ISTANBUL TECHNICAL UNIVERSITY

Computer Engineering Department

BLG 566E Digital Solutions for Smart Cities

Instructors:

Sema Fatma Oktuğ

Yusuf Yaslan

Spring 2018 Term Project Report

Cooperative Communication Topologies for Smart City IoT Applications

Sinan Atan	Tuğrul Yatağan
504162306	504161551

Table of Contents

1. Introduction

Smart cities are expected to provide their residents a variety of innovative services and applications using advanced technologies. These technologies are heavily influenced by recent communication methods. Wireless communication can provide flexibility and mobility to any smart city IoT application thus wireless connectivity has become more important to provide smart city IoT applications. Example smart city IoT applications which extensively need wireless communication can be; waste management, water/electricity/gas metering, environment/animal tracking, water/gas/fire detecting, and so on.

Wireless connection is expected to be reliable, efficient, scalable, fair, high throughput, low delay and green power in case of system design principles. It can be difficult to satisfy all these expectations due to the nature of wireless communication and behavior of wireless network entities. Mobile node which has low signal strength to base station may face drastic communication issues. To cope with this issue, relay nodes can be used to provide alternative communication path. This scheme is called as cooperative communication.

In this work, we propose a cooperative communication framework for smart city IoT applications which utilize machine learning methods to optimize relay node allocation policy.

2. Problem Description

Wireless communication reliability is severely affected by propagation medium and congestion. Either wireless communication throughput will decrease, or power consumption will increase if a network entity does not have a good communication path. If a wireless network entity tries to communicate through a longer path or through a heavily loaded (congested) node, not only its performance but the overall network performance will decrease due to the half-duplex nature of wireless communication.

Most of the wireless communication capable nodes are mobile, this makes it even more difficult to provide reliable wireless link between end nodes and base station. Thus, unpredictable channel state of mobility is the trade-off for wireless systems against flexibility.

In a common wireless smart city IoT application characteristics are;

- Most of the entities are low power or mobile end devices: animal trackers, waste management devices, water/gas/fire sensors, water/electricity/gas meters, etc.
- There are decent amount of fixed end devices which connected to power: traffic lights, street lamps, surveillance cameras, etc.
- There is at least one base station which provides internet access to other entities.

Using these fixed end devices as relay nodes can improve overall network connectivity, reliability, efficiency, throughput, delay and jitter. Mobile end nodes are not aware of the network topology thus they tend to select nearest relay node to reach base station. But selecting nearest relay node may not be the optimum solution for a mobile end node.

3. Proposed Framework

In our framework, we introduce a cooperation framework which use historic data as input and by the help of machine learning, assignment of cooperation relay is done for end nodes. This achieves better utilization of power by avoiding extra wireless signaling for resource allocation. Furthermore, when an end node is not in the coverage area of the base station, assignment of cooperation fails in classical methods. Our scheme eliminates those issues as well.

We utilize fixed relaying nodes for cooperative communication. Scale of fixed nodes in a common smart city application should be sufficient to cover most of the mobile end nodes. Furthermore, mobile end nodes should not waste their limited energy resources since they wouldn't continuously listen medium to participate wireless cooperation. We create a simple model for a common smart city application containing; one base station, N fixed relays, M_{UE} end-user and M_{IoT} sensor mobile end nodes. Proposed smart city application framework topology is illustrated in Figure 1.

In this architecture, we modelled every wireless node with following parameters;

- Time [0-23]: Time information is used as input, since usage and mobility characteristics of nodes change during the day.
- Node ID [0-($N+M_{UE}+M_{IoT}+1$)]: Unique identity of each node in the system. Cooperation pattern of each individual node in the network is tracked by node ID.
- Type {base, relay, end-user, IoT device}: Node type illustrates the category of each device to do a better classification for each node in the network in terms of mobility, usage, etc.
- Capacity [0-100]: Maximum throughput, towards base station, can be achieved by each node in a certain state. This is derived from underlying radio access technology capacity, but it reflects instantaneous value in specified condition.
- Rate [0-100]: Utilized throughput by each node. Rate is less than or equal to capacity for any node in the network.
- Distance to base station [0-5000]: Channel quality and signal strength are measured with distance factor from base station. This provides rough estimation of instantaneous capacity for end points.
- Distance to relay nodes [0-5000]: Similar to distance to base station, rather gives channel status information for each relay.
- Selected relay [0-1000]: Output parameter of classification, which gives the selection for each end node to cooperate. Each end node tries to select best relay for itself.

Base station and relay nodes can be able to obtain this data during daily operation. From this obtained data, base station can train a model for every end node. Base station should share this trained model with end nodes daily. Then, every end node can be able to select the best possible relay for cooperative communication. End nodes can select relay nodes offline. They don’t need to know current network topology, or they don’t require any external information.

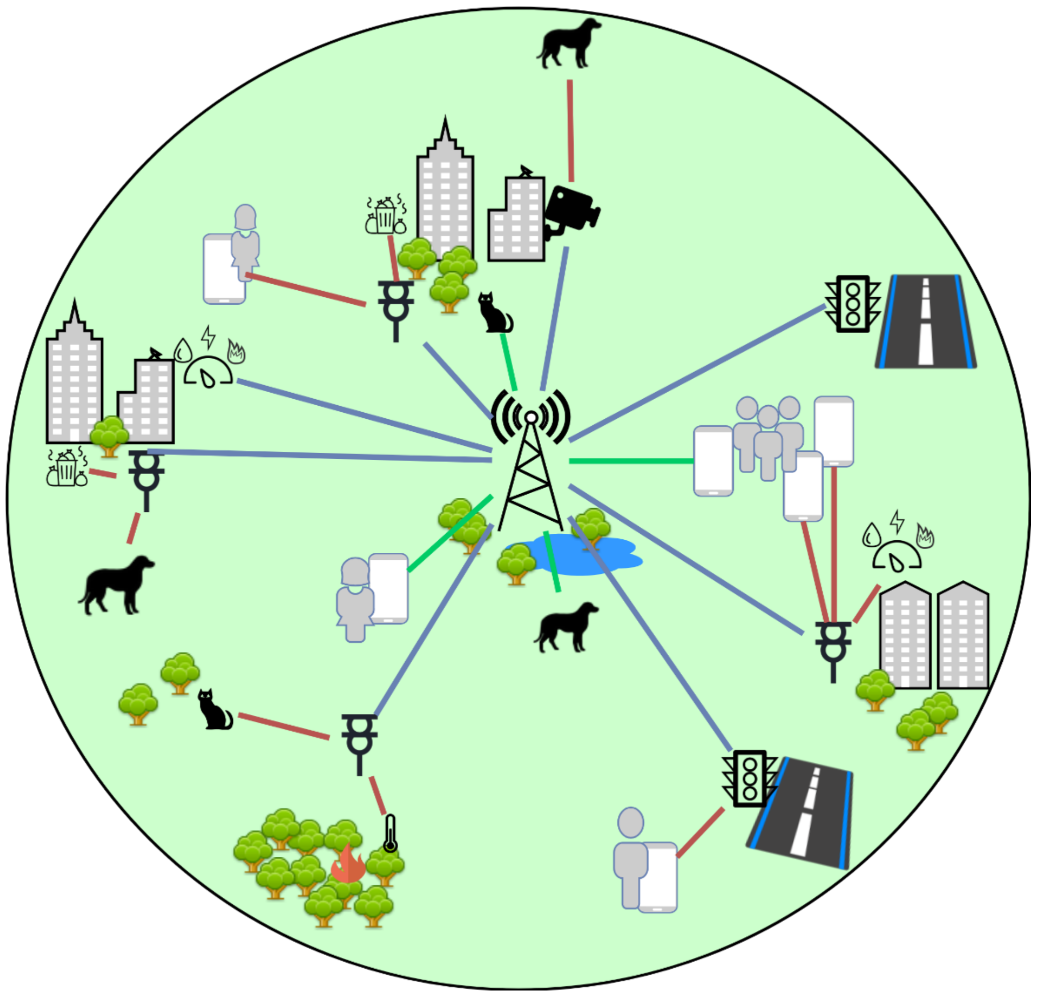


Figure 1. Architectural decomposition of proposed cooperative communication topology.

4. Results

In this work, we use Weka tool to analyze data set and performance of three different machine learning algorithms are surveyed; NaiveBayes, IBk and J48 (C4.5). We try to select the best algorithm. Processing power is not a constraint as calculations are done in base station. Results are fetched daily to end nodes as trained model to use for their future selections. Any failure in relay selection would lead to duplicated signaling which impacts the system performance.

We applied some assumptions to simplify our model;

- Only relay nodes are considered to cooperate with end points; cooperation between end points is not considered in the scope of this work.
- Only end points with lower capacity than required throughput is expected to cooperate.
- Clients are served as first in first out policy; no end nodes do a relay selection for speculated utilization by different end nodes in the future. End nodes only utilize single relay at a time.

Data set includes 1 base station, 5 fixed relaying nodes, 50 mobile end-user nodes and 50 mobile IoT sensor nodes. Technology-wise capacity of end-users and IoT sensors are 20 Mbit/s and 4 Mbit/s respectively. Similarly, relays have 200 Mbit/s capacity which does not vary due to fixed location and base station is considered to have unlimited capacity. Throughput of IoT sensors are fixed and 2 Mbit/s. End user throughput patterns vary during the day. Coverage area of the system is considered to be 10km in diameter, base station is located in the center of the area, and all end-users and IoT sensors reside within this range during the day, neither any endpoint leaves nor enters the system. Similarly, relays are geographically distributed in the coverage range.

5. Conclusion

In this work, we proposed a cooperative communication framework for a common smart city IoT application. Proposed framework uses machine learning methods by training data obtained from base station and fixed nodes, then framework uses this trained model to provide optimum relay node selection to mobile end nodes with reduced complexity.

Proposed framework shows that machine learning methods can classify the data well, which can be used as an input for future selections. This would improve overall reliability, efficiency, throughput, delay and jitter of the wireless network. Numerical model results are shown the effectiveness of the proposed scheme.

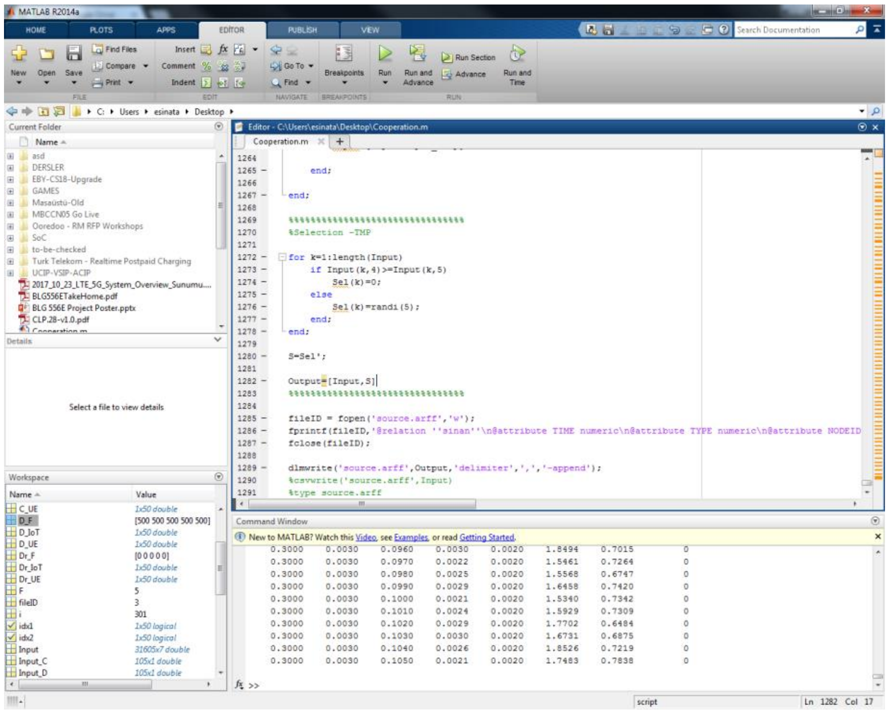
Obtaining real world data is important for future studies. As well as scale of the environment and cooperation between mobile nodes are some of the further studies in this topic.

6. Development and Modelling

Dataset for proposed scheme is generated by a Matlab code. Then, this dataset is processed trained and tested by Weka machine learning tool.

6.1. Model Data Generation

Matlab R2014 is used for generating data according to proposed framework data mode. Data generation process is done considering wireless communication attributes. Matlab code which we use to generate data can be found in “Proposed Model Data Generator Source Code” section.



```
        end;

    end;

    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    %Selection -TMP

    for k=1:length(Input)
        if Input(k,4)>=Input(k,5)
            Sel(k)=0;
        else
            Sel(k)=randi(5);
        end;
    end;

    S=Sel';

    Output=[Input,S]
    %%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

    fileID = fopen('source.arff','w');
    fprintf(fileID,'@relation ''sinan''\n@attribute TIME numeric\n@attribute TYPE numeric\n@attribute NODEID
    fclose(fileID);

    dlmwrite('source.arff',Output,'delimiter',',','-append');
    %csvwrite('source.arff',Input)
    %type source.arff
```

Name	Value
C_UE	1x50 double
D_F	[500 500 500 500 500]
D_IoT	1x50 double
D_UE	1x50 double
Dr_F	[0 0 0 0 0]
Dr_IoT	1x50 double
Dr_UE	1x50 double
F	5
fileID	3
i	301
idx1	1x50 logical
idx2	1x50 logical
Input	31605x7 double
Input_C	105x1 double
Input_D	105x1 double

```
    0.3000    0.0030    0.0960    0.0030    0.0020    1.8494    0.7015         0
    0.3000    0.0030    0.0970    0.0022    0.0020    1.5461    0.7264         0
    0.3000    0.0030    0.0980    0.0025    0.0020    1.5568    0.6747         0
    0.3000    0.0030    0.0990    0.0029    0.0020    1.6458    0.7420         0
    0.3000    0.0030    0.1000    0.0021    0.0020    1.5340    0.7342         0
    0.3000    0.0030    0.1010    0.0024    0.0020    1.5929    0.7309         0
    0.3000    0.0030    0.1020    0.0029    0.0020    1.7702    0.6484         0
    0.3000    0.0030    0.1030    0.0030    0.0020    1.6731    0.6875         0
    0.3000    0.0030    0.1040    0.0026    0.0020    1.8526    0.7219         0
    0.3000    0.0030    0.1050    0.0021    0.0020    1.7483    0.7838         0

fx >>
```

6.1.1. Example Generated Data

Example arff file generated by our data set generator is shown below. Weka tool can process this arff file for machine learning methods.

```
@relation 'cooperative'
@attribute TIME numeric
@attribute TYPE numeric
@attribute NODEID numeric
@attribute CAPACITY numeric
@attribute RATE numeric
@attribute BSDISTANCE numeric
@attribute R1DISTANCE numeric
@attribute R2DISTANCE numeric
@attribute R3DISTANCE numeric
@attribute R4DISTANCE numeric
@attribute R5DISTANCE numeric
@attribute selected {0, 1, 2, 3, 4, 5}
@data
0,0,1,50000,0,0,0,0,0,0,0,0
0,1,2,500,0,0,0,0,0,0,0,0
0,1,3,500,0,0,0,0,0,0,0,0
0,1,4,500,0,0,0,0,0,0,0,0
0,1,5,500,0,0,0,0,0,0,0,0
0,1,6,500,0,0,0,0,0,0,0,0
0,2,7,15.716,5.0776,1365.6,22.667,327.51,382.76,0,176.35,0
0,2,8,15.953,0,633.3,449.79,314.86,279.24,0,0,0
0,2,9,16.639,22.78,955.67,480.28,0,192.37,604.84,78.539,2
0,2,10,16.592,7.0863,1246.1,568.11,815.95,240.48,703.28,305.53,0
```

```
0,2,11,13.166,0,844.13,399.96,178.51,188.77,90.971,211.52,0
0,2,12,19.095,13.494,1617.6,79.366,362.21,53.925,454.06,66.315,0
0,2,13,18.034,14.95,878.99,223.96,264.21,0,95.039,93.067,0
0,2,14,9.0707,7.9433,1260.8,393.91,161.89,612.82,503.73,395.89,0
0,2,15,9.0488,21.357,1168.7,86.572,623.58,362.4,545.28,247.85,1
0,2,16,8.8092,11.212,1062.5,0,21.377,287.01,153.86,112.01,1
0,2,17,16.01,4.6789,816.11,224.66,867.62,386.23,512.62,557.92,0
0,2,18,18.415,10.904,1244.4,305.57,131.11,615.8,86.362,694.07,0
0,2,19,17.505,37.016,698.33,346.45,180.67,163.76,686.41,439.58,3
0,2,20,8.5343,8.1767,811.21,288.77,530.4,497.17,316.07,84.733,0
0,2,21,19.391,8.6493,1052.5,0,0,587.59,94.028,314.56,0
0,2,22,19.413,28.458,1287.6,618.24,422.71,587.55,440.98,495.88,2
0,2,23,11.359,10.922,740.31,125,268.9,663.35,49.169,159.04,0
0,2,24,15.729,26.754,1438.6,123.36,365.49,488.5,320.98,0,5
0,2,25,17.165,22.863,1067.4,218.54,237.05,398.47,0,483.85,4
0,2,26,14.486,31.776,774.58,0,439.35,322.36,101.76,0,5
…
```

6.1.2. Proposed Model Data Generator Source Code

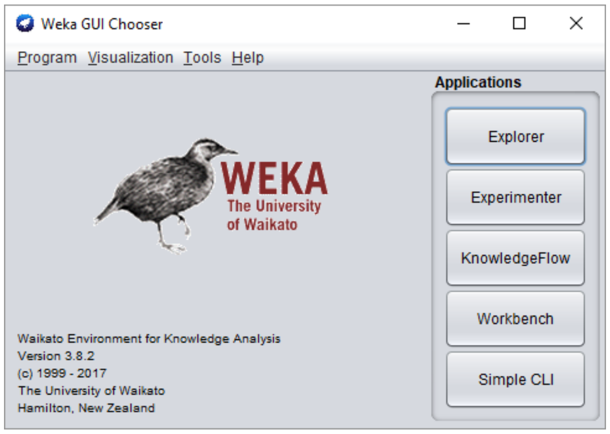
Matlab source code of proposed model data generator:

```
ADD MATLAB CODE HERE !!!
```

6.2. Weka Machine Learning Tool

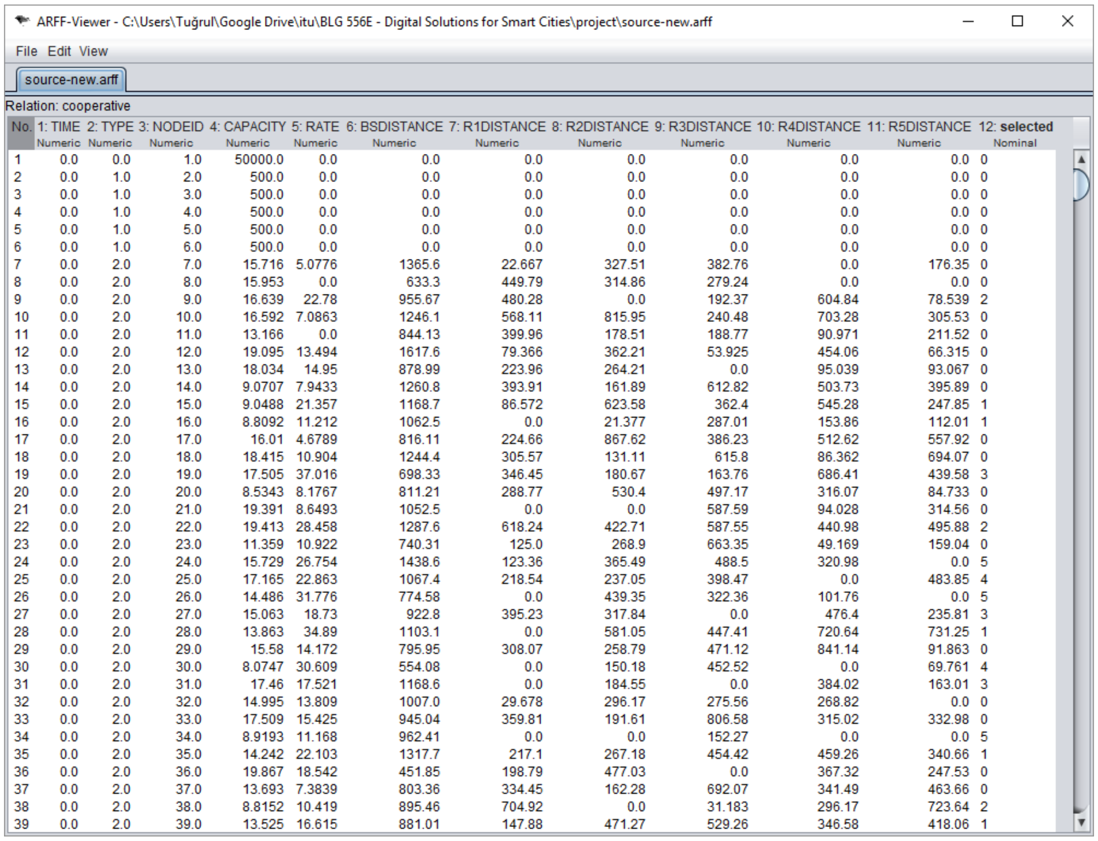
Weka is a powerful open source tool for machine learning algorithms for data mining tasks. The algorithms can either be applied directly to a dataset or called from your own Java code. Weka contains tools for data pre-processing, classification, regression, clustering, association rules, and visualization.

6.2.1. Weka Example Screenshot



Waikato Environment for Knowledge Analysis
Version 3.8.2
(c) 1999 - 2017
The University of Waikato
Hamilton, New Zealand

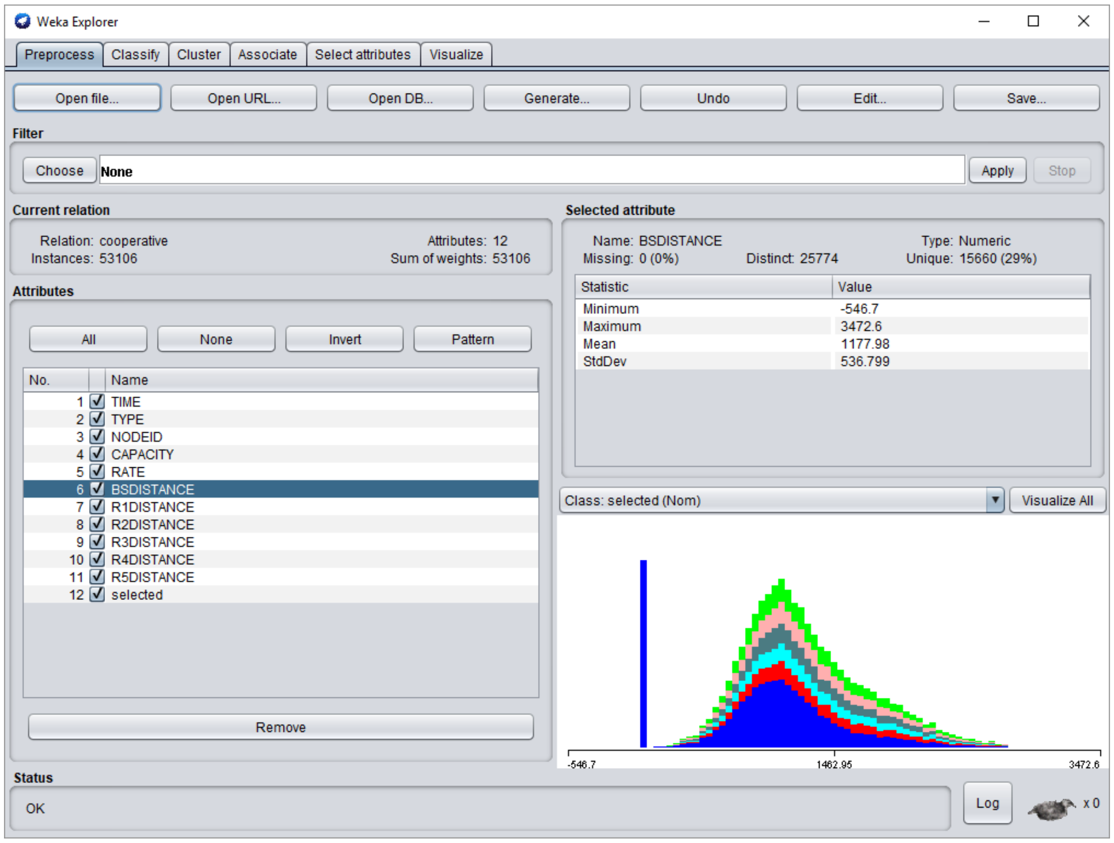
6.2.2. Weka arff File Explorer Screenshot


ARFF-Viewer - C:\Users\Tuğrul\Google Drive\itu\BLG 556E - Digital Solutions for Smart Cities\project\source-new.arff

Relation: cooperative

No.	1: TIME Numeric	2: TYPE Numeric	3: NODEID Numeric	4: CAPACITY Numeric	5: RATE Numeric	6: BSDISTANCE Numeric	7: R1DISTANCE Numeric	8: R2DISTANCE Numeric	9: R3DISTANCE Numeric	10: R4DISTANCE Numeric	11: R5DISTANCE Numeric	12: **selected** Nominal
1	0.0	0.0	1.0	50000.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
2	0.0	1.0	2.0	500.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
3	0.0	1.0	3.0	500.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
4	0.0	1.0	4.0	500.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
5	0.0	1.0	5.0	500.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
6	0.0	1.0	6.0	500.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
7	0.0	2.0	7.0	15.716	5.0776	1365.6	22.667	327.51	382.76	0.0	176.35	0
8	0.0	2.0	8.0	15.953	0.0	633.3	449.79	314.86	279.24	0.0	0.0	0
9	0.0	2.0	9.0	16.639	22.78	955.67	480.28	0.0	192.37	604.84	78.539	2
10	0.0	2.0	10.0	16.592	7.0863	1246.1	568.11	815.95	240.48	703.28	305.53	0
11	0.0	2.0	11.0	13.166	0.0	844.13	399.96	178.51	188.77	90.971	211.52	0
12	0.0	2.0	12.0	19.095	13.494	1617.6	79.366	362.21	53.925	454.06	66.315	0
13	0.0	2.0	13.0	18.034	14.95	878.99	223.96	264.21	0.0	95.039	93.067	0
14	0.0	2.0	14.0	9.0707	7.9433	1260.8	393.91	161.89	612.82	503.73	395.89	0
15	0.0	2.0	15.0	9.0488	21.357	1168.7	86.572	623.58	362.4	545.28	247.85	1
16	0.0	2.0	16.0	8.8092	11.212	1062.5	0.0	21.377	287.01	153.86	112.01	1
17	0.0	2.0	17.0	16.01	4.6789	816.11	224.66	867.62	386.23	512.62	557.92	0
18	0.0	2.0	18.0	18.415	10.904	1244.4	305.57	131.11	615.8	86.362	694.07	0
19	0.0	2.0	19.0	17.505	37.016	698.33	346.45	180.67	163.76	686.41	439.58	3
20	0.0	2.0	20.0	8.5343	8.1767	811.21	288.77	530.4	497.17	316.07	84.733	0
21	0.0	2.0	21.0	19.391	8.6493	1052.5	0.0	0.0	587.59	94.028	314.56	0
22	0.0	2.0	22.0	19.413	28.458	1287.6	618.24	422.71	587.55	440.98	495.88	2
23	0.0	2.0	23.0	11.359	10.922	740.31	125.0	268.9	663.35	49.169	159.04	0
24	0.0	2.0	24.0	15.729	26.754	1438.6	123.36	365.49	488.5	320.98	0.0	5
25	0.0	2.0	25.0	17.165	22.863	1067.4	218.54	237.05	398.47	0.0	483.85	4
26	0.0	2.0	26.0	14.486	31.776	774.58	0.0	439.35	322.36	101.76	0.0	5
27	0.0	2.0	27.0	15.063	18.73	922.8	395.23	317.84	0.0	476.4	235.81	3
28	0.0	2.0	28.0	13.863	34.89	1103.1	0.0	581.05	447.41	720.64	731.25	1
29	0.0	2.0	29.0	15.58	14.172	795.95	308.07	258.79	471.12	841.14	91.863	0
30	0.0	2.0	30.0	8.0747	30.609	554.08	0.0	150.18	452.52	0.0	69.761	4
31	0.0	2.0	31.0	17.46	17.521	1168.6	0.0	184.55	0.0	384.02	163.01	3
32	0.0	2.0	32.0	14.995	13.809	1007.0	29.678	296.17	275.56	268.82	0.0	0
33	0.0	2.0	33.0	17.509	15.425	945.04	359.81	191.61	806.58	315.02	332.98	0
34	0.0	2.0	34.0	8.9193	11.168	962.41	0.0	0.0	152.27	0.0	0.0	5
35	0.0	2.0	35.0	14.242	22.103	1317.7	217.1	267.18	454.42	459.26	340.66	1
36	0.0	2.0	36.0	19.867	18.542	451.85	198.79	477.03	0.0	367.32	247.53	0
37	0.0	2.0	37.0	13.693	7.3839	803.36	334.45	162.28	692.07	341.49	463.66	0
38	0.0	2.0	38.0	8.8152	10.419	895.46	704.92	0.0	31.183	296.17	723.64	2
39	0.0	2.0	39.0	13.525	16.615	881.01	147.88	471.27	529.26	346.58	418.06	1

6.2.3. Weka Input Selector Screenshot



Filter: None

Current relation

Relation: cooperative
Instances: 53106
Attributes: 12
Sum of weights: 53106

Selected attribute

Name: BSDISTANCE
Missing: 0 (0%)
Distinct: 25774
Type: Numeric
Unique: 15660 (29%)

Statistic	Value
Minimum	-546.7
Maximum	3472.6
Mean	1177.98
StdDev	536.799

Attributes

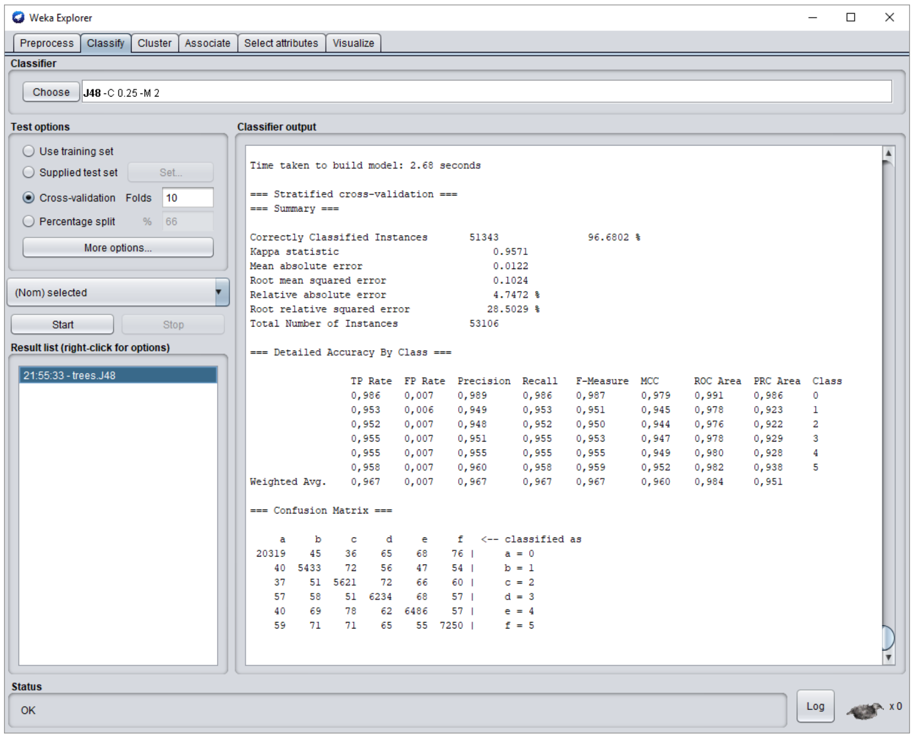
No.	Name
1	✓ TIME
2	✓ TYPE
3	✓ NODEID
4	✓ CAPACITY
5	✓ RATE
6	✓ BSDISTANCE
7	✓ R1DISTANCE
8	✓ R2DISTANCE
9	✓ R3DISTANCE
10	✓ R4DISTANCE
11	✓ R5DISTANCE
12	✓ selected

Class: selected (Nom)

Status

OK

6.2.4. Weka Classification Result Screenshot



Classifier: J48 -C 0.25 -M 2

Test options

Use training set
Supplied test set
[✓ Cross-validation] Folds 10
Percentage split % 66

(Nom) selected

Result list (right-click for options)

21:55:33 - trees.J48

Classifier output

```
Time taken to build model: 2.68 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances       51343               96.6802 %
Kappa statistic                          0.9571
Mean absolute error                      0.0122
Root mean squared error                  0.1024
Relative absolute error                  4.7472 %
Root relative squared error             28.5029 %
Total Number of Instances            53106

=== Detailed Accuracy By Class ===

                 TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                 0,986    0,007    0,989      0,986    0,987      0,979    0,991     0,986     0
                 0,953    0,006    0,949      0,953    0,951      0,945    0,978     0,923     1
                 0,952    0,007    0,948      0,952    0,950      0,944    0,976     0,922     2
                 0,955    0,007    0,951      0,955    0,953      0,947    0,978     0,929     3
                 0,955    0,007    0,955      0,955    0,955      0,949    0,980     0,928     4
                 0,958    0,007    0,960      0,958    0,959      0,952    0,982     0,938     5
Weighted Avg.    0,967    0,007    0,967      0,967    0,967      0,960    0,984     0,951

=== Confusion Matrix ===

     a     b     c     d     e     f   <-- classified as
 20319    45    36    65    68    76 |     a = 0
    40  5433    72    56    47    54 |     b = 1
    37    51  5621    72    66    60 |     c = 2
    57    58    51  6234    68    57 |     d = 3
    40    69    78    62  6486    57 |     e = 4
    59    71    71    65    55  7250 |     f = 5
```

Status

OK

7. References

[1] U. Raza, P. Kulkarni and M. Sooriyabandara, "Low Power Wide Area Networks: An Overview", IEEE Communications Surveys & Tutorials, vol. 19, no. 2, pp. 855-873, second quarter 2017

[2] “Cellular networks for massive IoT: Enabling low power wide area applications,” Ericsson, Stockholm, Sweden, Tech. Rep. UEN 284 23-3278, Jan. 2016.

[3] Y. He, F. R. Yu, N. Zhao, V. C. M. Leung and H. Yin, "Software-Defined Networks with Mobile Edge Computing and Caching for Smart Cities: A Big Data Deep Reinforcement Learning Approach," in IEEE Communications Magazine, vol. 55, no. 12, pp. 31-37, Dec. 2017.

[4] A. Al-Fuqaha et al., “Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications,” IEEE Commun. Surveys & Tutorials, vol. 17, 4th qtr. 2015, pp. 2347–76.

[5] T. Taleb et al., “Mobile Edge Computing Potential in Making Cities Smarter,” IEEE Commun. Mag., vol. 55, no. 3, Mar. 2017, pp. 38–43.

[6] G. Han et al., “Analysis of Energy-Efficient Connected Target Coverage Algorithms for Industrial Wireless Sensor Networks,” IEEE Trans. Industrial Informatics, vol. 13, Feb. 2017, pp. 135–43.

[7] P. Pandey and R. Prabhakar, "An analysis of machine learning techniques (J48 & AdaBoost)-for classification," 2016 1st India International Conference on Information Processing (IICIP), Delhi, 2016, pp. 1-6.

[8] C4.5: Programs for Machine Learning by J. Ross Quinlan. Morgan Kaufmann Publishers, Inc., 1993

8. Appendix

8.1. Matlab Codes

```
clear all; clc;
s=RandStream.create('mt19937ar','seed',sum(100*clock));
RandStream.setGlobalStream(s);
%Input=[Time, Type, NodeID, Capacity, Rate, BaseDistance, RelayDistances]
%Output=[Selection]

UE=50;
IoT=50;
F=5;
B=1;

C_avg_UE=20;
C_avg_F=50;
C_avg_IoT=2;

%TimexDay (2159: 90 Day Data Used)
ToD=0:1:2159;

%Preallocations
R_UE=zeros(1,UE);
```

```
R_IoT=zeros(1,IoT);
R_F=zeros(1,F);
Input=[];

%Types
Type_UE=zeros(1,UE)+2;
Type_IoT=zeros(1,IoT)+3;
Type_F=zeros(1,F)+1;
Type_B=zeros(1,B);

Input_Type=[Type_B';Type_F';Type_UE';Type_IoT'];

for x=1:1:length(ToD)
    if mod(ToD(x),24)==0
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=250.*randn(1,UE)+1000;
        D_IoT(1:IoT)=500.*randn(1,IoT)+1500;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_IoT<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;

        %End-Node Capacity Normalization
        idx1=C_UE<0;
        idx2=C_IoT<0;
        C_UE(idx1)=0;
        C_IoT(idx2)=0;
        idx1=C_UE>20;
        idx2=C_IoT>4;
        C_UE(idx1)=20;
        C_IoT(idx2)=4;



        %%%%%%%%%%%%%%%%%%%
        %Rate
        R_UE=10.*randn(1,UE)+13;
        R_IoT(1:IoT)=2;
        R_F(1:F)=0;
        R_B(1:B)=0;

        %End-Node Rate Normalization
        idx1=R_UE<0;
        R_UE(idx1)=0;
        %idx2=R_UE>C_UE;
        %R_UE(idx2)=0;
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=250.*randn(5,UE)+250;
        Dr_IoT=500.*randn(5,IoT)+350;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==1
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=200.*randn(1,UE)+900;
        D_IoT(1:IoT)=400.*randn(1,IoT)+1200;
```

```
D_F(1:F)=0;
D_B(1:B)=0;

%End-Node Distance Normalization
idx1=D_UE<0;
idx2=D_UE<0;
D_UE(idx1)=0;
D_IoT(idx2)=0;

idx1=D_UE>5000;
idx2=D_IoT>5000;
D_UE(idx1)=5000;
D_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=8.*randn(1,UE)+12;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=200.*randn(5,UE)+200;
Dr_IoT=400.*randn(5,IoT)+500;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);
```

```
        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==2
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=180.*randn(1,UE)+800;
        D_IoT(1:IoT)=360.*randn(1,IoT)+1000;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;
```

```
%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=4.*randn(1,UE)+10;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=180.*randn(5,UE)+150;
Dr_IoT=360.*randn(5,IoT)+300;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
idx1=Dr_UE<0;
idx2=Dr_UE<0;
Dr_UE(idx1)=0;
Dr_IoT(idx2)=0;

idx1=Dr_UE>5000;
idx2=Dr_IoT>5000;
Dr_UE(idx1)=5000;
Dr_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Generate Data Set
Input_C=[C_B';C_F';C_UE';C_IoT'];
Input_R=[R_B';R_F';R_UE';R_IoT'];
Input_D=[D_B;D_F';D_UE';D_IoT'];
Input_ID=(1:(B+F+UE+IoT))';
Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
%Time Input
Input_T=(zeros(1,length(Input_C))+ToD(x))';
```

```
Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==3
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=180.*randn(1,UE)+800;
        D_IoT(1:IoT)=360.*randn(1,IoT)+1000;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;

        %End-Node Capacity Normalization
        idx1=C_UE<0;
        idx2=C_IoT<0;
        C_UE(idx1)=0;
        C_IoT(idx2)=0;
        idx1=C_UE>20;
        idx2=C_IoT>4;
        C_UE(idx1)=20;
        C_IoT(idx2)=4;


        %%%%%%%%%%%%%%%%%%%
        %Rate
        R_UE=3.*randn(1,UE)+7;
        R_IoT(1:IoT)=2;
        R_F(1:F)=0;
        R_B(1:B)=0;

        %End-Node Rate Normalization
        idx1=R_UE<0;
        R_UE(idx1)=0;
        %idx2=R_UE>C_UE;
        %R_UE(idx2)=0;
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=180.*randn(5,UE)+150;
        Dr_IoT=360.*randn(5,IoT)+300;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==4
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=180.*randn(1,UE)+800;
        D_IoT(1:IoT)=360.*randn(1,IoT)+1000;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;
```

```
idx1=D_UE>5000;
idx2=D_IoT>5000;
D_UE(idx1)=5000;
D_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=2.*randn(1,UE)+6;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=180.*randn(5,UE)+150;
Dr_IoT=300.*randn(5,IoT)+300;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
idx1=Dr_UE<0;
idx2=Dr_UE<0;
Dr_UE(idx1)=0;
Dr_IoT(idx2)=0;

idx1=Dr_UE>5000;
idx2=Dr_IoT>5000;
```

```
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==5
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=250.*randn(1,UE)+1000;
        D_IoT(1:IoT)=600.*randn(1,IoT)+1700;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;

        %End-Node Capacity Normalization
        idx1=C_UE<0;
        idx2=C_IoT<0;
        C_UE(idx1)=0;
        C_IoT(idx2)=0;
        idx1=C_UE>20;
        idx2=C_IoT>4;
        C_UE(idx1)=20;
        C_IoT(idx2)=4;


        %%%%%%%%%%%%%%%%%%%
        %Rate
        R_UE=6.*randn(1,UE)+10;
        R_IoT(1:IoT)=2;
        R_F(1:F)=0;
        R_B(1:B)=0;

        %End-Node Rate Normalization
        idx1=R_UE<0;
        R_UE(idx1)=0;
        %idx2=R_UE>C_UE;
        %R_UE(idx2)=0;
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=200.*randn(5,UE)+250;
        Dr_IoT=600.*randn(5,IoT)+600;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==6
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).
```

```
%%%%%%%%%%%%%%%%%%%
%Distance to BS
D_UE=800.*randn(1,UE)+1600;
D_IoT(1:IoT)=600.*randn(1,IoT)+2000;
D_F(1:F)=0;
D_B(1:B)=0;

%End-Node Distance Normalization
idx1=D_UE<0;
idx2=D_UE<0;
D_UE(idx1)=0;
D_IoT(idx2)=0;

idx1=D_UE>5000;
idx2=D_IoT>5000;
D_UE(idx1)=5000;
D_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=10.*randn(1,UE)+12;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
```

```
        Dr_UE=600.*randn(5,UE)+400;
        Dr_IoT=800.*randn(5,IoT)+750;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;



        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==7
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=1000.*randn(1,UE)+1700;
        D_IoT(1:IoT)=500.*randn(1,IoT)+1500;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;



        %%%%%%%%%%%%%%%%%%%
```

```matlab
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;



%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=15.*randn(1,UE)+14;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;



%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=800.*randn(5,UE)+600;
Dr_IoT=400.*randn(5,IoT)+500;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
idx1=Dr_UE<0;
idx2=Dr_UE<0;
Dr_UE(idx1)=0;
Dr_IoT(idx2)=0;

idx1=Dr_UE>5000;
idx2=Dr_IoT>5000;
Dr_UE(idx1)=5000;
Dr_IoT(idx2)=5000;



%%%%%%%%%%%%%%%%%%%
%Generate Data Set
Input_C=[C_B';C_F';C_UE';C_IoT'];
Input_R=[R_B';R_F';R_UE';R_IoT'];
```

```
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==8
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=800.*randn(1,UE)+1500;
        D_IoT(1:IoT)=600.*randn(1,IoT)+1500;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;

        %End-Node Capacity Normalization
        idx1=C_UE<0;
        idx2=C_IoT<0;
        C_UE(idx1)=0;
        C_IoT(idx2)=0;
        idx1=C_UE>20;
        idx2=C_IoT>4;
        C_UE(idx1)=20;
        C_IoT(idx2)=4;


        %%%%%%%%%%%%%%%%%%%
        %Rate
        R_UE=4.*randn(1,UE)+12;
        R_IoT(1:IoT)=2;
        R_F(1:F)=0;
        R_B(1:B)=0;

        %End-Node Rate Normalization
        idx1=R_UE<0;
        R_UE(idx1)=0;
        %idx2=R_UE>C_UE;
        %R_UE(idx2)=0;
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=400.*randn(5,UE)+500;
        Dr_IoT=500.*randn(5,IoT)+500;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==9
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=250.*randn(1,UE)+750;
        D_IoT(1:IoT)=500.*randn(1,IoT)+1200;
        D_F(1:F)=0;
        D_B(1:B)=0;
```

```
%End-Node Distance Normalization
idx1=D_UE<0;
idx2=D_UE<0;
D_UE(idx1)=0;
D_IoT(idx2)=0;

idx1=D_UE>5000;
idx2=D_IoT>5000;
D_UE(idx1)=5000;
D_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=4.*randn(1,UE)+10;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=100.*randn(5,UE)+150;
Dr_IoT=300.*randn(5,IoT)+400;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
idx1=Dr_UE<0;
idx2=Dr_UE<0;
```

```
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==10
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=300.*randn(1,UE)+750;
        D_IoT(1:IoT)=600.*randn(1,IoT)+1300;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;

        %End-Node Capacity Normalization
        idx1=C_UE<0;
        idx2=C_IoT<0;
        C_UE(idx1)=0;
        C_IoT(idx2)=0;
        idx1=C_UE>20;
        idx2=C_IoT>4;
        C_UE(idx1)=20;
        C_IoT(idx2)=4;


        %%%%%%%%%%%%%%%%%%%
        %Rate
        R_UE=8.*randn(1,UE)+12;
        R_IoT(1:IoT)=2;
        R_F(1:F)=0;
        R_B(1:B)=0;

        %End-Node Rate Normalization
        idx1=R_UE<0;
        R_UE(idx1)=0;
        %idx2=R_UE>C_UE;
        %R_UE(idx2)=0;
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=300.*randn(5,UE)+200;
        Dr_IoT=500.*randn(5,IoT)+600;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
```

```
    Input=[Input;Input_temp];

elseif mod(ToD(x),24)==11
    %In general, you can generate N random numbers in the interval (a,b)
    %with the formula r = a + (b-a).*rand(N,1).

    %%%%%%%%%%%%%%%%%%%
    %Distance to BS
    D_UE=500.*randn(1,UE)+1200;
    D_IoT(1:IoT)=500.*randn(1,IoT)+1000;
    D_F(1:F)=0;
    D_B(1:B)=0;

    %End-Node Distance Normalization
    idx1=D_UE<0;
    idx2=D_UE<0;
    D_UE(idx1)=0;
    D_IoT(idx2)=0;

    idx1=D_UE>5000;
    idx2=D_IoT>5000;
    D_UE(idx1)=5000;
    D_IoT(idx2)=5000;


    %%%%%%%%%%%%%%%%%%%
    %Capacity
    C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
    C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
    C_F(1:F)=500;
    C_B(1:B)=50000;

    %End-Node Capacity Normalization
    idx1=C_UE<0;
    idx2=C_IoT<0;
    C_UE(idx1)=0;
    C_IoT(idx2)=0;
    idx1=C_UE>20;
    idx2=C_IoT>4;
    C_UE(idx1)=20;
    C_IoT(idx2)=4;


    %%%%%%%%%%%%%%%%%%%
    %Rate
    R_UE=12.*randn(1,UE)+15;
    R_IoT(1:IoT)=2;
    R_F(1:F)=0;
    R_B(1:B)=0;

    %End-Node Rate Normalization
    idx1=R_UE<0;
    R_UE(idx1)=0;
    %idx2=R_UE>C_UE;
    %R_UE(idx2)=0;
```

```
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=400.*randn(5,UE)+350;
        Dr_IoT=500.*randn(5,IoT)+500;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;



        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==12
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=700.*randn(1,UE)+2000;
        D_IoT(1:IoT)=500.*randn(1,IoT)+1500;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
```

```
D_UE(idx1)=5000;
D_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=15.*randn(1,UE)+18;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=400.*randn(5,UE)+450;
Dr_IoT=500.*randn(5,IoT)+600;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
idx1=Dr_UE<0;
idx2=Dr_UE<0;
Dr_UE(idx1)=0;
Dr_IoT(idx2)=0;

idx1=Dr_UE>5000;
idx2=Dr_IoT>5000;
Dr_UE(idx1)=5000;
Dr_IoT(idx2)=5000;
```

```
        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==13
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=300.*randn(1,UE)+1500;
        D_IoT(1:IoT)=500.*randn(1,IoT)+1000;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;

        %End-Node Capacity Normalization
        idx1=C_UE<0;
        idx2=C_IoT<0;
        C_UE(idx1)=0;
        C_IoT(idx2)=0;
        idx1=C_UE>20;
        idx2=C_IoT>4;
        C_UE(idx1)=20;
        C_IoT(idx2)=4;
        %%%%%%%%%%%%%%%%%%%
        %Rate
        R_UE=10.*randn(1,UE)+15;
        R_IoT(1:IoT)=2;
        R_F(1:F)=0;
        R_B(1:B)=0;

        %End-Node Rate Normalization
        idx1=R_UE<0;
        R_UE(idx1)=0;
        %idx2=R_UE>C_UE;
        %R_UE(idx2)=0;
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=250.*randn(5,UE)+350;
        Dr_IoT=500.*randn(5,IoT)+500;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==14
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
```

```
D_UE=450.*randn(1,UE)+1000;
D_IoT(1:IoT)=500.*randn(1,IoT)+1500;
D_F(1:F)=0;
D_B(1:B)=0;

%End-Node Distance Normalization
idx1=D_UE<0;
idx2=D_UE<0;
D_UE(idx1)=0;
D_IoT(idx2)=0;

idx1=D_UE>5000;
idx2=D_IoT>5000;
D_UE(idx1)=5000;
D_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=7.*randn(1,UE)+10;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=250.*randn(5,UE)+250;
Dr_IoT=500.*randn(5,IoT)+500;
Dr_F=zeros(5,F);
```

```
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==15
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=250.*randn(1,UE)+1000;
        D_IoT(1:IoT)=500.*randn(1,IoT)+1500;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
```

```
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=12.*randn(1,UE)+9;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=250.*randn(5,UE)+250;
Dr_IoT=500.*randn(5,IoT)+500;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
idx1=Dr_UE<0;
idx2=Dr_UE<0;
Dr_UE(idx1)=0;
Dr_IoT(idx2)=0;

idx1=Dr_UE>5000;
idx2=Dr_IoT>5000;
Dr_UE(idx1)=5000;
Dr_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Generate Data Set
Input_C=[C_B';C_F';C_UE';C_IoT'];
Input_R=[R_B';R_F';R_UE';R_IoT'];
Input_D=[D_B;D_F';D_UE';D_IoT'];
Input_ID=(1:(B+F+UE+IoT))';
Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
```

```
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==16
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=300.*randn(1,UE)+1200;
        D_IoT(1:IoT)=400.*randn(1,IoT)+1300;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;

        %End-Node Capacity Normalization
        idx1=C_UE<0;
        idx2=C_IoT<0;
        C_UE(idx1)=0;
        C_IoT(idx2)=0;
        idx1=C_UE>20;
        idx2=C_IoT>4;
        C_UE(idx1)=20;
        C_IoT(idx2)=4;


        %%%%%%%%%%%%%%%%%%%
        %Rate
        R_UE=8.*randn(1,UE)+12;
        R_IoT(1:IoT)=2;
        R_F(1:F)=0;
        R_B(1:B)=0;
        %End-Node Rate Normalization
        idx1=R_UE<0;
        R_UE(idx1)=0;
        %idx2=R_UE>C_UE;
        %R_UE(idx2)=0;
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=350.*randn(5,UE)+350;
        Dr_IoT=500.*randn(5,IoT)+400;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==17
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=400.*randn(1,UE)+1400;
        D_IoT(1:IoT)=400.*randn(1,IoT)+1200;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
```

```
D_UE(idx1)=0;
D_IoT(idx2)=0;

idx1=D_UE>5000;
idx2=D_IoT>5000;
D_UE(idx1)=5000;
D_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=10.*randn(1,UE)+14;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=350.*randn(5,UE)+450;
Dr_IoT=500.*randn(5,IoT)+400;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
idx1=Dr_UE<0;
idx2=Dr_UE<0;
Dr_UE(idx1)=0;
Dr_IoT(idx2)=0;
```

```
        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==18
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=600.*randn(1,UE)+2000;
        D_IoT(1:IoT)=400.*randn(1,IoT)+1200;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;

        %End-Node Capacity Normalization
        idx1=C_UE<0;
        idx2=C_IoT<0;
        C_UE(idx1)=0;
        C_IoT(idx2)=0;
        idx1=C_UE>20;
        idx2=C_IoT>4;
        C_UE(idx1)=20;
        C_IoT(idx2)=4;


        %%%%%%%%%%%%%%%%%%%
        %Rate
        R_UE=12.*randn(1,UE)+16;
        R_IoT(1:IoT)=2;
        R_F(1:F)=0;
        R_B(1:B)=0;

        %End-Node Rate Normalization
        idx1=R_UE<0;
        R_UE(idx1)=0;
        %idx2=R_UE>C_UE;
        %R_UE(idx2)=0;
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=400.*randn(5,UE)+600;
        Dr_IoT=200.*randn(5,IoT)+400;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==19
```

```
%In general, you can generate N random numbers in the interval (a,b)
%with the formula r = a + (b-a).*rand(N,1).

%%%%%%%%%%%%%%%%%%%
%Distance to BS
D_UE=350.*randn(1,UE)+1400;
D_IoT(1:IoT)=500.*randn(1,IoT)+1200;
D_F(1:F)=0;
D_B(1:B)=0;

%End-Node Distance Normalization
idx1=D_UE<0;
idx2=D_UE<0;
D_UE(idx1)=0;
D_IoT(idx2)=0;

idx1=D_UE>5000;
idx2=D_IoT>5000;
D_UE(idx1)=5000;
D_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=9.*randn(1,UE)+15;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;
```

```
        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=250.*randn(5,UE)+450;
        Dr_IoT=500.*randn(5,IoT)+500;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==20
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=250.*randn(1,UE)+1200;
        D_IoT(1:IoT)=500.*randn(1,IoT)+1600;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;
```

```
%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=10.*randn(1,UE)+15;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=250.*randn(5,UE)+250;
Dr_IoT=500.*randn(5,IoT)+600;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
idx1=Dr_UE<0;
idx2=Dr_UE<0;
Dr_UE(idx1)=0;
Dr_IoT(idx2)=0;

idx1=Dr_UE>5000;
idx2=Dr_IoT>5000;
Dr_UE(idx1)=5000;
Dr_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Generate Data Set
```

```
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==21
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=350.*randn(1,UE)+1100;
        D_IoT(1:IoT)=400.*randn(1,IoT)+1600;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;

        %End-Node Capacity Normalization
        idx1=C_UE<0;
        idx2=C_IoT<0;
        C_UE(idx1)=0;
        C_IoT(idx2)=0;
        idx1=C_UE>20;
        idx2=C_IoT>4;
        C_UE(idx1)=20;
        C_IoT(idx2)=4;


        %%%%%%%%%%%%%%%%%%%
        %Rate
        R_UE=12.*randn(1,UE)+16;
        R_IoT(1:IoT)=2;
        R_F(1:F)=0;
        R_B(1:B)=0;

        %End-Node Rate Normalization
        idx1=R_UE<0;
        R_UE(idx1)=0;
        %idx2=R_UE>C_UE;
        %R_UE(idx2)=0;
        %R_UE=R_UE+C_UE.*idx2;


        %%%%%%%%%%%%%%%%%%%
        %Relay Distances
        Dr_UE=200.*randn(5,UE)+300;
        Dr_IoT=400.*randn(5,IoT)+800;
        Dr_F=zeros(5,F);
        Dr_B=zeros(5,B);

        %End-Node Relay Distance Normalization
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    elseif mod(ToD(x),24)==22
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=400.*randn(1,UE)+1000;
        D_IoT(1:IoT)=600.*randn(1,IoT)+1500;
        D_F(1:F)=0;
```

```
D_B(1:B)=0;

%End-Node Distance Normalization
idx1=D_UE<0;
idx2=D_UE<0;
D_UE(idx1)=0;
D_IoT(idx2)=0;

idx1=D_UE>5000;
idx2=D_IoT>5000;
D_UE(idx1)=5000;
D_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Capacity
C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
C_F(1:F)=500;
C_B(1:B)=50000;

%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=12.*randn(1,UE)+15;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=250.*randn(5,UE)+250;
Dr_IoT=500.*randn(5,IoT)+500;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
```

```
        idx1=Dr_UE<0;
        idx2=Dr_UE<0;
        Dr_UE(idx1)=0;
        Dr_IoT(idx2)=0;

        idx1=Dr_UE>5000;
        idx2=Dr_IoT>5000;
        Dr_UE(idx1)=5000;
        Dr_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Generate Data Set
        Input_C=[C_B';C_F';C_UE';C_IoT'];
        Input_R=[R_B';R_F';R_UE';R_IoT'];
        Input_D=[D_B;D_F';D_UE';D_IoT'];
        Input_ID=(1:(B+F+UE+IoT))';
        Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
        %Time Input
        Input_T=(zeros(1,length(Input_C))+ToD(x))';


Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    else
        %In general, you can generate N random numbers in the interval (a,b)
        %with the formula r = a + (b-a).*rand(N,1).

        %%%%%%%%%%%%%%%%%%%
        %Distance to BS
        D_UE=300.*randn(1,UE)+1000;
        D_IoT(1:IoT)=450.*randn(1,IoT)+1500;
        D_F(1:F)=0;
        D_B(1:B)=0;

        %End-Node Distance Normalization
        idx1=D_UE<0;
        idx2=D_UE<0;
        D_UE(idx1)=0;
        D_IoT(idx2)=0;

        idx1=D_UE>5000;
        idx2=D_IoT>5000;
        D_UE(idx1)=5000;
        D_IoT(idx2)=5000;


        %%%%%%%%%%%%%%%%%%%
        %Capacity
        C_UE=20-real(log(D_UE).*abs(randn(1,UE)));
        C_IoT(1:IoT)=4-real(log(D_IoT).*abs(randn(1,IoT)));
        C_F(1:F)=500;
        C_B(1:B)=50000;
```

```
%End-Node Capacity Normalization
idx1=C_UE<0;
idx2=C_IoT<0;
C_UE(idx1)=0;
C_IoT(idx2)=0;
idx1=C_UE>20;
idx2=C_IoT>4;
C_UE(idx1)=20;
C_IoT(idx2)=4;


%%%%%%%%%%%%%%%%%%%
%Rate
R_UE=6.*randn(1,UE)+15;
R_IoT(1:IoT)=2;
R_F(1:F)=0;
R_B(1:B)=0;

%End-Node Rate Normalization
idx1=R_UE<0;
R_UE(idx1)=0;
%idx2=R_UE>C_UE;
%R_UE(idx2)=0;
%R_UE=R_UE+C_UE.*idx2;


%%%%%%%%%%%%%%%%%%%
%Relay Distances
Dr_UE=300.*randn(5,UE)+250;
Dr_IoT=600.*randn(5,IoT)+500;
Dr_F=zeros(5,F);
Dr_B=zeros(5,B);

%End-Node Relay Distance Normalization
idx1=Dr_UE<0;
idx2=Dr_UE<0;
Dr_UE(idx1)=0;
Dr_IoT(idx2)=0;

idx1=Dr_UE>5000;
idx2=Dr_IoT>5000;
Dr_UE(idx1)=5000;
Dr_IoT(idx2)=5000;


%%%%%%%%%%%%%%%%%%%
%Generate Data Set
Input_C=[C_B';C_F';C_UE';C_IoT'];
Input_R=[R_B';R_F';R_UE';R_IoT'];
Input_D=[D_B;D_F';D_UE';D_IoT'];
Input_ID=(1:(B+F+UE+IoT))';
Input_Dr=[Dr_B';Dr_F';Dr_UE';Dr_IoT'];
%Time Input
Input_T=(zeros(1,length(Input_C))+ToD(x))';
```

```
Input_temp=[Input_T,Input_Type,Input_ID,Input_C,Input_R,Input_D,Input_Dr];
        Input=[Input;Input_temp];

    end;

end;

%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
%Selection -TMP

for k=1:length(Input)
    if Input(k,4)>=Input(k,5)
        Sel(k)=0;
    else
        tmp=min(Input(k,7:11));
        for a=1:1:F
            if tmp==Input(k,6+a)
                Sel(k)=a;
            end;
        end;
    end;
end;

S=Sel';

Output=[Input,S];
%Output2=[mod(Output(:,1),24),Output(:,2:12)];
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

fileID = fopen('source-new.arff','w');
fprintf(fileID,'@relation ''sinan''\n@attribute TIME numeric\n@attribute TYPE
numeric\n@attribute NODEID numeric\n@attribute CAPACITY numeric\n@attribute
RATE numeric\n@attribute BSDISTANCE numeric\n@attribute R1DISTANCE
numeric\n@attribute R2DISTANCE numeric\n@attribute R3DISTANCE
numeric\n@attribute R4DISTANCE numeric\n@attribute R5DISTANCE
numeric\n@attribute selected {0, 1, 2, 3, 4, 5}\n@data\n');
fclose(fileID);

dlmwrite('source-new.arff',Output,'delimiter',',','-append');
%csvwrite('source.arff',Input)
%type source.arff

%dlmwrite('source-new.txt',Output2,'delimiter',',','-append');

count=zeros(1,24);
for x=1:1:length(Output2)
    if Output2(x,1)==0 && Output2(x,5)>Output2(x,4)
        count(1)=count(1)+1;
    elseif Output2(x,1)==1 && Output2(x,5)>Output2(x,4)
        count(2)=count(2)+1;
    elseif Output2(x,1)==2 && Output2(x,5)>Output2(x,4)
        count(3)=count(3)+1;
    elseif Output2(x,1)==3 && Output2(x,5)>Output2(x,4)
        count(4)=count(4)+1;
    elseif Output2(x,1)==4 && Output2(x,5)>Output2(x,4)
        count(5)=count(5)+1;
    elseif Output2(x,1)==5 && Output2(x,5)>Output2(x,4)
        count(6)=count(6)+1;
    elseif Output2(x,1)==7 && Output2(x,5)>Output2(x,4)
        count(8)=count(8)+1;
    elseif Output2(x,1)==8 && Output2(x,5)>Output2(x,4)
        count(9)=count(9)+1;
    elseif Output2(x,1)==9 && Output2(x,5)>Output2(x,4)
        count(10)=count(10)+1;
    elseif Output2(x,1)==10 && Output2(x,5)>Output2(x,4)
        count(11)=count(11)+1;
    elseif Output2(x,1)==11 && Output2(x,5)>Output2(x,4)
        count(12)=count(12)+1;
    elseif Output2(x,1)==12 && Output2(x,5)>Output2(x,4)
        count(13)=count(13)+1;
    elseif Output2(x,1)==13 && Output2(x,5)>Output2(x,4)
        count(14)=count(14)+1;
    elseif Output2(x,1)==14 && Output2(x,5)>Output2(x,4)
        count(15)=count(15)+1;
    elseif Output2(x,1)==15 && Output2(x,5)>Output2(x,4)
        count(16)=count(16)+1;
    elseif Output2(x,1)==16 && Output2(x,5)>Output2(x,4)
        count(17)=count(17)+1;
    elseif Output2(x,1)==17 && Output2(x,5)>Output2(x,4)
        count(18)=count(18)+1;
    elseif Output2(x,1)==18 && Output2(x,5)>Output2(x,4)
        count(19)=count(19)+1;
    elseif Output2(x,1)==19 && Output2(x,5)>Output2(x,4)
        count(20)=count(20)+1;
    elseif Output2(x,1)==20 && Output2(x,5)>Output2(x,4)
        count(21)=count(21)+1;
    elseif Output2(x,1)==21 && Output2(x,5)>Output2(x,4)
        count(22)=count(22)+1;
    elseif Output2(x,1)==22 && Output2(x,5)>Output2(x,4)
        count(23)=count(23)+1;
    elseif Output2(x,1)==23 && Output2(x,5)>Output2(x,4)
        count(24)=count(24)+1;
    end;
end;
percentage=count./(length(Output)/24);
figure;
grid on; hold on;
plot(1:24,percentage,'r-o','MarkerSize',6,'LineWidth',2);
title('Outage Percentage of End Nodes in Base Station');
xlabel('Time in Hour'); ylabel('Outage Percentage'); grid on;
legend('Hourly Mean Outage');
```