4,5,6; 7,8,9];
```

or

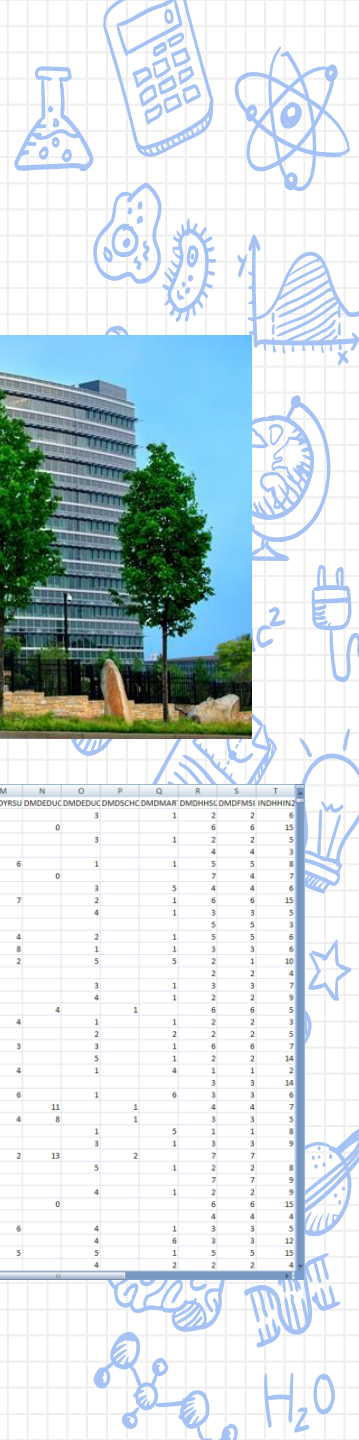
```
>> A = [1 2 3; 4 5 6; 7 8 9];
```

or

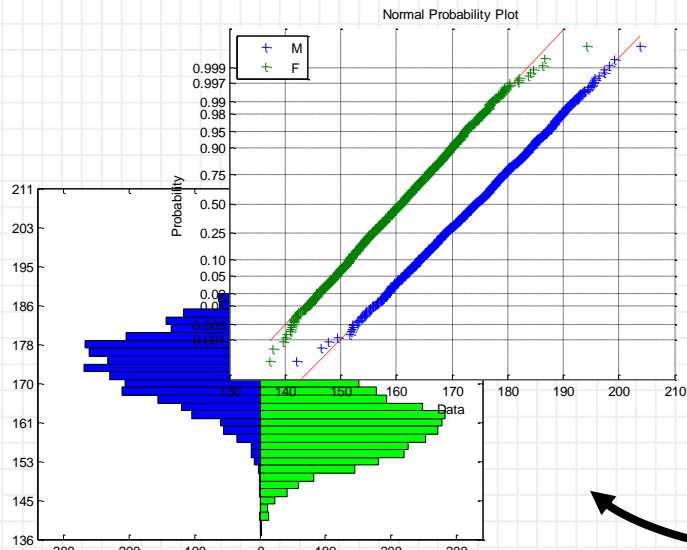
```
>> A = [1 2 3  
4 5 6  
7 8 9] } data entry  
mode
```



Course Example: Biomedical Data

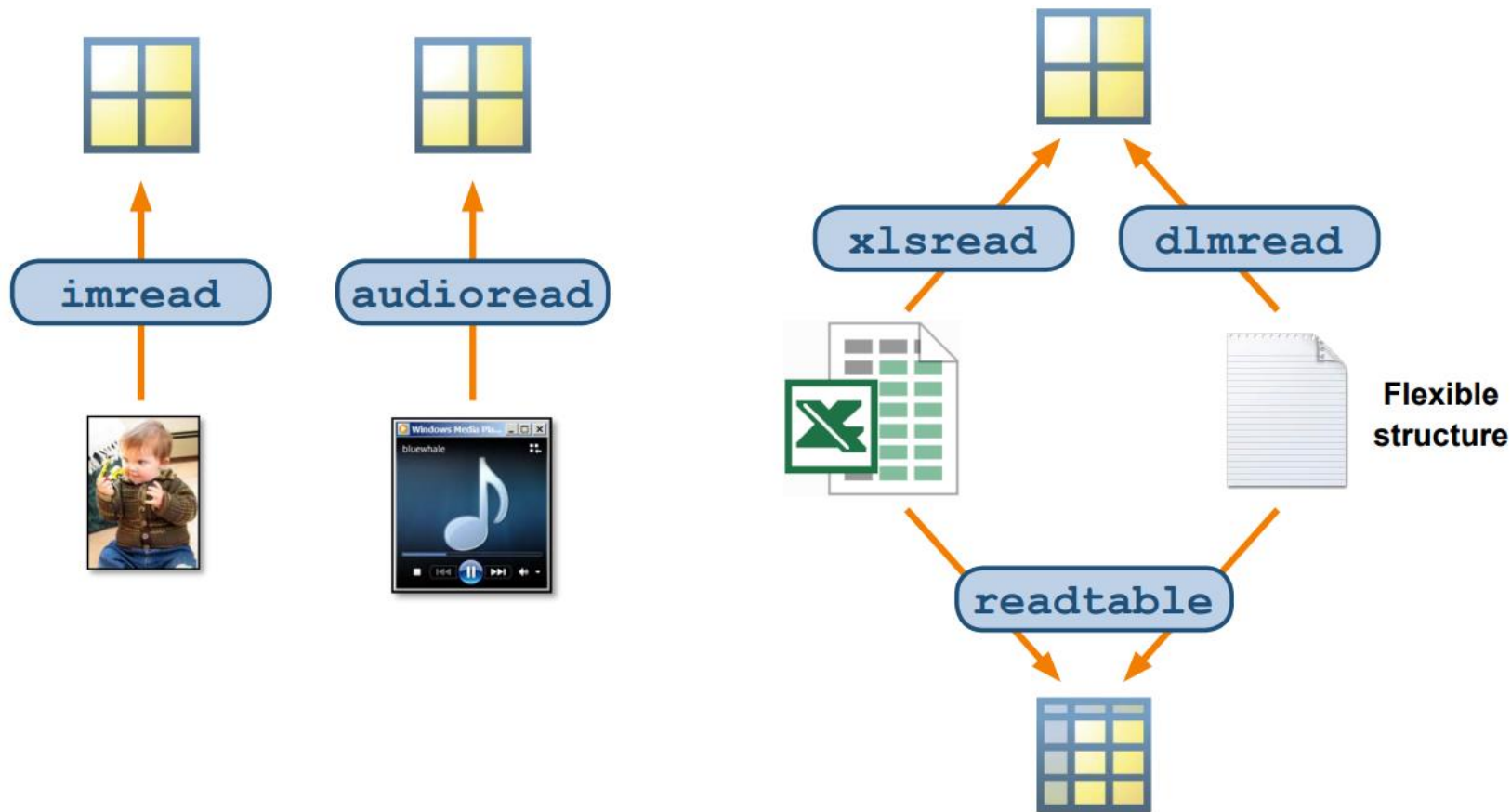


NHANES



| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T |
|----|-------|----------|----------|----------|---------|----------|----------|----------|---------|--------|---------|---------|--------|---------|---------|---------|--------|---------|---------|---------|
| 1 | SEGN | SDOSKVVY | RIDSTATR | RIDEXMHI | RIAGENF | RIDAGEYR | RIDAGEMF | RIDAGEEX | RIDRETH | DMQMLU | DMDOBOP | DMDCITZ | DMOVSU | DMDEUDC | DMDEUDC | DMDSCHC | DMDMAR | DMDHSHL | DMDSMSI | INSHHNZ |
| 2 | 41475 | 5 | 2 | 2 | 2 | 62 | 751 | 752 | 5 | 2 | 1 | 1 | | | | | | | | |
| 3 | 41476 | 5 | 2 | 1 | 2 | 6 | 81 | 82 | 5 | 2 | 1 | 1 | | | | | | | | |
| 4 | 41477 | 5 | 2 | 2 | 2 | 1 | 71 | 859 | 860 | 3 | 1 | 1 | 1 | | | | | | | |
| 5 | 41478 | 5 | 2 | 2 | 2 | 1 | 17 | 17 | 3 | | | 1 | 1 | | | | | | | |
| 6 | 41479 | 5 | 2 | 1 | 1 | 52 | 629 | 630 | 1 | 2 | 2 | 1 | | 6 | | | | | | |
| 7 | 41480 | 5 | 2 | 1 | 1 | 6 | 81 | 81 | 1 | | 1 | 1 | | | 0 | | | | | |
| 8 | 41481 | 5 | 2 | 1 | 1 | 21 | 254 | 254 | 4 | 2 | 1 | 1 | | | | | | | | |
| 9 | 41482 | 5 | 2 | 2 | 1 | 64 | 778 | 779 | 1 | 2 | 2 | 2 | | 7 | | | | | | |
| 10 | 41483 | 5 | 2 | 1 | 1 | 66 | 805 | 804 | 4 | 1 | 1 | 1 | | | | | | | | |
| 11 | 41484 | 5 | 2 | 1 | 1 | 0 | 9 | 30 | 3 | | | 1 | 1 | | | | | | | |
| 12 | 41485 | 5 | 2 | 1 | 2 | 30 | 360 | 361 | 2 | 2 | 4 | 1 | | 4 | | | | | | |
| 13 | 41486 | 5 | 2 | 1 | 2 | 61 | 734 | 735 | 1 | 2 | 2 | 1 | | 8 | | | | | | |
| 14 | 41487 | 5 | 2 | 1 | 1 | 27 | 331 | 332 | 5 | 2 | 5 | 2 | | 2 | | | | | | |
| 15 | 41488 | 5 | 2 | 1 | 1 | 5 | 61 | 61 | 1 | | 1 | 1 | | | | | | | | |
| 16 | 41489 | 5 | 2 | 1 | 2 | 40 | 482 | 483 | 1 | 2 | 1 | 1 | | | | | | | | |
| 17 | 41490 | 5 | 2 | 2 | 2 | 66 | 802 | 803 | 4 | 2 | 1 | 1 | | | | | | | | |
| 18 | 41491 | 5 | 2 | 2 | 2 | 11 | 134 | 136 | 3 | | | 1 | | | | | | | | |
| 19 | 41492 | 5 | 2 | 2 | 1 | 72 | 866 | 866 | 3 | 2 | 5 | 1 | | 4 | | | | | | |
| 20 | 41493 | 5 | 2 | 2 | 2 | 77 | 934 | 935 | 3 | 2 | 1 | 1 | | | | | | | | |
| 21 | 41494 | 5 | 2 | 1 | 1 | 40 | 480 | 481 | 1 | 2 | 2 | 2 | | 3 | | | | | | |
| 22 | 41495 | 5 | 2 | 1 | 1 | 61 | 739 | 740 | 3 | 2 | 1 | 1 | | | | | | | | |
| 23 | 41496 | 5 | 2 | 2 | 2 | 64 | 776 | 777 | 1 | 2 | 2 | 2 | | 4 | | | | | | |
| 24 | 41497 | 5 | 2 | 2 | 2 | 2 | 27 | 28 | 5 | | 1 | 1 | | | | | | | | |
| 25 | 41498 | 5 | 2 | 1 | 1 | 68 | 824 | 826 | 4 | 2 | 5 | 1 | | 6 | | | | | | |
| 26 | 41499 | 5 | 2 | 1 | 2 | 17 | 210 | 211 | 1 | 2 | 1 | 1 | | | | | | | | |
| 27 | 41500 | 5 | 2 | 1 | 1 | 14 | 179 | 180 | 1 | | 2 | 2 | | 4 | | | | | | |
| 28 | 41501 | 5 | 2 | 1 | 1 | 70 | 846 | 847 | 3 | 2 | 1 | 1 | | | | | | | | |
| 29 | 41502 | 5 | 2 | 1 | 1 | 29 | 353 | 354 | 1 | 2 | 1 | 1 | | | | | | | | |
| 30 | 41503 | 5 | 2 | 2 | 1 | 18 | 222 | 222 | 3 | 2 | 5 | 2 | | | | | | | | |
| 31 | 41504 | 5 | 2 | 1 | 1 | 63 | 763 | 764 | 3 | 1 | 1 | 1 | | 2 | | | | | | |
| 32 | 41505 | 5 | 2 | 1 | 1 | 1 | 16 | 17 | 1 | | 1 | 1 | | | | | | | | |
| 33 | 41506 | 5 | 2 | 2 | 1 | 77 | 927 | 927 | 3 | 1 | 1 | 1 | | | | | | | | |
| 34 | 41507 | 5 | 2 | 1 | 2 | 6 | 75 | 75 | 4 | | 1 | 1 | | | | | | | | |
| 35 | 41508 | 5 | 2 | 1 | 1 | 1 | 17 | 18 | 2 | | 1 | 1 | | | | | | | | |
| 36 | 41509 | 5 | 2 | 1 | 1 | 48 | 579 | 579 | 2 | 2 | 4 | 2 | | 6 | | | | | | |
| 37 | 41510 | 5 | 2 | 2 | 2 | 33 | 406 | 407 | 3 | 2 | 1 | 1 | | | | | | | | |
| 38 | 41511 | 5 | 2 | 1 | 1 | 35 | 425 | 426 | 1 | 2 | 2 | 2 | | 5 | | | | | | |
| 39 | 41512 | 5 | 2 | 2 | 2 | 80 | | | 3 | 2 | 1 | 1 | | | | | | | | |

Importing Data Programmatically



Removing Missing Values

```
data_rm=rmmissing(data)
```

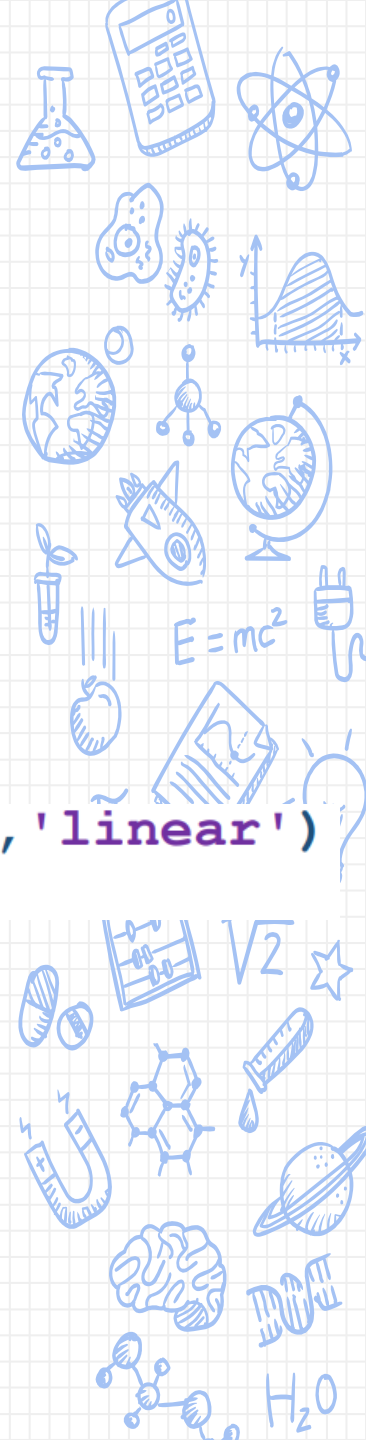
| NaN | NaN |
|-----|-----|
| 1 | 4 |
| 6 | NaN |
| 3 | 1 |
| 2 | 7 |

x

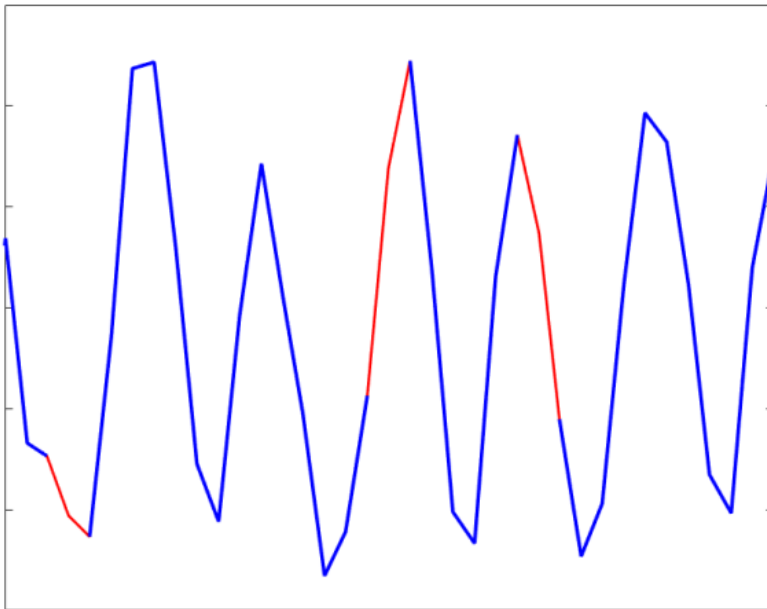


| | |
|---|---|
| 1 | 4 |
| 3 | 1 |
| 2 | 7 |

x



Replacing Missing Values



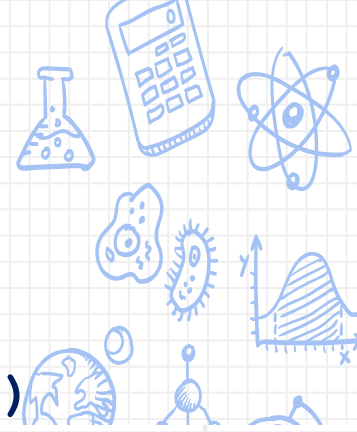
| |
|-----|
| 3 |
| NaN |
| NaN |
| 2 |
| 4 |
| NaN |
| 1 |
| 6 |

x

```
y = fillmissing(x, 'linear')
```

| |
|------|
| 3 |
| 2.67 |
| 2.33 |
| 2 |
| 4 |
| 2.50 |
| 1 |
| 6 |

y



Indexing into Table Arrays

```
>> x = data(5:20, [9,12,18])
```

```
>> x = data(5:20, {'BMXHT', 'BMXLEG', 'BMXWAIST'})
```



data

5610x21 table table

| SECON | BMDSTATS | BMXWT | BMIWT | BMXRECUM | BMIRECUM | BMXHEAD | BMIHEAD | BMXHT | BMIHT | BMXBMI | BMXLEG | BMILEG | BMXARML | BMIARML | BMXARMC | BMIARMC | BMXWAIST |
|-------|----------|-------|-------|----------|----------|---------|---------|-------|-------|--------|--------|--------|---------|---------|---------|---------|----------|
| 41475 | 3 | 138.9 | | | | | | 154.7 | | 58.04 | 34.3 | | 37.6 | | 45.2 | | 156.3 |
| 41477 | 1 | 83.9 | | | | | | 167.1 | | 30.05 | 32.4 | | 38.2 | | 34.1 | | 109.5 |
| 41479 | 1 | 65.7 | | | | | | 154.4 | | 27.56 | 33.3 | | 34.1 | | 33.2 | | 95.4 |
| 41481 | 1 | 77.9 | | | | | | 182.7 | | 23.34 | 43.6 | | 43 | | 31 | | 79.5 |
| 41482 | 1 | 101.6 | | | | | | 173.8 | | 33.64 | 43.5 | | 40 | | 32.8 | | 117 |
| 41483 | 3 | 133.1 | | | | | | 173.8 | | 44.06 | 36.5 | | 38.9 | | 40.5 | | 145.6 |
| 41485 | 1 | 64.8 | | | | | | 157.9 | | 25.99 | 34.3 | | 32.6 | | 30.7 | | 89.7 |
| 41486 | 1 | 86.2 | | | | | | 166.2 | | 31.21 | 35 | | 36 | | 35.3 | | 97 |
| 41487 | 1 | 67.1 | | | | | | 169.2 | | 23.44 | 40 | | 37 | | 29.9 | | 82.9 |
| 41489 | 1 | 91.8 | | | | | | 158.4 | | 36.59 | 37 | | 34 | | 37.8 | | 109.2 |
| 41490 | 1 | 70.7 | | | | | | 159.8 | | 27.69 | 40.5 | | 37 | | 31.2 | | 98.4 |
| 41492 | 1 | 82.6 | | | | | | 168.7 | | 29.02 | 34 | | 39 | | 34 | | 106.2 |
| 41493 | 1 | 53.3 | | | | | | 163.4 | | 19.96 | 37.1 | | 36.6 | | 21.9 | | 78 |
| 41494 | 1 | 70.5 | | | | | | 166.4 | | 25.46 | 39 | | 36.4 | | 32 | | 95.6 |
| 41495 | 1 | 87.2 | | | | | | 184.8 | | 25.53 | 41 | | 41.7 | | 32.6 | | 106.9 |
| 41496 | 1 | 67.8 | | | | | | 154.6 | | 28.37 | 33.5 | | 35.2 | | 33.3 | | 100.9 |
| 41498 | 3 | 77.4 | | | | | | 165.8 | | 28.16 | 39.4 | | 39 | | 31.1 | | 95.5 |
| 41499 | 4 | | | | | | | | | | | | | | | | |
| 41501 | 3 | 114.8 | | | | | | 177.9 | 3 | 36.27 | 41 | | 39.2 | | 37.2 | | 132 |
| 41502 | 1 | 82.4 | | | | | | 168.2 | | 29.13 | 40.4 | | 38.5 | | 36.6 | | 95.4 |
| 41503 | 1 | 73.1 | | | | | | 173.9 | | 24.17 | 40.1 | | 36.9 | | 30.6 | | 85.9 |
| 41504 | 1 | 74.3 | | | | | | 178.5 | 3 | 23.32 | 41.7 | | 40 | | 29 | | 95 |
| 41506 | 3 | | | | | | | 176.9 | | | | | | | | | |
| 41509 | 1 | 101.3 | | | | | | 171.9 | | 34.28 | 36.5 | | 38.9 | | 42 | | 114.5 |
| 41510 | 1 | 66.8 | | | | | | 171.8 | | 22.63 | 37.6 | | 35.2 | | 28.2 | | 81.9 |
| 41511 | 1 | 78.8 | | | | | | 173.6 | | 26.15 | 38.5 | | 36.9 | | 30.6 | | 93.5 |
| 41512 | 3 | 44.5 | | | | | | 154.7 | | 18.47 | | 1 | | 1 | | 1 | |
| 41513 | 1 | 42.5 | | | | | | 159.9 | | 22.4 | 29.2 | | 30 | | 24.4 | | 78.2 |
| 41514 | 1 | 87.4 | | | | | | 171.7 | | 29.65 | 35.7 | | 41 | | 32.1 | | 111.9 |
| 41516 | 3 | 95.3 | | | 3 | | | 160.6 | 3 | 36.95 | | 1 | 40.4 | | 35.5 | | 126.4 |
| 41518 | 1 | 93 | | | | | | 178.7 | | 29.12 | 38.4 | | 37.2 | | 32.6 | | 101.9 |
| 41519 | 1 | 96.5 | | | | | | 184.5 | | 28.35 | 44.2 | | 42.2 | | 34.2 | | 113.7 |
| 41522 | 1 | 80.4 | | | | | | 174.9 | | 26.28 | 44.2 | | 41 | | 30.9 | | 107 |

1

2

3

4

5

6

7


8

9

10 ...

Indexing into Table Array Variables

```
>> x = data.BPXPLS(5:20)
```

 x <16x1 double>

| SEQN | PEASCST1 | PEASCTM1 | PEASCCT1 | BPXCHR | BPQ150A | BPQ150B | BPQ150C | BPQ150D | BPAARW | BPACSZ | BPXPLS | BPXPULS | BPXPTY | BPXML1 | BPXSY1 | BPXD11 | BPAEN1 | BPXSY2 | BPXD12 |
|-------|----------|----------|----------|--------|---------|---------|---------|---------|--------|--------|--------|---------|--------|--------|--------|--------|--------|--------|--------|
| 41475 | 1 | 612 | | | 2 | 2 | 2 | 2 | 1 | 3 | 66 | 1 | 1 | 150 | 128 | 64 | 2 | 122 | 60 |
| 41476 | 1 | 9 | | 72 | | | | | | | | 1 | | | | | | | |
| 41477 | 1 | 625 | | | 2 | 2 | 2 | 2 | 1 | 4 | 78 | 1 | 1 | 180 | 144 | 60 | 2 | 148 | 60 |
| 41478 | 1 | 278 | | 120 | | | | | | | | 1 | | | | | | | |
| 41479 | 1 | 620 | | | 1 | 2 | 2 | 2 | 1 | 4 | 62 | 1 | 1 | 140 | 112 | 70 | 2 | 108 | 66 |
| 41480 | 1 | 79 | | 86 | | | | | | | | 1 | | | | | | | |
| 41481 | 1 | 533 | | | 2 | 2 | 2 | 2 | 1 | 4 | 52 | 1 | 1 | 140 | 112 | 62 | 2 | 104 | 64 |
| 41482 | 1 | 561 | | | 2 | 2 | 2 | 2 | 1 | 4 | 76 | 1 | 1 | 150 | 116 | 78 | 2 | 114 | 80 |
| 41483 | 1 | 748 | | | 2 | 2 | 2 | 2 | 1 | 5 | 60 | 1 | 1 | 140 | 110 | 62 | 2 | 112 | 56 |
| 41484 | 1 | 285 | | 134 | | | | | | | | 1 | | | | | | | |
| 41485 | 1 | 547 | | | 2 | 2 | 2 | 2 | 1 | 4 | 68 | 1 | 1 | 140 | 108 | 44 | 2 | 110 | 42 |
| 41486 | 1 | 556 | | | 2 | 2 | 2 | 2 | 1 | 4 | 62 | 1 | 1 | 150 | 126 | 64 | 2 | 120 | 70 |
| 41487 | 1 | 539 | | | 2 | 2 | 2 | 2 | 1 | 4 | 74 | 1 | 1 | 150 | 120 | 84 | 2 | 116 | 80 |
| 41488 | 1 | 59 | | 110 | | | | | | | | 1 | | | | | | | |
| 41489 | 1 | 570 | | | 2 | 2 | 2 | 2 | 1 | 4 | 58 | 1 | 1 | 130 | 106 | 66 | 2 | 114 | 72 |
| 41490 | 1 | 564 | | | 1 | 2 | 2 | 2 | 1 | 4 | 72 | 1 | 1 | 150 | 128 | 64 | 2 | 134 | 62 |
| 41491 | 1 | 555 | | | 2 | 2 | 2 | 2 | 1 | 2 | 84 | 1 | 1 | 130 | 120 | 76 | 2 | 122 | 78 |
| 41492 | 1 | 704 | | | 2 | 2 | 2 | 2 | 1 | 4 | 62 | 1 | 1 | 180 | 156 | 94 | 2 | 152 | 86 |
| 41493 | 1 | 567 | | | 2 | 2 | 2 | 2 | 1 | 3 | 68 | 1 | 1 | 150 | 106 | 42 | 2 | 118 | 54 |
| 41494 | 1 | 670 | | | 2 | 2 | 2 | 2 | 1 | 4 | 82 | 1 | 1 | 140 | 120 | 78 | 2 | 108 | 64 |
| 41495 | 1 | 676 | | | 2 | 2 | 2 | 2 | 1 | 4 | 68 | 1 | 1 | 150 | 102 | 64 | 2 | 98 | 62 |
| 41496 | 1 | 676 | | | 2 | 2 | 1 | 2 | 1 | 4 | 78 | 1 | 1 | 210 | 192 | 86 | 2 | 192 | 84 |
| 41497 | 1 | 20 | | 96 | | | | | | | | 1 | | | | | | | |
| 41498 | 1 | 698 | | | 1 | 2 | 2 | 2 | 1 | 4 | 60 | 1 | 1 | 240 | 226 | 96 | 2 | 204 | 88 |
| 41499 | 1 | 467 | | | 2 | 2 | 2 | 2 | 1 | 3 | 80 | 1 | 1 | 130 | 116 | 52 | 2 | 114 | 68 |
| 41500 | 1 | 531 | | | 2 | 2 | 2 | 2 | 1 | 4 | 104 | 1 | 1 | 140 | 114 | 58 | 2 | 116 | 56 |
| 41501 | 1 | 574 | | | 2 | 2 | 2 | 2 | 1 | 4 | 60 | 1 | 1 | 170 | 150 | 70 | 2 | 144 | 66 |
| 41502 | 1 | 516 | | | 2 | 2 | 2 | 2 | 1 | 4 | 70 | 1 | 1 | 150 | 124 | 54 | 2 | 116 | 68 |
| 41503 | 1 | 625 | | | 1 | 2 | 2 | 2 | 1 | 4 | 66 | 1 | 1 | 130 | 100 | 52 | 2 | 108 | 46 |
| 41504 | 1 | 743 | | | 2 | 2 | 2 | 2 | 1 | 4 | 72 | 1 | 1 | 180 | 148 | 88 | 2 | 146 | 96 |
| 41505 | 1 | 296 | | 130 | | | | | | | | 1 | | | | | | | |
| 41506 | 1 | 510 | | | 2 | 2 | 2 | 2 | 2 | 3 | 60 | 1 | 1 | 160 | 128 | 84 | 2 | 124 | 84 |

Categorical Data

| IDNum | Sex | Age | Ethnicity | Pulse | BPSyst1 |
|-------|-----|-----|-----------|-------|---------|
| 41475 | 2 | 752 | 5 | 66 | 128 |
| 41477 | 1 | 860 | 3 | 78 | 144 |
| 41479 | 1 | 630 | 1 | 62 | 112 |
| 41481 | 1 | 254 | 4 | 52 | 112 |
| 41482 | 1 | 779 | 1 | 76 | 116 |
| 41483 | 1 | 804 | 4 | 60 | 110 |
| 41485 | 2 | 361 | 2 | 68 | 108 |
| 41486 | 2 | 735 | 1 | 62 | 126 |
| 41487 | 1 | 332 | 5 | 74 | 120 |
| 41489 | 2 | 483 | 1 | 58 | 106 |
| 41490 | 2 | 803 | 4 | 72 | 128 |
| 41492 | 1 | 866 | 3 | 62 | 156 |
| 41493 | 2 | 935 | 3 | 68 | 106 |
| 41494 | 1 | 481 | 1 | 82 | 120 |
| 41495 | 1 | 740 | 3 | 68 | 102 |
| 41496 | 2 | 777 | 1 | 78 | 192 |
| 41498 | 1 | 826 | 4 | 60 | 226 |

`data.Sex=categorical(data.Sex);`



1 =



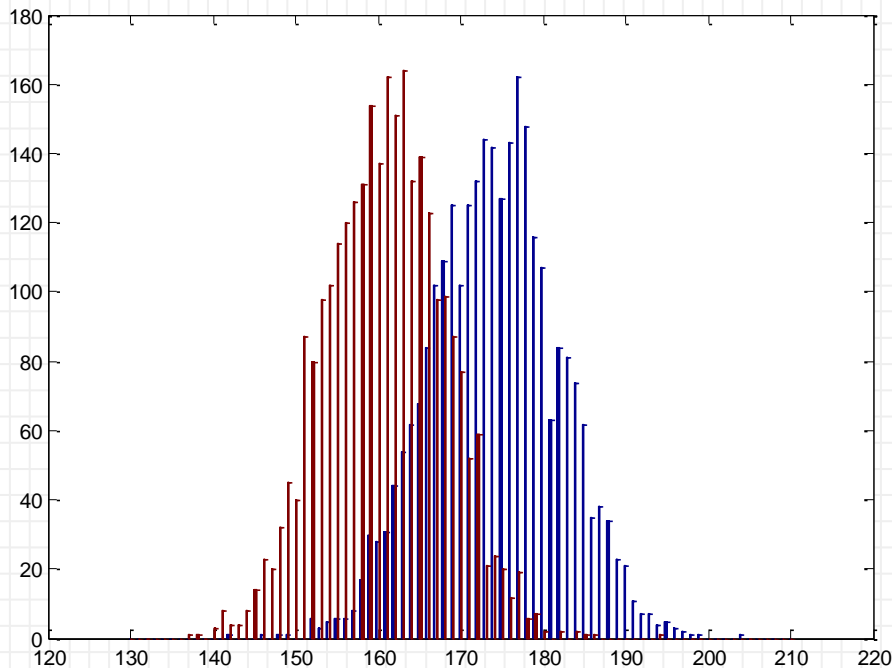
2 =



| IDNum | Sex | Age | Ethnicity | Pulse | BPSyst1 |
|-------|-----|-----|-----------|-------|---------|
| 41475 | F | 752 | Other | 66 | 128 |
| 41477 | M | 860 | White | 78 | 144 |
| 41479 | M | 630 | MexAm | 62 | 112 |
| 41481 | M | 254 | Black | 52 | 112 |
| 41482 | M | 779 | MexAm | 76 | 116 |
| 41483 | M | 804 | Black | 60 | 110 |
| 41485 | F | 361 | Hispanic | 68 | 108 |
| 41486 | F | 735 | MexAm | 62 | 126 |
| 41487 | M | 332 | Other | 74 | 120 |
| 41489 | F | 483 | MexAm | 58 | 106 |
| 41490 | F | 803 | Black | 72 | 128 |
| 41492 | M | 866 | White | 62 | 156 |
| 41493 | F | 935 | White | 68 | 106 |
| 41494 | M | 481 | MexAm | 82 | 120 |
| 41495 | M | 740 | White | 68 | 102 |
| 41496 | F | 777 | MexAm | 78 | 192 |
| 41498 | M | 826 | Black | 60 | 226 |

Histograms

```
>> hist(data,bins)
```



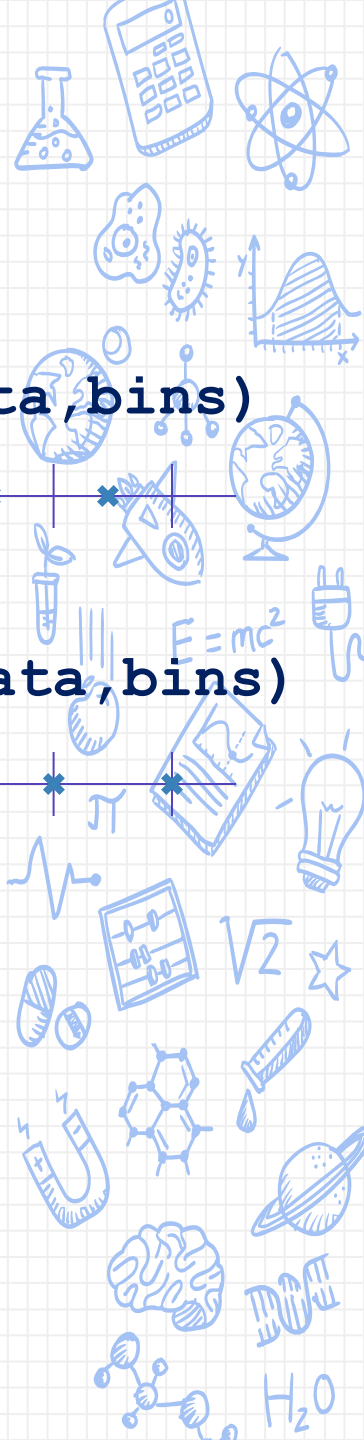
```
>> n = hist(data,bins)
```

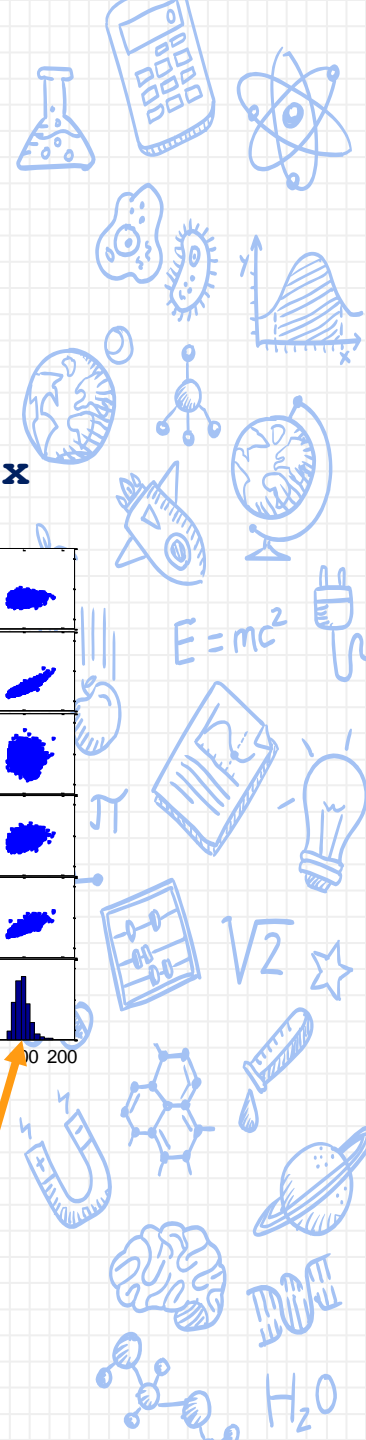


```
>> n = histc(data,bins)
```

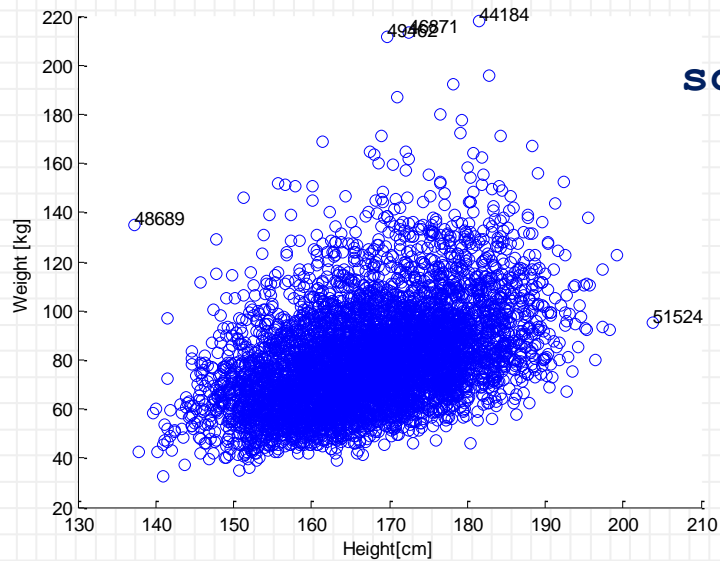


```
>> bar(n)
```





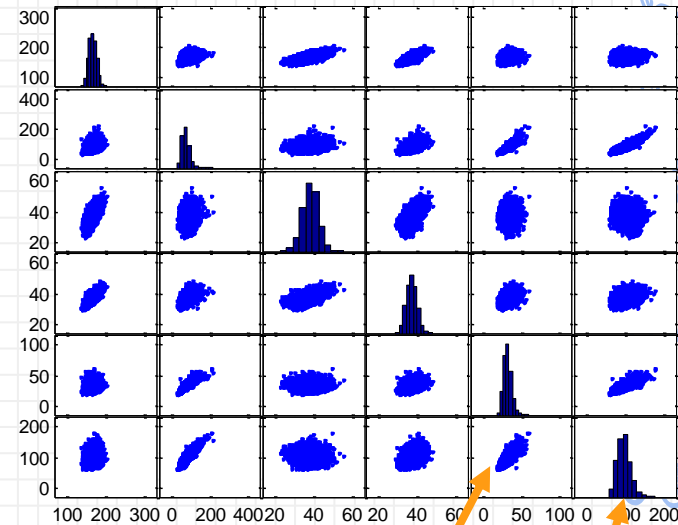
Correlations



scatter

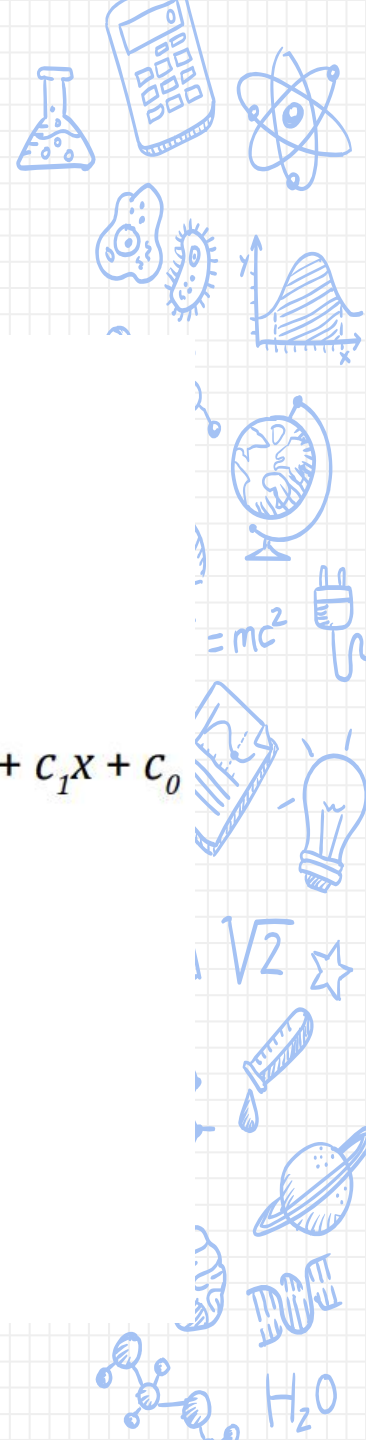
gname

plotmatrix

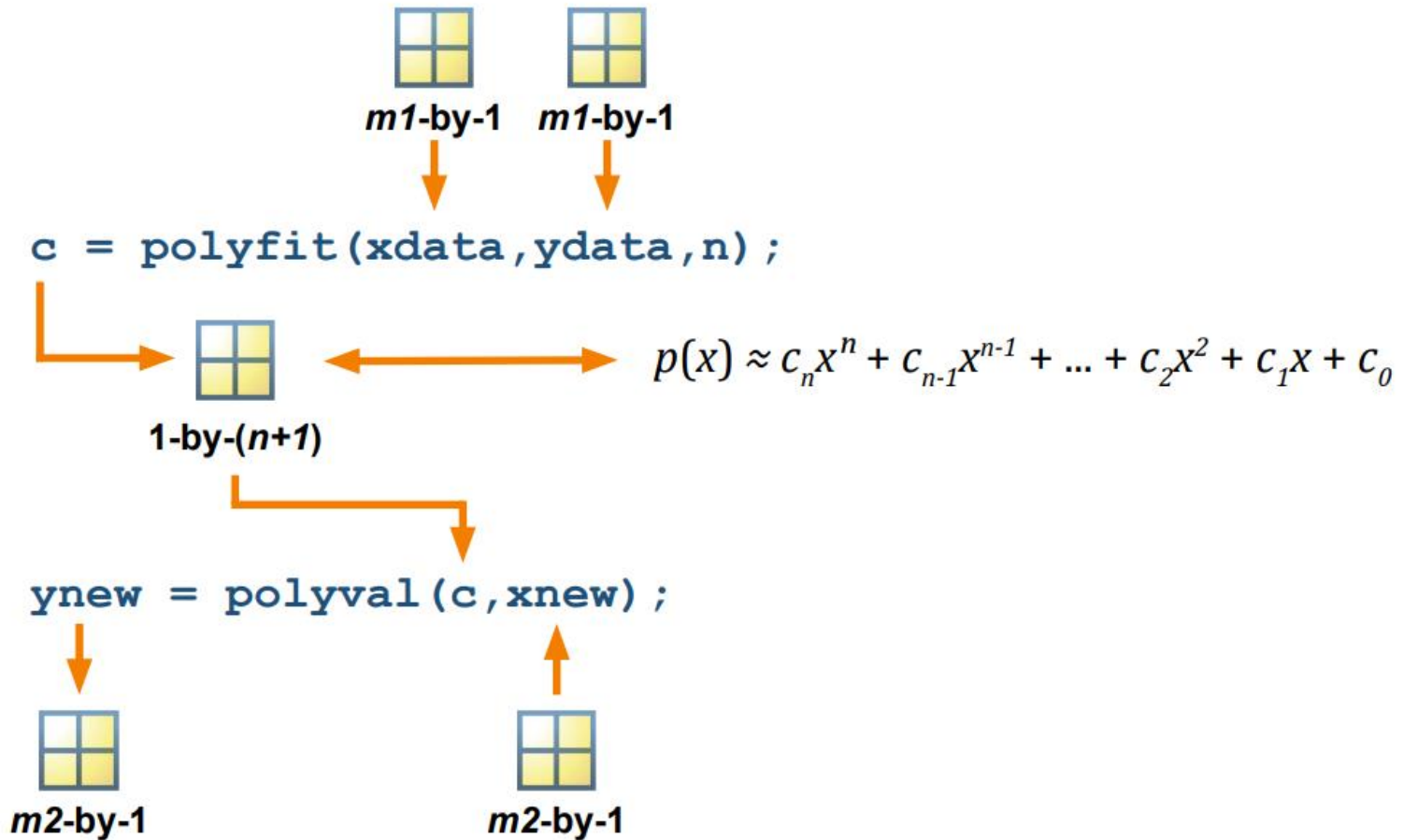


```
>> corr(X)
```

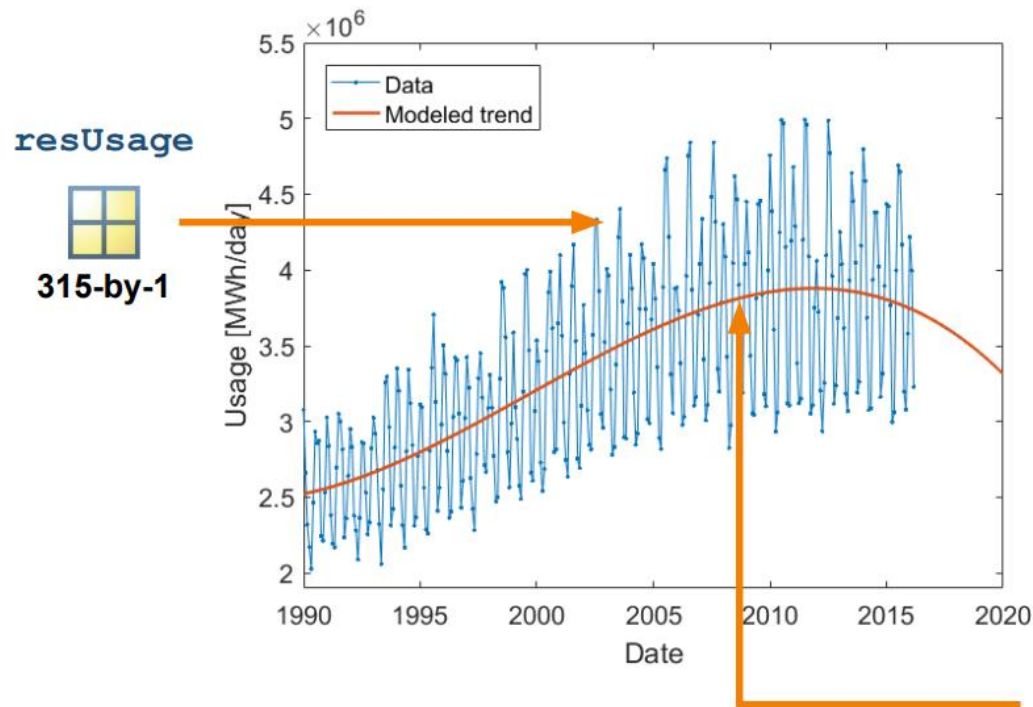
| | | | | | |
|--------|--------|---------|--------|--------|---------|
| 1.0000 | 0.4480 | 0.7442 | 0.7969 | 0.2393 | 0.1714 |
| 0.4480 | 1.0000 | 0.2456 | 0.5932 | 0.8930 | 0.8844 |
| 0.7442 | 0.2456 | 1.0000 | 0.6071 | 0.0995 | -0.0401 |
| 0.7969 | 0.5932 | 0.6071 | 1.0000 | 0.4558 | 0.4066 |
| 0.2393 | 0.8930 | 0.0995 | 0.4558 | 1.0000 | 0.8176 |
| 0.1714 | 0.8844 | -0.0401 | 0.4066 | 0.8176 | 1.0000 |



Fitting a Polynomial



Adding a Theoretical Curve



1. Create independent variable

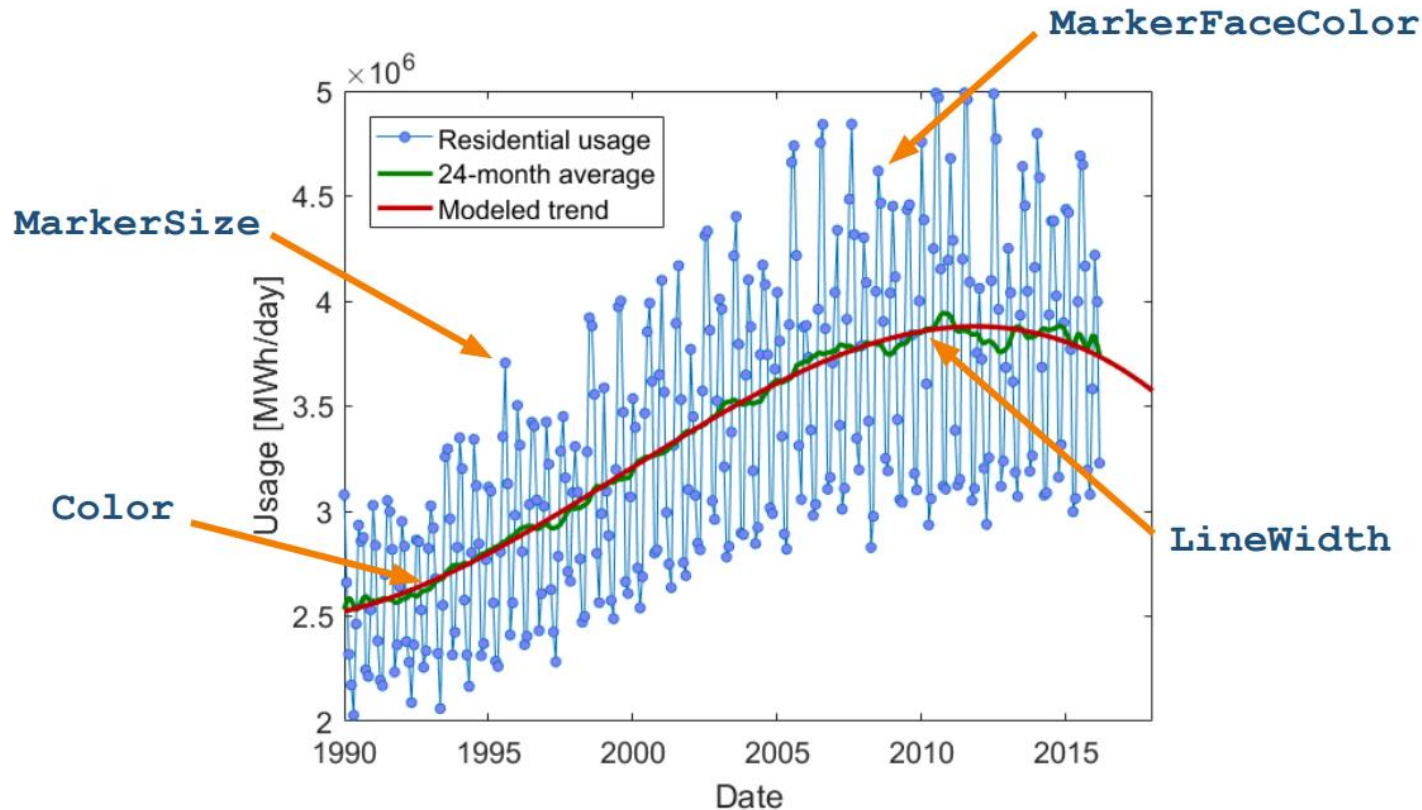

m-by-1

2. Create dependent variable


m-by-1

3. Make plot

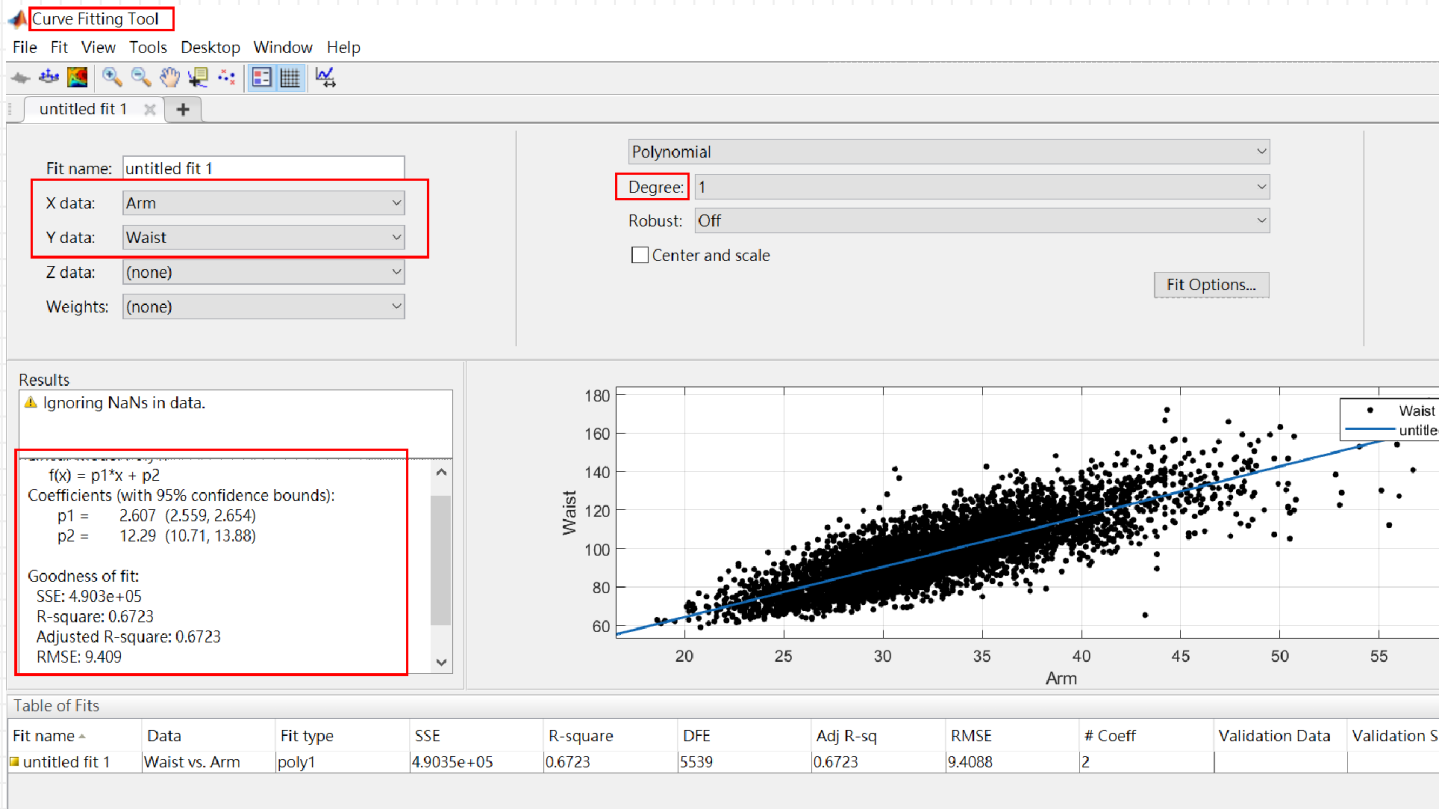
Customizing Plots

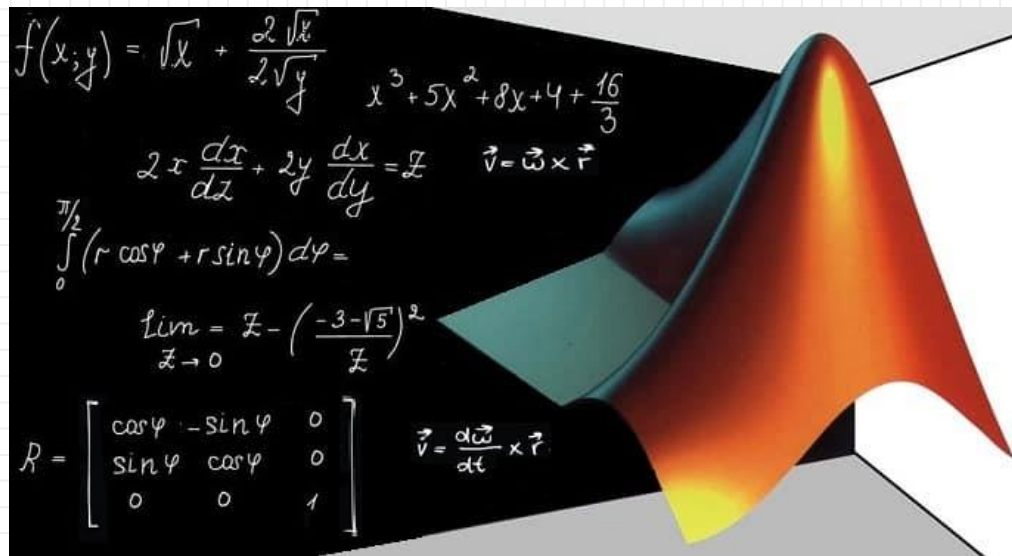


```
plot(x,y,'PropertyName',Value)
```

Curve Fitting Tool

cftool





Thanks for your attention