

Fuzzy Logic Inference System for Rating Stores

Introduction:

The code has been designed to calculate the rating of stores based on their performance in terms of daily customers, level of items stocked (electronics/groceries), and number of competitors. The case has following highlights.

1. It uses Mamdani Fuzzy Model.
2. The data was analyzed for correlations to decide the 3 input variables out of given 4.
3. Menu is displayed to take the values from the user.
4. The user specifies the number of stores to be rated.
5. Output is the rating of each store and also the best store in the given list of stores.
6. Following were decided:
 - i. Defining linguistic and output variables: Scale to fuzzy **predicates**
 - Defining membership functions and their ranges for each of the variables
 - ii. Deciding defuzzification function
 - iii. Definition of fuzzy functions (And, Or, ...)
 - iv. Defining fuzzy rules for the inference system

Steps:

- Analyze the input variables on the basis of the given data
- Identify Inputs and Outputs
- Define Range of Input and Output.
- Select suitable membership values for all input and output.
- Identify membership function. This function will be used to fuzzify inputs.
- Design the Rules.
- Create the FIS1.fis file
- Load the FIS1.fis file
- Prompt user for input the data.
- Evaluate the input data using the loaded FIS file
- The result is store rating for each of the stores.
- The store with the best rating is also displayed.

Choice of Input Parameters:

We ran following analysis on the given data:

1. Plotted days vs. each of the input parameters: No significant difference
2. Plotted sales vs. each of the input parameters: No significant difference except negative correlation between sales and number of competitors
3. Tabulated the frequency: No significant result

4. Plotted pairwise correlation amongst all 5 columns of the given data: Highest correlation was observed between Groceries and Electronics. Both are commodities to be sold.

Conclusion: Either Groceries or Electronics can be picked with Daily customers and Number of competitors as the input parameters.

Implementation: Done for following input choices:

1. Daily customers, Number of competitors, Electronics
2. Daily customers, Number of competitors, Groceries

Rules:

1. If (Customer is low) and (Electronics is low) and (Competitors is low) then (StoreRating is poor) (1)
2. If (Customer is high) and (Electronics is high) and (Competitors is high) then (StoreRating is excellent) (1)
3. If (Customer is low) and (Electronics is medium) and (Competitors is low) then (StoreRating is poor) (0.2)
4. If (Customer is not medium) and (Electronics is not medium) and (Competitors is low) then (StoreRating is okay) (0.9)
5. If (Customer is low) and (Electronics is low) and (Competitors is medium) then (StoreRating is okay) (0.7)
6. If (Customer is low) and (Electronics is low) and (Competitors is high) then (StoreRating is okay) (0.8)
7. If (Customer is not high) and (Electronics is not high) and (Competitors is not high) then (StoreRating is okay) (1)
8. If (Customer is not high) and (Electronics is not low) and (Competitors is not low) then (StoreRating is fair) (0.6)
9. If (Customer is not high) and (Electronics is high) and (Competitors is not high) then (StoreRating is fair) (0.4)
10. If (Customer is low) and (Electronics is high) and (Competitors is high) then (StoreRating is good) (0.2)
11. If (Customer is medium) and (Electronics is low) and (Competitors is low) then (StoreRating is okay) (0.4)
12. If (Customer is medium) and (Electronics is not high) and (Competitors is not low) then (StoreRating is fair) (0.9)
13. If (Customer is not low) and (Electronics is medium) and (Competitors is not low) then (StoreRating is fair) (1)
14. If (Customer is not low) and (Electronics is not medium) and (Competitors is high) then (StoreRating is good) (1)
15. If (Customer is high) and (Electronics is low) and (Competitors is medium) then (StoreRating is good) (0.8)
16. If (Customer is high) and (Electronics is medium) and (Competitors is low) then (StoreRating is good) (0.4)
17. If (Customer is high) and (Electronics is medium) and (Competitors is high) then (StoreRating is excellent) (0.8)

18. If (Customer is high) and (Electronics is high) and (Competitors is low) then (StoreRating is good) (0.6)
19. If (Customer is high) and (Electronics is high) and (Competitors is medium) then (StoreRating is excellent) (0.4)

Code:

MATLAB Code:

```
%% Clear data
clc,clear

%% Select input variables

data=readtable('value.csv');
days=table2array(data(:,1));
sales=table2array(data(:,2));
cust=table2array(data(:,3));
elect=table2array(data(:,4));
groc=table2array(data(:,5)); %???
comp=table2array(data(:,6));

min(sales) % 95.6
max(sales) % 103.9
min(cust) % 96.7
max(cust) % 103.3
min(elect) %96.3
max(elect) % 103.6
min(groc) %96.7
max(groc) %102.8
min(comp) %95.6
max(comp) %104.2

figure(1),subplot(2,2,1)
    line(days,cust)
    title('Days vs. Customer'), xlabel('Days'),ylabel('Customer')
figure(1),subplot(2,2,2)
    plot(days,elect)
    title('Days vs. Electronics'), xlabel('Days'),ylabel('Electronics')
figure(1),subplot(2,2,3)
    plot(days,groc)
    title('Days vs. Groceries'), xlabel('Days'),ylabel('Groceries')
figure(1),subplot(2,2,4)
    plot(days,comp)
    title('Days vs. Competitions'), xlabel('Days'),ylabel('Competitions')

figure(2),subplot(2,2,1)
    plot(sales,cust)
    title('Sales vs. Customer'), xlabel('Sales'),ylabel('Customer')
figure(2),subplot(2,2,2)
    plot(sales,elect)
    title('Sales vs. Electronics'), xlabel('Sales'),ylabel('Electronics')
figure(2),subplot(2,2,3)
```

```

        plot(sales,groc)
        title('Sales vs. Groceries'), xlabel('Sales'),ylabel('Groceries')
    figure(2),subplot(2,2,4)
        plot(sales,comp)
        title('Sales vs. Competitions'), xlabel('Sales'),ylabel('Competitions')

tbl=tabulate(cust);
figure(3), corrplot(data);

%% Choice of Groceries, Electronics as input

prompt = {'Does your store sell Electronics or Groceries (0/1):','Enter number of
stores to be compared:'};
title = 'About the Stores';
choice = inputdlg(prompt,title);
ch = str2double(choice{1});
n= str2double(choice{2}); % Asking for number of stores for which rating is to be
compared
list_names = string.empty(n,0);
list_cust = double.empty(n,0);
list_elect = double.empty(n,0);
list_comp = double.empty(n,0);

%% Taking input data
for i = 1:n
    if ch == 0 %electronics
        prompt = {'Enter Store name:','Enter daily customers rating [0-
10]:','Enter electronic items rating [0-10]:','Enter number of competitors rating
[0-10]:'};
    else
        prompt = {'Enter Store name:','Enter daily customers rating [0-
10]:','Enter groceries items rating [0-10]:','Enter number of competitors rating
[0-10]:'};
    end
    title = 'Find Store Ratings';
    answer = inputdlg(prompt,title);
    name = answer{1};
    cust = str2double(answer{2});
    elect = str2double(answer{3});
    comp = str2double(answer{4});

    list_names(i) = name;
    list_cust(i) = cust;
    list_elect(i)= elect;
    list_comp(i) = comp;
end

disp(list_names)
disp(list_cust)
disp(list_elect)
disp(list_comp)

%% Opening FIS created using Fuzzy Logic Toolbox
if ch == 0 %electronics
    fismat = readfis('FIS1');
else
    fismat = readfis('FIS2');
end

```

```

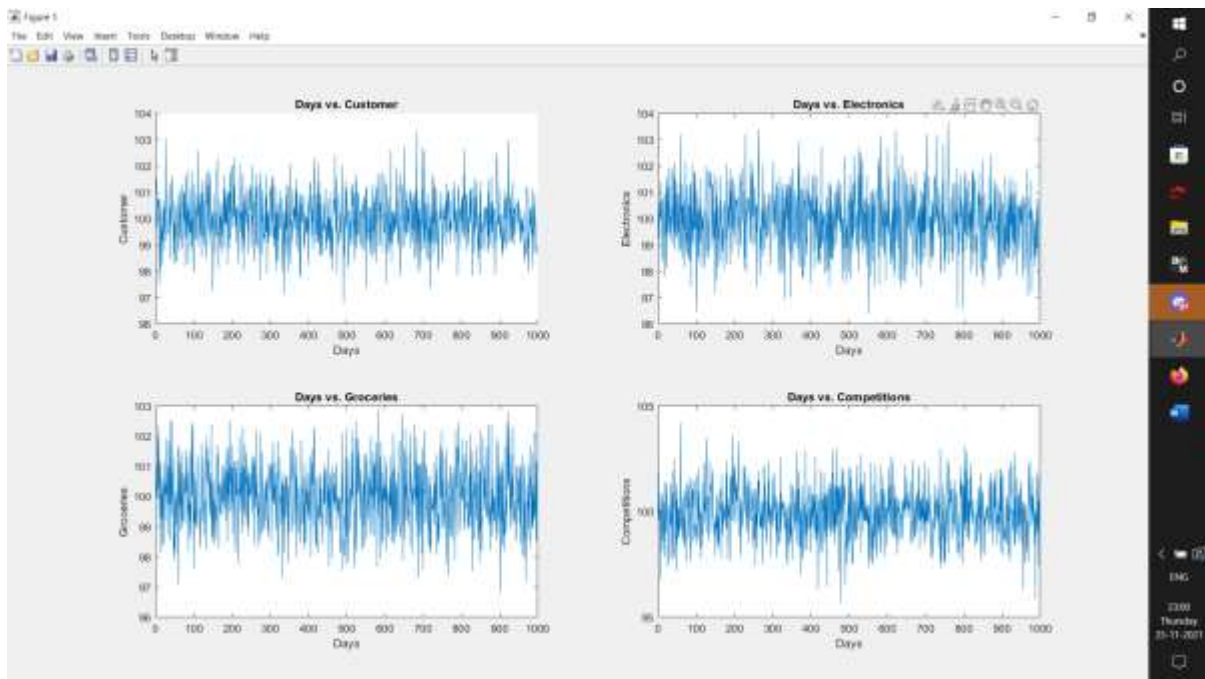
inputdat = transpose(cat(1,list_cust,list_elect,list_comp));
if n == 1
    out = evalfis(fismat,inputdat);
else
    out = evalfis(fismat,inputdat,n);
end
disp(inputdat);
disp(out);

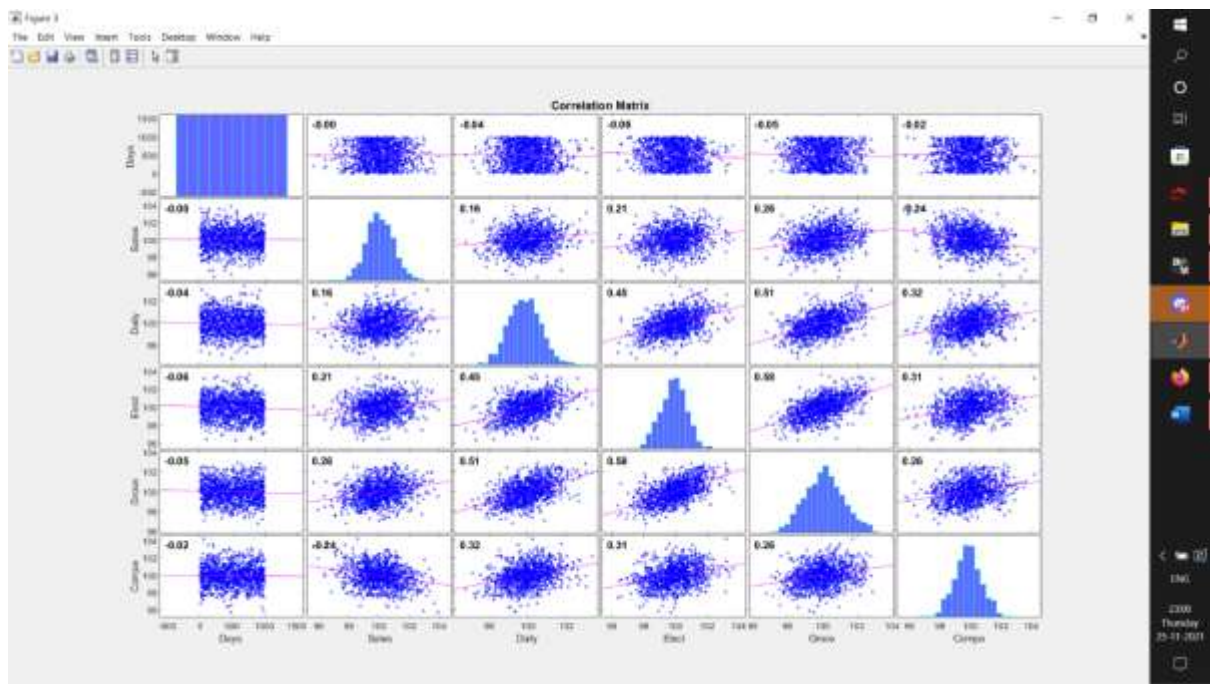
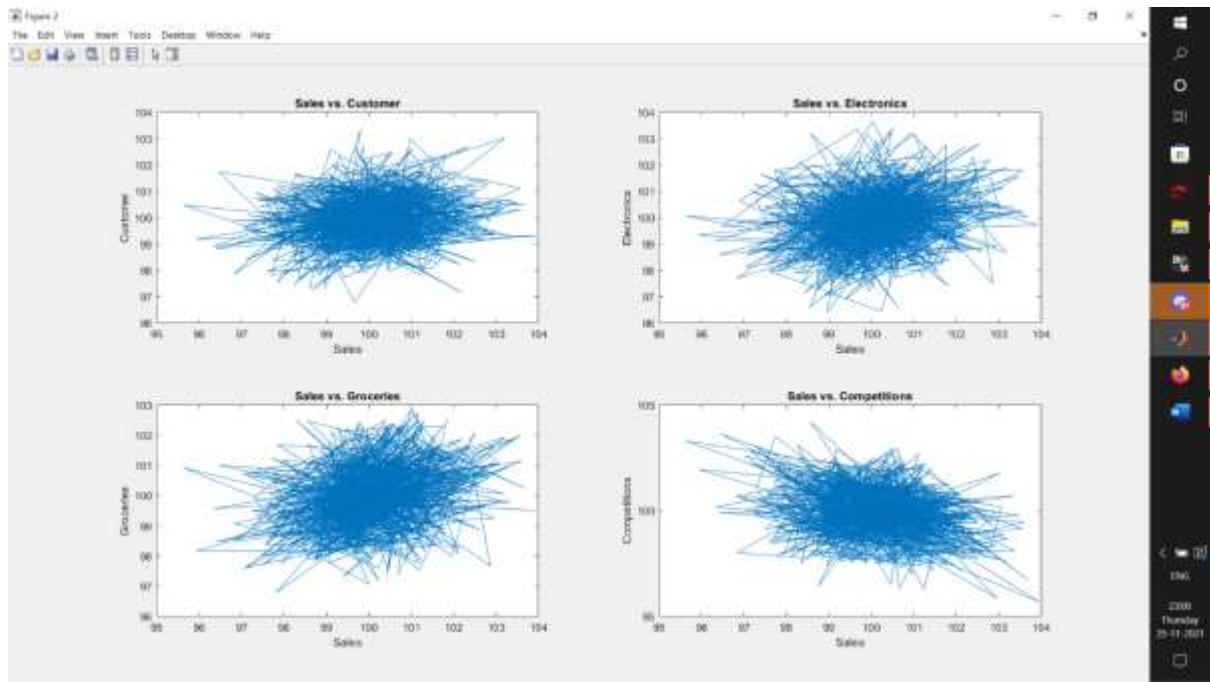
%% Finding maximum rating

if (n == 1)
    disp("Only one store was given");
else
    [max_num, max_ind] = max(out(:));
    %sprintf('Best store is %s ',list_names(max_ind));
    disp('Best Store is ');
    disp(list_names(max_ind));
end

```

Output Screenshots:





Input 1:

About the St... — □ ×

Does your store sell Electronics or Groceries (0/1):

1

Enter number of stores to be compared:

2

OK Cancel

Find ... — □ ×

Enter Store name:

Store1

Enter daily customers rating [0-10]:

7

Enter groceries items rating [0-10]:

6

Enter number of competitors rating [0-10]:

8

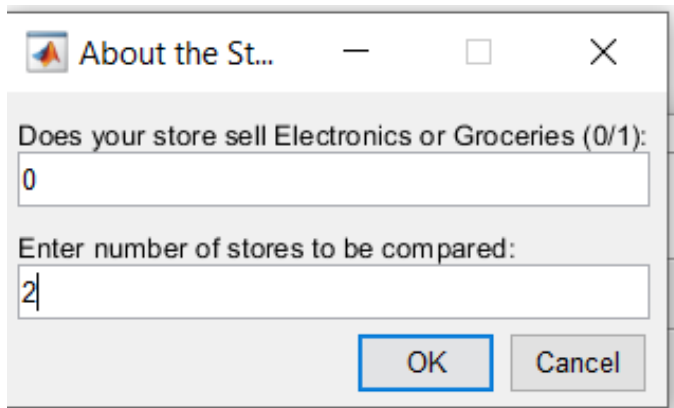
OK Cancel

```
7 6 8
9 8 9

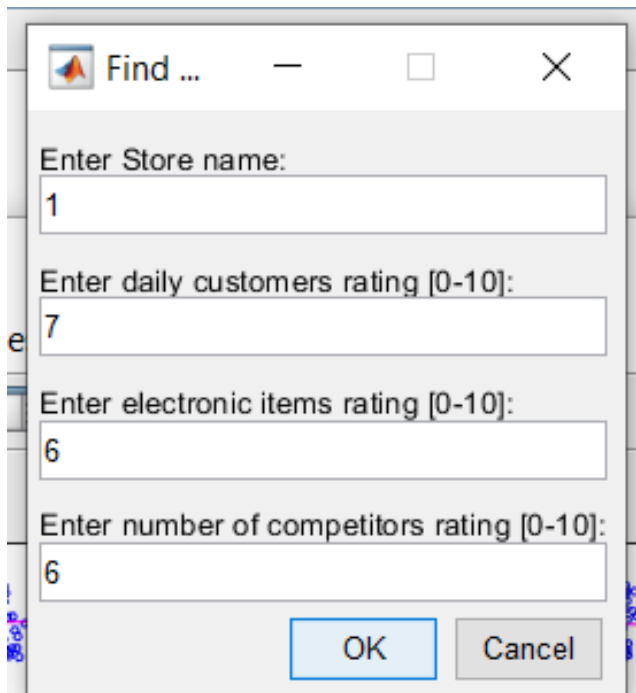
8.7290
10.0000

Best Store is
Store2
>>
```

Input 2:



Dialog box titled "About the St...". It contains two input fields and two buttons. The first input field is labeled "Does your store sell Electronics or Groceries (0/1):" and contains the value "0". The second input field is labeled "Enter number of stores to be compared:" and contains the value "2". The buttons are "OK" and "Cancel".



Dialog box titled "Find ...". It contains four input fields and two buttons. The first input field is labeled "Enter Store name:" and contains the value "1". The second input field is labeled "Enter daily customers rating [0-10]:" and contains the value "7". The third input field is labeled "Enter electronic items rating [0-10]:" and contains the value "6". The fourth input field is labeled "Enter number of competitors rating [0-10]:" and contains the value "6". The buttons are "OK" and "Cancel".

Find ...

Enter Store name:

2

Enter daily customers rating [0-10]:

5

Enter electronic items rating [0-10]:

9

Enter number of competitors rating [0-10]:

7

OK Cancel

```
8.7290
6.8101

Best Store is
1
>>
```

Input 3:

About the St...

Does your store sell Electronics or Groceries (0/1):

1

Enter number of stores to be compared:

3

OK Cancel

Find ...

Enter Store name:
1

Enter daily customers rating [0-10]:
7

Enter groceries items rating [0-10]:
6

Enter number of competitors rating [0-10]:
6

OK Cancel

Find ...

Enter Store name:
2

Enter daily customers rating [0-10]:
7

Enter groceries items rating [0-10]:
6

Enter number of competitors rating [0-10]:
8

OK Cancel

Find ...

Enter Store name:
3

Enter daily customers rating [0-10]:
5

Enter groceries items rating [0-10]:
9

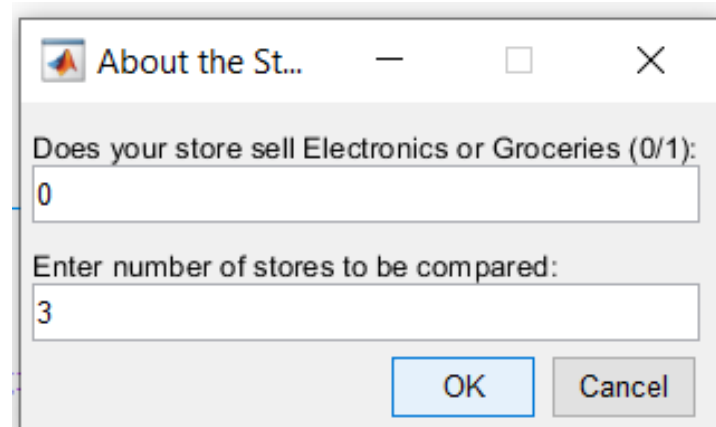
Enter number of competitors rating [0-10]:
8

OK Cancel

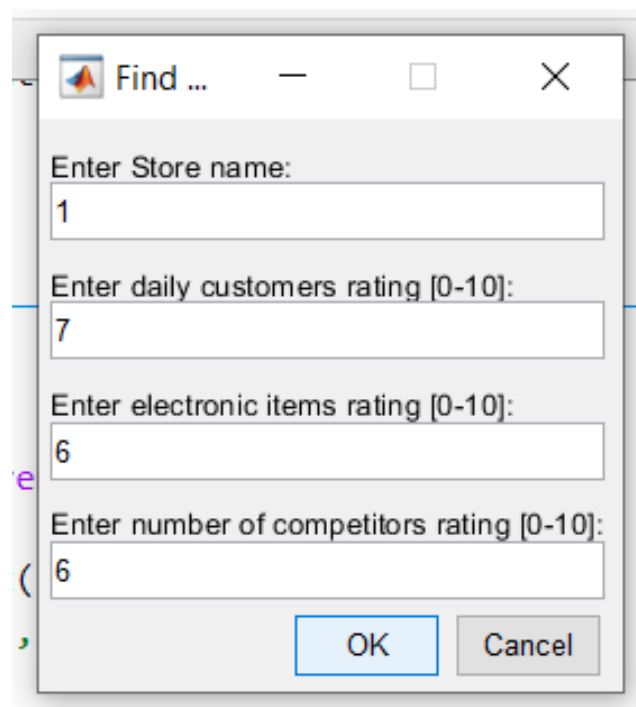
```
5.0075
5.0075
5.0015

Best Store is
1
>>
```

Input 4:



A screenshot of a MATLAB-style dialog box titled "About the St...". It contains two input fields: the first is labeled "Does your store sell Electronics or Groceries (0/1):" and contains the value "0"; the second is labeled "Enter number of stores to be compared:" and contains the value "3". At the bottom right are "OK" and "Cancel" buttons.



A screenshot of a MATLAB-style dialog box titled "Find ...". It contains four input fields: "Enter Store name:" with value "1", "Enter daily customers rating [0-10]:" with value "7", "Enter electronic items rating [0-10]:" with value "6", and "Enter number of competitors rating [0-10]:" with value "6". At the bottom right are "OK" and "Cancel" buttons.

Find ...

Enter Store name:
2

Enter daily customers rating [0-10]:
4

Enter electronic items rating [0-10]:
10

Enter number of competitors rating [0-10]:
3

OK Cancel

Find ...

Enter Store name:
3

Enter daily customers rating [0-10]:
8

Enter electronic items rating [0-10]:
2

Enter number of competitors rating [0-10]:
9

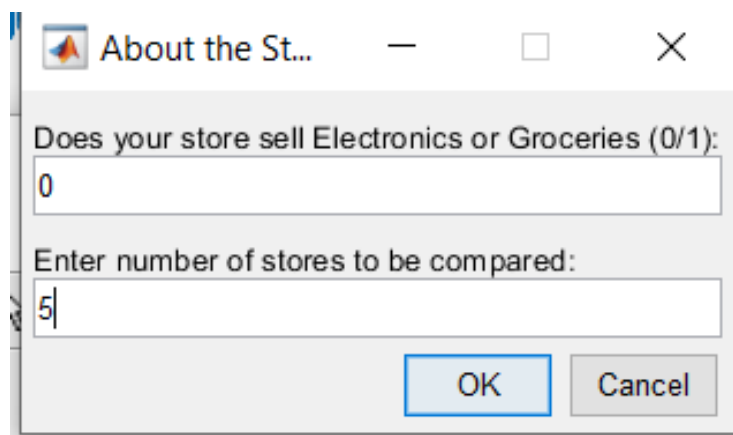
OK Cancel

Best Store is

1

>>

Input 5:



A screenshot of a dialog box titled "About the St...". It contains two input fields and two buttons. The first input field is labeled "Does your store sell Electronics or Groceries (0/1):" and contains the value "0". The second input field is labeled "Enter number of stores to be compared:" and contains the value "5". At the bottom right are "OK" and "Cancel" buttons.

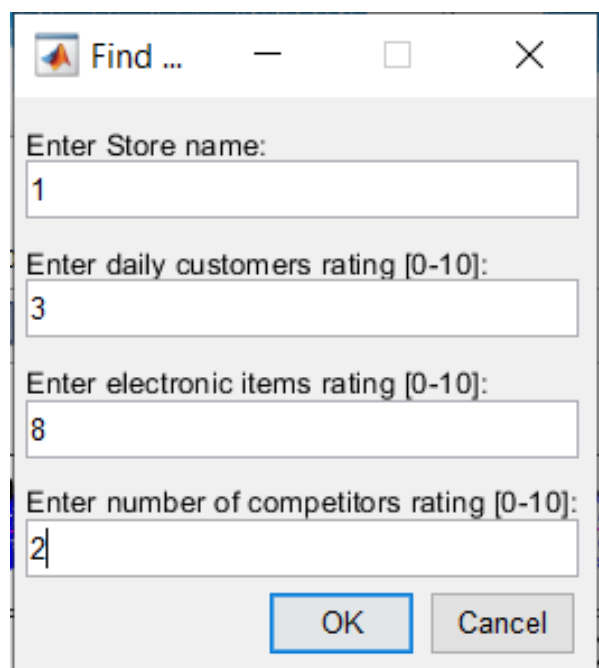
Does your store sell Electronics or Groceries (0/1):

0

Enter number of stores to be compared:

5

OK Cancel



A screenshot of a dialog box titled "Find ...". It contains four input fields and two buttons. The first input field is labeled "Enter Store name:" and contains the value "1". The second input field is labeled "Enter daily customers rating [0-10]:" and contains the value "3". The third input field is labeled "Enter electronic items rating [0-10]:" and contains the value "8". The fourth input field is labeled "Enter number of competitors rating [0-10]:" and contains the value "2". At the bottom right are "OK" and "Cancel" buttons.

Enter Store name:

1

Enter daily customers rating [0-10]:

3

Enter electronic items rating [0-10]:

8

Enter number of competitors rating [0-10]:

2

OK Cancel

Find ...

Enter Store name:

2

Enter daily customers rating [0-10]:

6

Enter electronic items rating [0-10]:

7

Enter number of competitors rating [0-10]:

8

OK Cancel

Find ...

Enter Store name:

3

Enter daily customers rating [0-10]:

7

Enter electronic items rating [0-10]:

10

Enter number of competitors rating [0-10]:

5

OK Cancel

Find ...

Enter Store name:
4

Enter daily customers rating [0-10]:
8

Enter electronic items rating [0-10]:
7

Enter number of competitors rating [0-10]:
6

OK Cancel

Find ...

Enter Store name:
5

Enter daily customers rating [0-10]:
8

Enter electronic items rating [0-10]:
10

Enter number of competitors rating [0-10]:
4

OK Cancel

Best Store is

5

fx >>