Matlab Code:

```
% Reads Input Excel File and Generates Machine Part Matrix
inputFileName = 'PFASTInputFile.xlsx';

%% Part Related data
PartDataSheet = 1;
[num,txt,rawPartData] = xlsread(inputFileName,PartDataSheet);
partNum=rawPartData(:,1);
machineSeqOfOperation=rawPartData(:,2);
batchQuantity=rawPartData(:,3);
partNum=partNum(2:end);
machineSeqOfOperation=machineSeqOfOperation(2:end);
batchQuantity=batchQuantity(2:end);
partNumMat = cell2mat(partNum);
batchQuantityMat = cell2mat(batchQuantity);
partNums= unique(partNumMat);
assert(numel(partNums) == numel(partNumMat),'Input Part Data Contains
Duplicates');

%% Machine Related data
MachineDatasheet = 2;
numMachineData = xlsread(inputFileName,MachineDatasheet);
machineNumMat = numMachineData(:,1);
machineNums= unique(machineNumMat);
machineNums = sort(machineNums);
assert(numel(machineNumMat) == numel(machineNums),'Input Machine Data
Contains Duplicates');

%%  Machine Part Matrix Generation
machinePartMat= zeros(numel(partNums),numel(machineNums));
%operationSequences = cellfun(@(str) regexprep(str,',',' '),
machineSeqOfOperation, 'UniformOutput', false);

for indM = 1: numel(partNums)
    tmpMachineStr = machineSeqOfOperation{indM};

    if isempty(tmpMachineStr)
         continue
    elseif numel(tmpMachineStr)> 1
        tmpMachineStr= regexprep(tmpMachineStr,',',' ');
        tmpMachinemat= str2num(tmpMachineStr);
        machinePartMat(indM,:) = ismember(machineNums,tmpMachinemat)';
    elseif(isfinite(tmpMachineStr))
        machinePartMat(indM,:) = ismember(machineNums,tmpMachineStr)';
    else
        continue
    end
end

%% Hierarchical Clustering
partsDistMat=zeros(numel(partNums));
machineDistMat=zeros(numel(machineNums));
for indP1= 1: numel(partNums)
    tmpPart1= machinePartMat(indP1,:);
    numPart1= sum(tmpPart1);
```

```
    for indP2= 1: numel(partNums)
         tmpPart2= machinePartMat(indP2,:);
         numPart2= sum(tmpPart2);
         if (indP1 ==indP2)
             continue
         else
             numCommonMatch= sum(tmpPart2& tmpPart1);
             partsDistMat(indP1,indP2)=(1-
(numCommonMatch)/(numPart2+numPart1-numCommonMatch));
             %numCommonMach/numel(machineNums);
         end
    end
end
Y= squareform(partsDistMat);
Z = linkage(Y,'complete');
dendrogram(Z);

%% K-means Clustering
[idx,C,sumd,D] = kmeans(machinePartMat,4,...
    'Display','final','Replicates',5, 'Start','sample');
Cluster1= find(idx==1);
Cluster2= find(idx==2);
Cluster3= find(idx==3);
Cluster4= find(idx==4);
```

Figures:

Machine part matrix is incorrect in the paper, as Part 10 doesn't have Operation Sequence 7 and it also has missing entry for Operation Sequence 6.

Part	Operation sequence	Batch quantity
1	1, 4, 8, 9	2
2	1, 4, 7, 4, 8, 7	3
3	1, 2, 4, 7, 8, 9	1
4	1, 4, 7, 9	3
5	1, 6, 10, 7, 9	2
6	6, 10, 7, 8, 9	1
7	6, 4, 8, 9	2
8	3, 5, 2, 6, 4, 8, 9	1
9	3, 5, 6, 4, 8, 9	1
10	4, 6, 4, 8	2
11	6	3
12	11, 7, 12	1
13	11, 12	1
14	11, 7, 10	3
15	1, 7, 11, 10, 11, 12	1
16	1, 7, 11, 10, 11, 12	2
17	11, 7, 12	1
18	6, 7, 10	3
19	12	2

	Machine											
Part	1	2	3	4	5	6	7	8	9	10	11	12
1	1			1				1	1			
2	1			1			1	1				
3	1	1		1			1	1	1			
4	1			1			1		1			
5	1					1	1		1	1		
6						1	1	1	1	1		
7				1		1		1	1			
8		1	1	1	1	1		1	1			
9			1	1	1	1		1	1			
10				1		1	1	1				
11						1						
12							1				1	1
13											1	1
14							1			1	1	
15	1						1			1	1	1
16	1						1			1	1	1
17							1				1	1
18						1	1			1		
19												1

Table 5. Machine–part matrix for the data in table 3.

Machine part matrix per my algorithm

MATLAB 7.6.0 (R2008a)

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C:\Users\Murali\Documents\MATLAB

Shortcuts How to Add What's New

Variable Editor - machinePartMat

Stack: Base

machinePartMat <19x12 double>

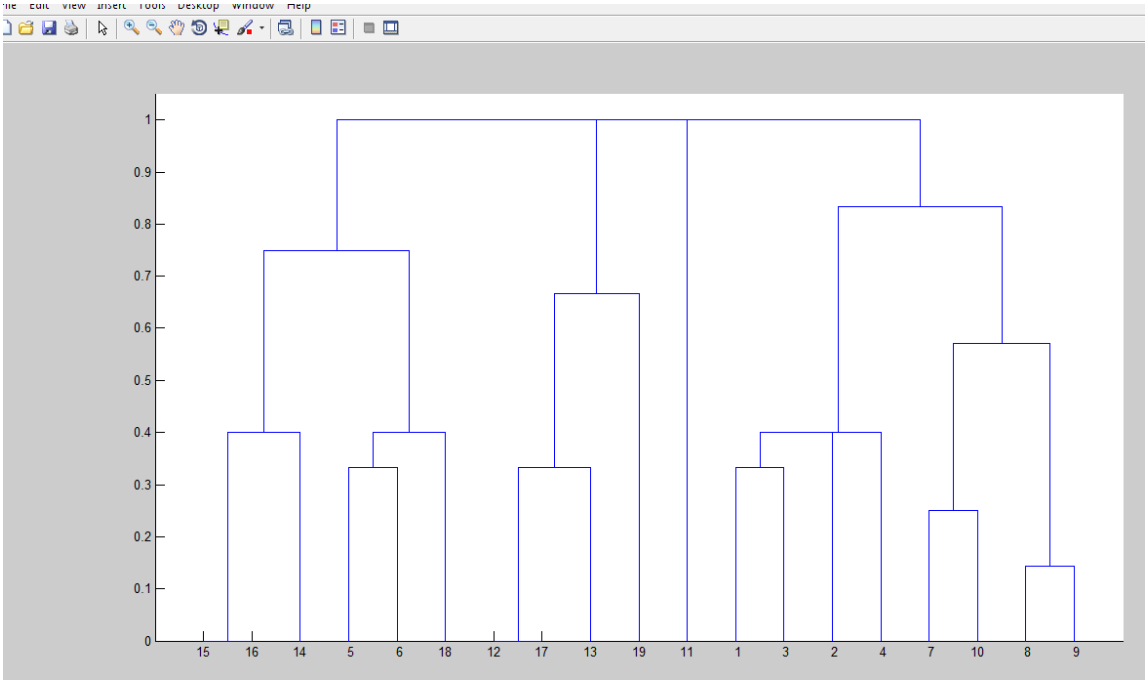
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1	0	0	1	0	0	0	1	1	0	0	0	
2	1	0	0	1	0	0	1	1	0	0	0	0	
3	1	1	0	1	0	0	1	1	1	0	0	0	
4	1	0	0	1	0	0	1	0	1	0	0	0	
5	1	0	0	0	0	1	1	0	1	1	0	0	
6	0	0	0	0	0	1	1	1	1	1	0	0	
7	0	0	0	1	0	1	0	1	1	0	0	0	
8	0	1	1	1	1	1	0	1	1	0	0	0	
9	0	0	1	1	1	1	0	1	1	0	0	0	
10	0	0	0	1	0	1	0	1	0	0	0	0	
11	0	0	0	0	0	1	0	0	0	0	0	0	
12	0	0	0	0	0	0	1	0	0	0	1	1	
13	0	0	0	0	0	0	0	0	0	0	1	1	
14	0	0	0	0	0	0	1	0	0	1	1	0	
15	1	0	0	0	0	0	1	0	0	1	1	1	
16	1	0	0	0	0	0	1	0	0	1	1	1	
17	0	0	0	0	0	0	1	0	0	0	1	1	
18	0	0	0	0	0	1	1	0	0	1	0	0	
19	0	0	0	0	0	0	0	0	0	0	0	1	
20													
21													
22													
23													

Parts Distance Matrix for the above Machine part matrix

partsDistMat <19x19 double>

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	0	0.4000	0.3333	0.4000	0.7143	0.7143	0.4000	0.6250	0.5714	0.6000	1	1	1	1	0.8750	0.8750	1	1	1
2	0.4000	0	0.3333	0.4000	0.7143	0.7143	0.6667	0.7778	0.7500	0.6000	1	0.8333	1	0.8333	0.7143	0.7143	0.8333	0.8333	1
3	0.3333	0.3333	0	0.3333	0.6250	0.6250	0.5714	0.5556	0.6667	0.7143	1	0.8750	1	0.8750	0.7778	0.7778	0.8750	0.8750	1
4	0.4000	0.4000	0.3333	0	0.5000	0.7143	0.6667	0.7778	0.7500	0.8333	1	0.8333	1	0.8333	0.7143	0.7143	0.8333	0.8333	1
5	0.7143	0.7143	0.6250	0.5000	0	0.3333	0.7143	0.8000	0.7778	0.8571	0.8000	0.8571	1	0.6667	0.5714	0.5714	0.8571	0.4000	1
6	0.7143	0.7143	0.6250	0.7143	0.3333	0	0.5000	0.6667	0.6250	0.6667	0.8000	0.8571	1	0.6667	0.7500	0.7500	0.8571	0.4000	1
7	0.4000	0.6667	0.5714	0.6667	0.7143	0.5000	0	0.4286	0.3333	0.2500	0.7500	1	1	1	1	1	1	0.8333	1
8	0.6250	0.7778	0.5556	0.7778	0.8000	0.6667	0.4286	0	0.1429	0.5714	0.8571	1	1	1	1	1	1	0.8889	1
9	0.5714	0.7500	0.6667	0.7500	0.7778	0.6250	0.3333	0.1429	0	0.5000	0.8333	1	1	1	1	1	1	0.8750	1
10	0.6000	0.6000	0.7143	0.8333	0.8571	0.6667	0.2500	0.5714	0.5000	0	0.6667	1	1	1	1	1	1	0.8000	1
11	1	1	1	1	0.8000	0.8000	0.7500	0.8571	0.8333	0.6667	0	1	1	1	1	1	1	0.6667	1
12	1	0.8333	0.8750	0.8333	0.8571	0.8571	1	1	1	1	1	0	0.3333	0.5000	0.4000	0.4000	0	0.8000	0.6667
13	1	1	1	1	1	1	1	1	1	1	1	0.3333	0	0.7500	0.6000	0.6000	0.3333	1	0.5000
14	1	0.8333	0.8750	0.8333	0.6667	0.6667	1	1	1	1	1	0.5000	0.7500	0	0.4000	0.4000	0.5000	0.5000	1
15	0.8750	0.7143	0.7778	0.7143	0.5714	0.7500	1	1	1	1	1	0.4000	0.6000	0.4000	0	0	0.4000	0.6667	0.8000
16	0.8750	0.7143	0.7778	0.7143	0.5714	0.7500	1	1	1	1	1	0.4000	0.6000	0.4000	0	0	0.4000	0.6667	0.8000
17	1	0.8333	0.8750	0.8333	0.8571	0.8571	1	1	1	1	1	0	0.3333	0.5000	0.4000	0.4000	0	0.8000	0.6667
18	1	0.8333	0.8750	0.8333	0.4000	0.4000	0.8333	0.8889	0.8750	0.8000	0.6667	0.8000	1	0.5000	0.6667	0.6667	0.8000	0	1
19	1	1	1	1	1	1	1	1	1	1	1	0.6667	0.5000	1	0.8000	0.8000	0.6667	1	0
20																			
21																			
22																			
23																			

Dendogram for the above Parts Distance Matrix



Kmeans Clustering for Machine part matrix using Squared Euclidean distance between rows:

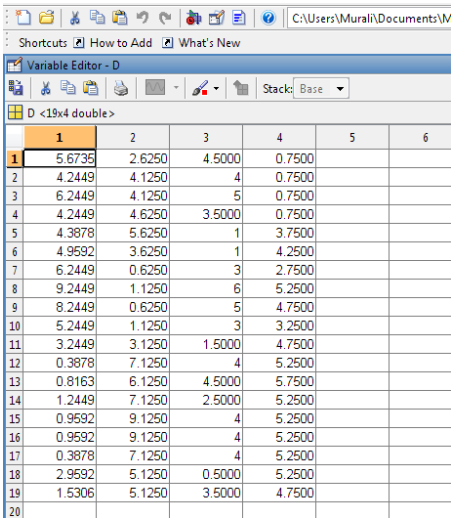
Cluster1: [12;13;14;15;16;17;19]

Cluster2: [7;8;9;10]

Cluster3: [5;6;11;18]

Cluster4: [1;2;3;4]

Distances matrix from each point to every centroid



Variable Editor - D

D <19x4 double>

	1	2	3	4	5	6
1	5.6735	2.6250	4.5000	0.7500		
2	4.2449	4.1250	4	0.7500		
3	6.2449	4.1250	5	0.7500		
4	4.2449	4.6250	3.5000	0.7500		
5	4.3878	5.6250	1	3.7500		
6	4.9592	3.6250	1	4.2500		
7	6.2449	0.6250	3	2.7500		
8	9.2449	1.1250	6	5.2500		
9	8.2449	0.6250	5	4.7500		
10	5.2449	1.1250	3	3.2500		
11	3.2449	3.1250	1.5000	4.7500		
12	0.3878	7.1250	4	5.2500		
13	0.8163	6.1250	4.5000	5.7500		
14	1.2449	7.1250	2.5000	5.2500		
15	0.9592	9.1250	4	5.2500		
16	0.9592	9.1250	4	5.2500		
17	0.3878	7.1250	4	5.2500		
18	2.9592	5.1250	0.5000	5.2500		
19	1.5306	5.1250	3.5000	4.7500		
20						