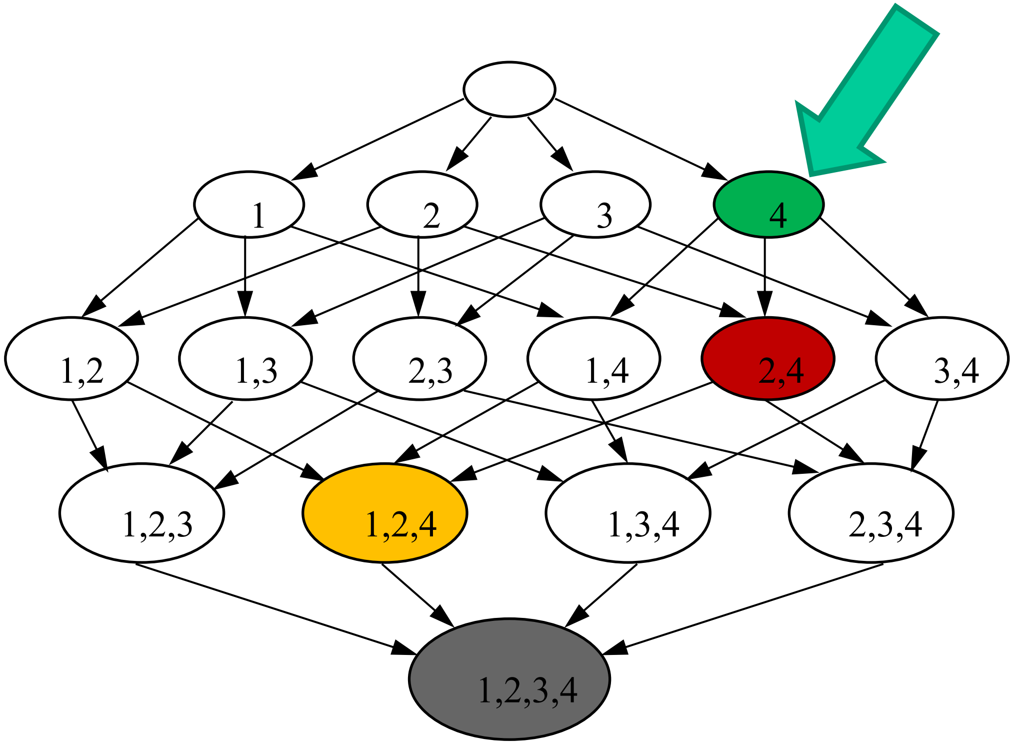
Project 2 Part 2 Briefing

What are we doing at each node?

We are running k-fold cross validation
This is a special case, where k is the number of objects in our dataset
(also called *leave-one-out*)
Depending on the node, we will be using various subsets of the features.

However, let us start by using *all* the features. I will write Matlab guide code..



Predictive Accuracy I

- How do we *estimate* the **accuracy** of our classifier?

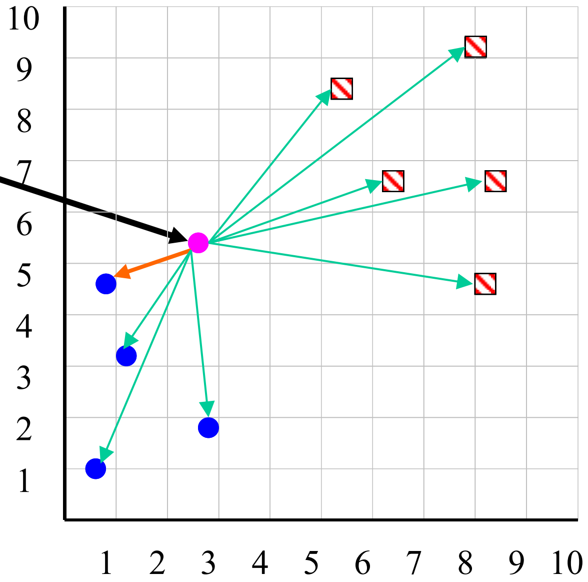
  We can use ***K*-fold cross validation**

We divide the dataset into *K* equal sized sections. The algorithm is tested *K* times, each time leaving out one of the *K* section from building the classifier, but using it to *test* the classifier instead

$$\text{Accuracy} = \frac{\text{Number of correct classifications}}{\text{Number of instances in our database}}$$

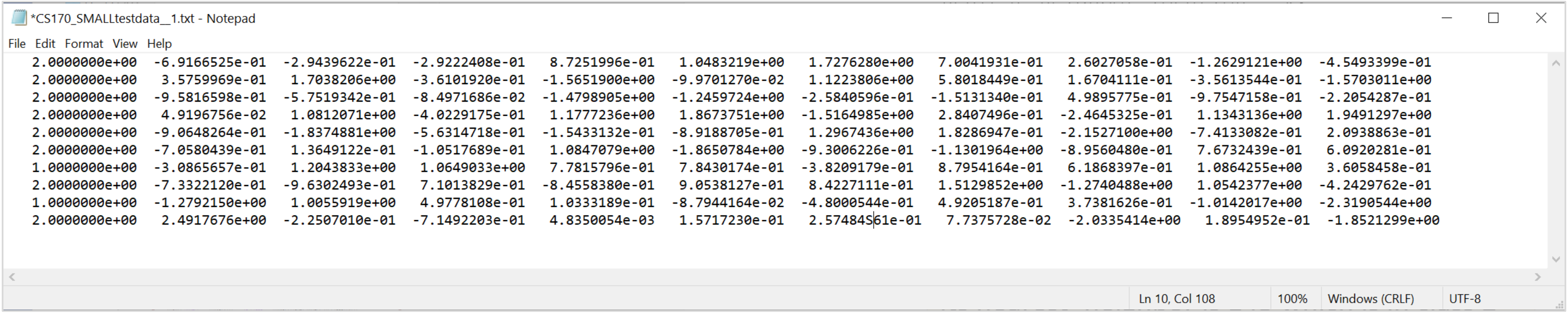
$K = 10$

Insect ID	Abdomen Length	Antennae Length	Insect Class
1	2.7	5.5	Grasshopper
2	8.0	9.1	Katydid
3	0.9	4.7	Grasshopper
4	1.1	3.1	Grasshopper
5	5.4	8.5	Katydid
6	2.9	1.9	Grasshopper
7	6.1	6.6	Katydid
8	0.5	1.0	Grasshopper
9	8.3	6.6	Katydid
10	8.1	4.7	Katydids



I am going to test on this smaller dataset…

C:\Users\eamon\Documents\MATLAB\CS170_SMALLtestdata__1.txt



```
   2.0000000e+00  -6.9166525e-01  -2.9439622e-01  -2.9222408e-01   8.7251996e-01   1.0483219e+00   1.7276280e+00   7.0041931e-01   2.6027058e-01  -1.2629121e+00  -4.5493399e-01
   2.0000000e+00   3.5759969e-01   1.7038206e+00  -3.6101920e-01  -1.5651900e+00  -9.9701270e-02   1.1223806e+00   5.8018449e-01   1.6704111e-01  -3.5613544e-01  -1.5703011e+00
   2.0000000e+00  -9.5816598e-01  -5.7519342e-01  -8.4971686e-02  -1.4798905e+00  -1.2459724e+00  -2.5840596e-01  -1.5131340e-01   4.9895775e-01  -9.7547158e-01  -2.2054287e-01
   2.0000000e+00   4.9196756e-02   1.0812071e+00  -4.0229175e-01   1.1777236e+00   1.8673751e+00  -1.5164985e+00   2.8407496e-01  -2.4645325e-01   1.1343136e+00   1.9491297e+00
   2.0000000e+00  -9.0648264e-01  -1.8374881e+00  -5.6314718e-01  -1.5433132e-01  -8.9188705e-01   1.2967436e+00   1.8286947e-01  -2.1527100e+00  -7.4133082e-01   2.0938863e-01
   2.0000000e+00  -7.0580439e-01   1.3649122e-01  -1.0517689e-01   1.0847079e+00  -1.8650784e+00  -9.3006226e-01  -1.1301964e+00  -8.9560480e-01   7.6732439e-01   6.0920281e-01
   1.0000000e+00  -3.0865657e-01   1.2043833e+00   1.0649033e+00   7.7815796e-01   7.8430174e-01  -3.8209179e-01   8.7954164e-01   6.1868397e-01   1.0864255e+00   3.6058458e-01
   2.0000000e+00  -7.3322120e-01  -9.6302493e-01   7.1013829e-01  -8.4558380e-01   9.0538127e-01   8.4227111e-01   1.5129852e+00  -1.2740488e+00   1.0542377e+00  -4.2429762e-01
   1.0000000e+00  -1.2792150e+00   1.0055919e+00   4.9778108e-01   1.0333189e-01  -8.7944164e-02  -4.8000544e-01   4.9205187e-01   3.7381626e-01  -1.0142017e+00  -2.3190544e+00
   2.0000000e+00   2.4917676e+00  -2.2507010e-01  -7.1492203e-01   4.8350054e-03   1.5717230e-01   2.57484S61e-01   7.7375728e-02  -2.0335414e+00   1.8954952e-01  -1.8521299e+00
```

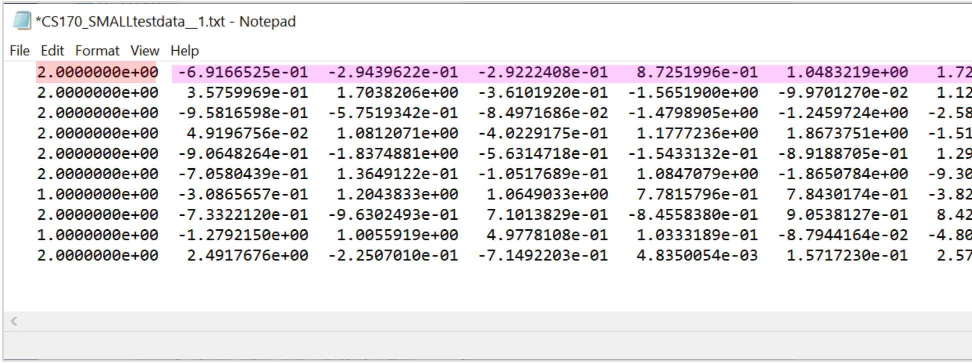
K = the number of rows

$K = 10$

Insect ID	Abdomen Length	Antennae Length	Insect Class
1	2.7	5.5	Grasshopper
2	8.0	9.1	Katydid
3	0.9	4.7	Grasshopper
4	1.1	3.1	Grasshopper
5	5.4	8.5	Katydid
6	2.9	1.9	Grasshopper
7	6.1	6.6	Katydid
8	0.5	1.0	Grasshopper
9	8.3	6.6	Katydid
10	8.1	4.7	Katydids

```
function accuracy = cs170demo()
data = load('C:\Users\eamon\Documents\MATLAB\CS170_SMALLtestdata__1.txt’);

 for i = 1 : size(data,1)
    object_to_classify = data(i,2:end);
    label_object_to_classify = data(i,1);


    disp(['Looping over i, at the ',int2str(i),' location']);
    disp(['The ',int2str(i),'th object is in class ',num2str(label_object_to_classify)]);


 end
end
```

```
Looping over i, at the 1 location
The 1th object is in class 2
Looping over i, at the 2 location
The 2th object is in class 2
Looping over i, at the 3 location
The 3th object is in class 2
Looping over i, at the 4 location
The 4th object is in class 2
Looping over i, at the 5 location
The 5th object is in class 2
Looping over i, at the 6 location
The 6th object is in class 2
Looping over i, at the 7 location
The 7th object is in class 1
Looping over i, at the 8 location
The 8th object is in class 2
Looping over i, at the 9 location
The 9th object is in class 1
Looping over i, at the 10 location
The 10th object is in class 2
```


*CS170_SMALLtestdata__1.txt - Notepad
File Edit Format View Help

```
2.0000000e+00  -6.9166525e-01  -2.9439622e-01  -2.9222408e-01   8.7251996e-01   1.0483219e+00   1.72
2.0000000e+00   3.5759969e-01   1.7038206e+00  -3.6101920e-01  -1.5651900e+00  -9.9701270e-02   1.12
2.0000000e+00  -9.5816598e-01  -5.7519342e-01  -8.4971686e-02  -1.4798905e+00  -1.2459724e+00  -2.58
2.0000000e+00   4.9196756e-02   1.0812071e+00  -4.0229175e-01   1.1777236e+00   1.8673751e+00  -1.51
2.0000000e+00  -9.0648264e-01  -1.8374881e+00  -5.6314718e-01  -1.5433132e-01  -8.9188705e-01   1.29
2.0000000e+00  -7.0580439e-01   1.3649122e-01  -1.0517689e-01   1.0847079e+00  -1.8650784e+00  -9.30
1.0000000e+00  -3.0865657e-01   1.2043833e+00   1.0649033e+00   7.7815796e-01   7.8430174e-01  -3.82
2.0000000e+00  -7.3322120e-01  -9.6302493e-01   7.1013829e-01  -8.4558380e-01   9.0538127e-01   8.42
1.0000000e+00  -1.2792150e+00   1.0055919e+00   4.9778108e-01   1.0333189e-01  -8.7944164e-02  -4.80
2.0000000e+00   2.4917676e+00  -2.2507010e-01  -7.1492203e-01   4.8350054e-03   1.5717230e-01   2.57
```

```
function accuracy = cs170demo()
data = load('C:\Users\eamon\Documents\MATLAB\CS170_SMALLtestdata__1.txt’);

 for i = 1 : size(data,1)
    object_to_classify = data(i,2:end);
    label_object_to_classify = data(i,1);

    for k = 1 : size(data,1)
       disp(['Ask if ',int2str(i),' is nearest neigbour with ', int2str(k)])

    end

 end
end
```

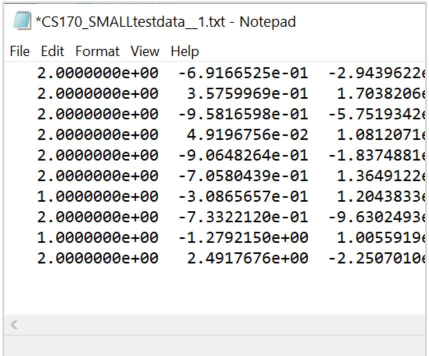
```
Ask if 1 is nearest neigbour with 1
Ask if 1 is nearest neigbour with 2
Ask if 1 is nearest neigbour with 3
Ask if 1 is nearest neigbour with 4
Ask if 1 is nearest neigbour with 5
Ask if 1 is nearest neigbour with 6
Ask if 1 is nearest neigbour with 7
Ask if 1 is nearest neigbour with 8
Ask if 1 is nearest neigbour with 9
Ask if 1 is nearest neigbour with 10
Ask if 2 is nearest neigbour with 1
Ask if 2 is nearest neigbour with 2
Ask if 2 is nearest neigbour with 3
Ask if 2 is nearest neigbour with 4
Ask if 2 is nearest neigbour with 5
Ask if 2 is nearest neigbour with 6
Ask if 2 is nearest neigbour with 7
Ask if 2 is nearest neigbour with 8
Ask if 2 is nearest neigbour with 9
Ask if 2 is nearest neigbour with 10
Ask if 3 is nearest neigbour with 1
Ask if 3 is nearest neigbour with 2
Ask if 3 is nearest neigbour with 3
…
```

```
function accuracy = cs170demo()
data = load('C:\Users\eamon\Documents\MATLAB\CS170_SMALLtestdata__1.txt’);

 for i = 1 : size(data,1)
    object_to_classify = data(i,2:end);
    label_object_to_classify = data(i,1);

      for k = 1 : size(data,1)
        if k ~= i  % don’t compare to yourself!!!
           disp(['Ask if ',int2str(i),' is nearest neigbour with ', int2str(k)])
        end
    end

 end
end
```

```
Ask if 1 is nearest neigbour with 2
Ask if 1 is nearest neigbour with 3
Ask if 1 is nearest neigbour with 4
Ask if 1 is nearest neigbour with 5
Ask if 1 is nearest neigbour with 6
Ask if 1 is nearest neigbour with 7
Ask if 1 is nearest neigbour with 8
Ask if 1 is nearest neigbour with 9
Ask if 1 is nearest neigbour with 10
Ask if 2 is nearest neigbour with 1
Ask if 2 is nearest neigbour with 3
Ask if 2 is nearest neigbour with 4
Ask if 2 is nearest neigbour with 5
Ask if 2 is nearest neigbour with 6
Ask if 2 is nearest neigbour with 7
Ask if 2 is nearest neigbour with 8
Ask if 2 is nearest neigbour with 9
Ask if 2 is nearest neigbour with 10
Ask if 3 is nearest neigbour with 1
Ask if 3 is nearest neigbour with 2
Ask if 3 is nearest neigbour with 4
```

```
function accuracy = cs170demo()
data = load('C:\Users\eamon\Documents\MATLAB\CS170_SMALLtestdata__1.txt');

 for i = 1 : size(data,1)
    object_to_classify = data(i,2:end);
    label_object_to_classify = data(i,1);

    nearest_neighbor_distance = inf;
    nearest_neighbor_location = inf;
    for k = 1 : size(data,1)
       disp(['Ask if ',int2str(i),' is nearest neigbour with ', int2str(k)])

        if k ~= i
             distance = sqrt(sum((object_to_classify - data(k,2:end)).^2));
             if  distance <   nearest_neighbor_distance
                    nearest_neighbor_distance = distance;
                    nearest_neighbor_location = k;
                    nearest_neighbor_label    = data(nearest_neighbor_location,1);
             end
        end
    end

 end
end
```

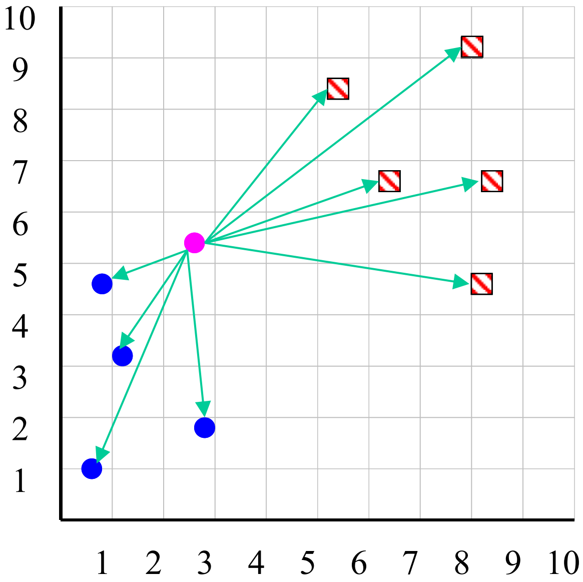
$$p = p_1, p_2,\dots,p_n$$
$$q = q_1, q_2,\dots,q_n$$
$$d(p,q) = \sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \cdots + (q_n - p_n)^2}$$



*CS170_SMALLtestdata__1.txt - Notepad

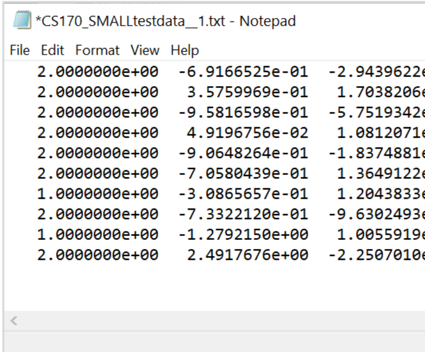
File Edit Format View Help

```
  2.0000000e+00  -6.9166525e-01  -2.9439622e
  2.0000000e+00   3.5759969e-01   1.7038206e
  2.0000000e+00  -9.5816598e-01  -5.7519342e
  2.0000000e+00   4.9196756e-02   1.0812071e
  2.0000000e+00  -9.0648264e-01  -1.8374881e
  2.0000000e+00  -7.0580439e-01   1.3649122e
  1.0000000e+00  -3.0865657e-01   1.2043833e
  2.0000000e+00  -7.3322120e-01  -9.6302493e
  1.0000000e+00  -1.2792150e+00   1.0055919e
  2.0000000e+00   2.4917676e+00  -2.2507010e
```



```
function accuracy = cs170demo()
data = load('C:\Users\eamon\Documents\MATLAB\CS170_SMALLtestdata__1.txt’);

 for i = 1 : size(data,1)
    object_to_classify = data(i,2:end);
    label_object_to_classify = data(i,1);

    nearest_neighbor_distance = inf;
    nearest_neighbor_location = inf;
    for k = 1 : size(data,1)
        if k ~= i
             distance = sqrt(sum((object_to_classify - data(k,2:end)).^2));
             if  distance <   nearest_neighbor_distance
                    nearest_neighbor_distance = distance;
                    nearest_neighbor_location = k;
                    nearest_neighbor_label    = data(nearest_neighbor_location,1);
             end
        end
    end
    disp(['Object ', num2str(i), ' is class ', num2str(label_object_to_classify)]);
    disp(['Its nearest_neighbor is ', num2str(nearest_neighbor_location), ' which is in class ',
num2str( nearest_neighbor_label )]);

 end
end
```

```
Object 1 is class 2
Its nearest_neighbor is 9 which is in class 1
Object 2 is class 2
Its nearest_neighbor is 9 which is in class 1
Object 3 is class 2
Its nearest_neighbor is 9 which is in class 1
Object 4 is class 2
Its nearest_neighbor is 7 which is in class 1
Object 5 is class 2
Its nearest_neighbor is 8 which is in class 2
```

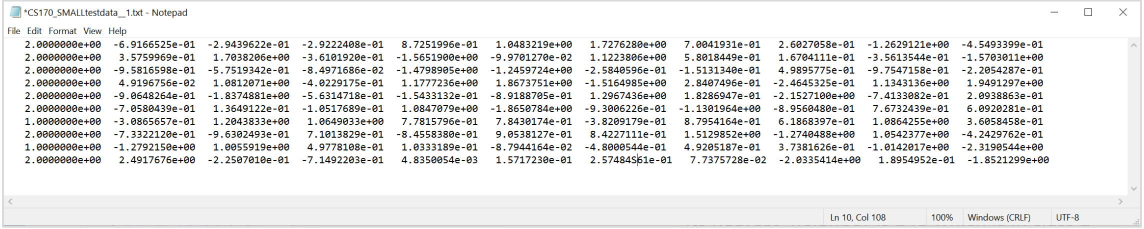

*CS170_SMALLtestdata__1.txt - Notepad
File Edit Format View Help

```
   2.0000000e+00  -6.9166525e-01  -2.9439622e
   2.0000000e+00   3.5759969e-01   1.7038206e
   2.0000000e+00  -9.5816598e-01  -5.7519342e
   2.0000000e+00   4.9196756e-02   1.0812071e
   2.0000000e+00  -9.0648264e-01  -1.8374881e
   2.0000000e+00  -7.0580439e-01   1.3649122e
   1.0000000e+00  -3.0865657e-01   1.2043833e
   2.0000000e+00  -7.3322120e-01  -9.6302493e
   1.0000000e+00  -1.2792150e+00   1.0055919e
   2.0000000e+00   2.4917676e+00  -2.2507010e
```

```
function accuracy = cs170demo()
data = load('C:\Users\eamon\Documents\MATLAB\CS170_SMALLtestdata__1.txt’);
number_correctly_classfied = 0;

 for i = 1 : size(data,1)
    object_to_classify = data(i,2:end);
    label_object_to_classify = data(i,1);

    nearest_neighbor_distance = inf;
    nearest_neighbor_location = inf;
    for k = 1 : size(data,1)
        if k ~= i
             distance = sqrt(sum((object_to_classify - data(k,2:end)).^2));
             if  distance <   nearest_neighbor_distance
                    nearest_neighbor_distance = distance;
                    nearest_neighbor_location = k;
                    nearest_neighbor_label    = data(nearest_neighbor_location,1);
             end
        end
    end

    if label_object_to_classify == nearest_neighbor_label;
         number_correctly_classfied = number_correctly_classfied + 1;
    end

 end
 accuracy = number_correctly_classfied / size(data,1);
end
```

The code above is 90% of what you need!!!

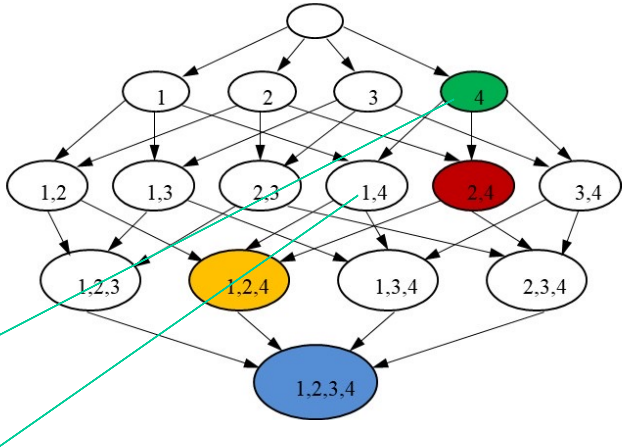
This function returns 0.4000



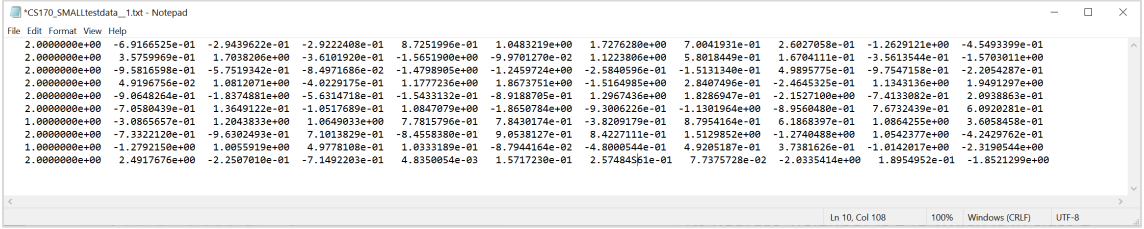
*CS170_SMALLtestdata__1.txt - Notepad

```
   2.0000000e+00  -6.9166525e-01  -2.9439622e-01  -2.9222408e-01   8.7251996e-01   1.0483219e+00   1.7276280e+00   7.0041931e-01   2.6027058e-01  -1.2629121e+00  -4.5493399e-01
   2.0000000e+00   3.5759969e-01   1.7038206e+00  -3.6101920e-01  -1.5651900e+00  -9.9701270e-02   1.1223806e+00   5.8018449e-01   1.6704111e-01  -3.5613544e-01  -1.5703011e+00
   2.0000000e+00  -9.5816598e-01  -5.7519342e-01  -8.4971686e-02  -1.4798905e+00  -1.2459724e+00  -2.5840596e-01  -1.5131340e-01   4.9895775e-01  -9.7547158e-01  -2.2054287e-01
   2.0000000e+00   4.9196756e-02   1.0812071e+00  -4.0229175e-01   1.1777236e+00   1.8673751e+00  -1.5164985e+00   2.8407496e-01  -2.4645325e-01   1.1343136e+00   1.9491297e+00
   2.0000000e+00  -9.0648264e-01  -1.8374881e+00  -5.6314718e-01  -1.5433132e-01  -8.9188705e-01   1.2967436e+00   1.8286947e-01  -2.1527100e+00  -7.4133082e-01   2.0938863e-01
   2.0000000e+00  -7.0580439e-01   1.3649122e-01  -1.0517689e-01   1.0847079e+00  -1.8650784e+00  -9.3006226e-01  -1.1301964e+00  -8.9560480e-01   7.6732439e-01   6.0920281e-01
   1.0000000e+00  -3.0865657e-01   1.2043833e+00   1.0649033e+00   7.7815796e-01   7.8430174e-01  -3.8209179e-01   8.7954164e-01   6.1868397e-01   1.0864255e+00   3.6058458e-01
   2.0000000e+00  -7.3322120e-01  -9.6302493e-01   7.1013829e-01  -8.4558380e-01   9.0538127e-01   8.4227111e-01   1.5129852e+00  -1.2740488e+00   1.0542377e+00  -4.2429762e-01
   1.0000000e+00  -1.2792150e+00   1.0055919e+00   4.9778108e-01   1.0333189e-01  -8.7944164e-02  -4.8000544e-01   4.9205187e-01   3.7381626e-01  -1.0142017e+00  -2.3190544e+00
   2.0000000e+00   2.4917676e+00  -2.2507010e-01  -7.1492203e-01   4.8350054e-03   1.5717230e-01   2.57484S61e-01   7.7375728e-02  -2.0335414e+00   1.8954952e-01  -1.8521299e+00
```

Ln 10, Col 108 100% Windows (CRLF) UTF-8



```
function accuracy= leave_one_out_cross_validation(data,current_set,feature_to_add)

number_correctly_classfied = 0;

 for i = 1 : size(data,1)
    object_to_classify = data(i,2:end);
    label_object_to_classify = data(i,1);

    nearest_neighbor_distance = inf;
    nearest_neighbor_location = inf;
    for k = 1 : size(data,1)
        if k ~= i
             distance = sqrt(sum((object_to_classify - data(k,2:end)).^2));
             if  distance <   nearest_neighbor_distance
                    nearest_neighbor_distance = distance;
                    nearest_neighbor_location = k;
                    nearest_neighbor_label     = data(nearest_neighbor_location,1);
             end
        end
    end

    if label_object_to_classify == nearest_neighbor_label;
         number_correctly_classfied = number_correctly_classfied + 1;
    end

 end
 accuracy = number_correctly_classfied / size(data,1);
end
```



*CS170_SMALLtestdata__1.txt - Notepad
File Edit Format View Help
Ln 10, Col 108
100%
Windows (CRLF)
UTF-8

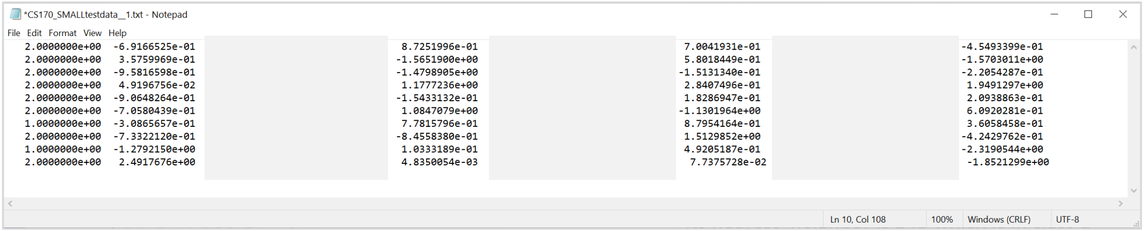
```
  2.0000000e+00  -6.9166525e-01  -2.9439622e-01  -2.9222408e-01   8.7251996e-01   1.0483219e+00   1.7276280e+00   7.0041931e-01   2.6027058e-01  -1.2629121e+00  -4.5493399e-01
  2.0000000e+00   3.5759969e-01   1.7038206e+00  -3.6101920e-01  -1.5651900e+00  -9.9701270e-02   1.1223806e+00   5.8018449e-01   1.6704111e-01  -3.5613544e-01  -1.5703011e+00
  2.0000000e+00  -9.5816598e-01  -5.7519342e-01  -8.4971686e-02  -1.4798905e+00  -1.2459724e+00  -2.5840596e-01  -1.5131340e-01   4.9895775e-01  -9.7547158e-01  -2.2054287e-01
  2.0000000e+00   4.9196756e-02   1.0812071e+00  -4.0229175e-01   1.1777236e+00   1.8673751e+00  -1.5164985e+00   2.8407496e-01  -2.4645325e-01   1.1343136e+00   1.9491297e+00
  2.0000000e+00  -9.0648264e-01  -1.8374881e+00  -5.6314718e-01  -1.5433132e-01  -8.9188705e-01   1.2967436e+00   1.8286947e-01  -2.1527100e+00  -7.4133082e-01   2.0938863e-01
  2.0000000e+00  -7.0580439e-01   1.3649122e-01  -1.0517689e-01   1.0847079e+00  -1.8650784e+00  -9.3006226e-01  -1.1301964e+00  -8.9560480e-01   7.6732439e-01   6.0920281e-01
  1.0000000e+00  -3.0865657e-01   1.2043833e+00   1.0649033e+00   7.7815796e-01   7.8430174e-01  -3.8209179e-01   8.7954164e-01   6.1868397e-01   1.0864255e+00   3.6058458e-01
  2.0000000e+00  -7.3322120e-01  -9.6302493e-01   7.1013829e-01  -8.4558380e-01   9.0538127e-01   8.4227111e-01   1.5129852e+00  -1.2740488e+00   1.0542377e+00  -4.2429762e-01
  1.0000000e+00  -1.2792150e+00   1.0055919e+00   4.9778108e-01   1.0333189e-01  -8.7944164e-02  -4.8000544e-01   4.9205187e-01   3.7381626e-01  -1.0142017e+00  -2.3190544e+00
  2.0000000e+00   2.4917676e+00  -2.2507010e-01  -7.1492203e-01   4.8350054e-03   1.5717230e-01   2.57484561e-01   7.7375728e-02  -2.0335414e+00   1.8954952e-01  -1.8521299e+00
```

1 4 7

10

```
function accuracy= leave_one_out_cross_validation(data,current_set,feature_to_add)
```

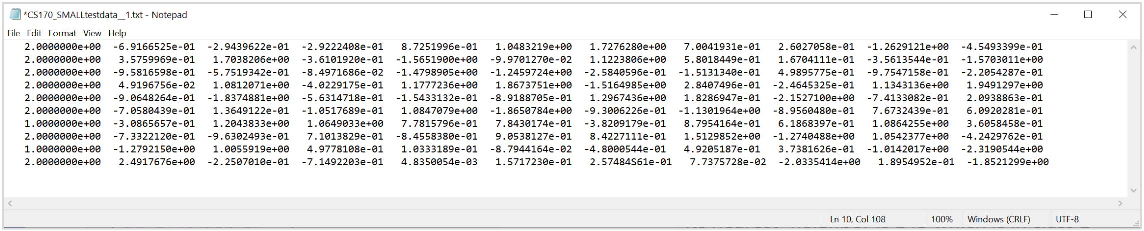
Some code to do this…



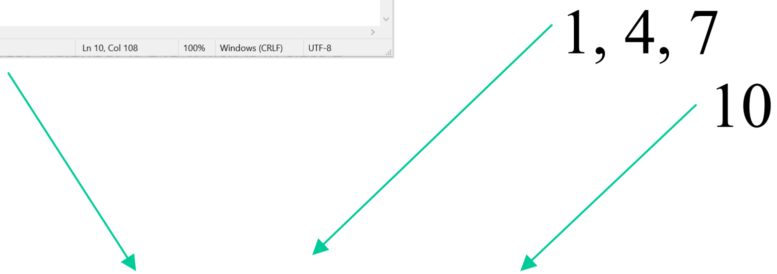
*CS170_SMALLtestdata__1.txt - Notepad
File Edit Format View Help
Ln 10, Col 108
100%
Windows (CRLF)
UTF-8

```
  2.0000000e+00  -6.9166525e-01    8.7251996e-01    7.0041931e-01   -4.5493399e-01
  2.0000000e+00   3.5759969e-01   -1.5651900e+00    5.8018449e-01   -1.5703011e+00
  2.0000000e+00  -9.5816598e-01   -1.4798905e+00   -1.5131340e-01   -2.2054287e-01
  2.0000000e+00   4.9196756e-02    1.1777236e+00    2.8407496e-01    1.9491297e+00
  2.0000000e+00  -9.0648264e-01   -1.5433132e-01    1.8286947e-01    2.0938863e-01
  2.0000000e+00  -7.0580439e-01    1.0847079e+00   -1.1301964e+00    6.0920281e-01
  1.0000000e+00  -3.0865657e-01    7.7815796e-01    8.7954164e-01    3.6058458e-01
  2.0000000e+00  -7.3322120e-01   -8.4558380e-01    1.5129852e+00   -4.2429762e-01
  1.0000000e+00  -1.2792150e+00    1.0333189e-01    4.9205187e-01   -2.3190544e+00
  2.0000000e+00   2.4917676e+00    4.8350054e-03     7.7375728e-02   -1.8521299e+00
```

```
number_correctly_classfied = 0;

 for i = 1 : size(data,1)
    object_to_classify = data(i,2:end);
    label_object_to_classify = data(i,1);

    nearest_neighbor_distance = inf;
    nearest_neighbor_location = inf;
    for k = 1 : size(data,1)
        if k ~= i
             distance = sqrt(sum((object_to_classify - data(k,2:end)).^2));
             if  distance <   nearest_neighbor_distance
                    nearest_neighbor_distance = distance;
                    nearest_neighbor_location = k;
                    nearest_neighbor_label     = data(nearest_neighbor_location,1);
             end
        end
    end

    if label_object_to_classify == nearest_neighbor_label;
         number_correctly_classfied = number_correctly_classfied + 1;
    end

 end
 accuracy = number_correctly_classfied / size(data,1);
end
```

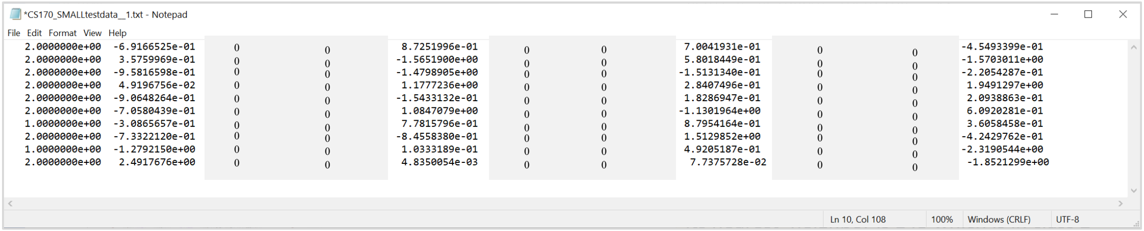

*CS170_SMALLtestdata__1.txt - Notepad
File Edit Format View Help
Ln 10, Col 108
100%
Windows (CRLF)
UTF-8

```
   2.0000000e+00  -6.9166525e-01  -2.9439622e-01  -2.9222408e-01   8.7251996e-01   1.0483219e+00   1.7276280e+00   7.0041931e-01   2.6027058e-01  -1.2629121e+00  -4.5493399e-01
   2.0000000e+00   3.5759969e-01   1.7038206e+00  -3.6101920e-01  -1.5651900e+00  -9.9701270e-02   1.1223806e+00   5.8018449e-01   1.6704111e-01  -3.5613544e-01  -1.5703011e+00
   2.0000000e+00  -9.5816598e-01  -5.7519342e-01  -8.4971686e-02  -1.4798905e+00  -1.2459724e+00  -2.5840596e-01  -1.5131340e-01   4.9895775e-01  -9.7547158e-01  -2.2054287e-01
   2.0000000e+00   4.9196756e-02   1.0812071e+00  -4.0229175e-01   1.1777236e+00   1.8673751e+00  -1.5164985e+00   2.8407496e-01  -2.4645325e-01   1.1343136e+00   1.9491297e+00
   2.0000000e+00  -9.0648264e-01  -1.8374881e+00  -5.6314718e-01  -1.5433132e-01  -8.9188705e-01   1.2967436e+00   1.8286947e-01  -2.1527100e+00  -7.4133082e-01   2.0938863e-01
   2.0000000e+00  -7.0580439e-01   1.3649122e-01  -1.0517689e-01   1.0847079e+00  -1.8650784e+00  -9.3006226e-01  -1.1301964e+00  -8.9560480e-01   7.6732439e-01   6.0920281e-01
   1.0000000e+00  -3.0865657e-01   1.2043833e+00   1.0649033e+00   7.7815796e-01   7.8430174e-01  -3.8209179e-01   8.7954164e-01   6.1868397e-01   1.0864255e+00   3.6058458e-01
   2.0000000e+00  -7.3322120e-01  -9.6302493e-01   7.1013829e-01  -8.4558380e-01   9.0538127e-01   8.4227111e-01   1.5129852e+00  -1.2740488e+00   1.0542377e+00  -4.2429762e-01
   1.0000000e+00  -1.2792150e+00   1.0055919e+00   4.9778108e-01   1.0333189e-01  -8.7944164e-02  -4.8000544e-01   4.9205187e-01   3.7381626e-01  -1.0142017e+00  -2.3190544e+00
   2.0000000e+00   2.4917676e+00  -2.2507010e-01  -7.1492203e-01   4.8350054e-03   1.5717230e-01   2.57484S61e-01   7.7375728e-02  -2.0335414e+00   1.8954952e-01  -1.8521299e+00
```



```
function accuracy= leave_one_out_cross_validation(data,current_set,feature_to_add)
```

Some code to do this…


*CS170_SMALLtestdata__1.txt - Notepad
File Edit Format View Help
Ln 10, Col 108
100%
Windows (CRLF)
UTF-8

```
   2.0000000e+00  -6.9166525e-01   0   0   8.7251996e-01   0   0   7.0041931e-01   0   0  -4.5493399e-01
   2.0000000e+00   3.5759969e-01   0   0  -1.5651900e+00   0   0   5.8018449e-01   0   0  -1.5703011e+00
   2.0000000e+00  -9.5816598e-01   0   0  -1.4798905e+00   0   0  -1.5131340e-01   0   0  -2.2054287e-01
   2.0000000e+00   4.9196756e-02   0   0   1.1777236e+00   0   0   2.8407496e-01   0   0   1.9491297e+00
   2.0000000e+00  -9.0648264e-01   0   0  -1.5433132e-01   0   0   1.8286947e-01   0   0   2.0938863e-01
   2.0000000e+00  -7.0580439e-01   0   0   1.0847079e+00   0   0  -1.1301964e+00   0   0   6.0920281e-01
   1.0000000e+00  -3.0865657e-01   0   0   7.7815796e-01   0   0   8.7954164e-01   0   0   3.6058458e-01
   2.0000000e+00  -7.3322120e-01   0   0  -8.4558380e-01   0   0   1.5129852e+00   0   0  -4.2429762e-01
   1.0000000e+00  -1.2792150e+00   0   0   1.0333189e-01   0   0   4.9205187e-01   0   0  -2.3190544e+00
   2.0000000e+00   2.4917676e+00   0   0   4.8350054e-03   0   0   7.7375728e-02   0   0  -1.8521299e+00
```

```
number_correctly_classfied = 0;

 for i = 1 : size(data,1)
    object_to_classify = data(i,2:end);
    label_object_to_classify = data(i,1);

    nearest_neighbor_distance = inf;
    nearest_neighbor_location = inf;
    for k = 1 : size(data,1)
        if k ~= i
            distance = sqrt(sum((object_to_classify - data(k,2:end)).^2));
            if  distance <   nearest_neighbor_distance
                   nearest_neighbor_distance = distance;
                   nearest_neighbor_location = k;
                   nearest_neighbor_label     = data(nearest_neighbor_location,1);
            end
        end
    end

    if label_object_to_classify == nearest_neighbor_label;
         number_correctly_classfied = number_correctly_classfied + 1;
    end

 end
 accuracy = number_correctly_classfied / size(data,1);
end
```

Done!!!!