VIT®

Vellore Institute of Technology

(Deemed to be University under section 3 of UGC Act, 1956)

School of Computer Science and Engineering

CSE3046-Programming for Data Science

Process: Obtain Data from Various Resources

Assignment-3

HANDLING MISSING DATA

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REG NO: 19BDS0083

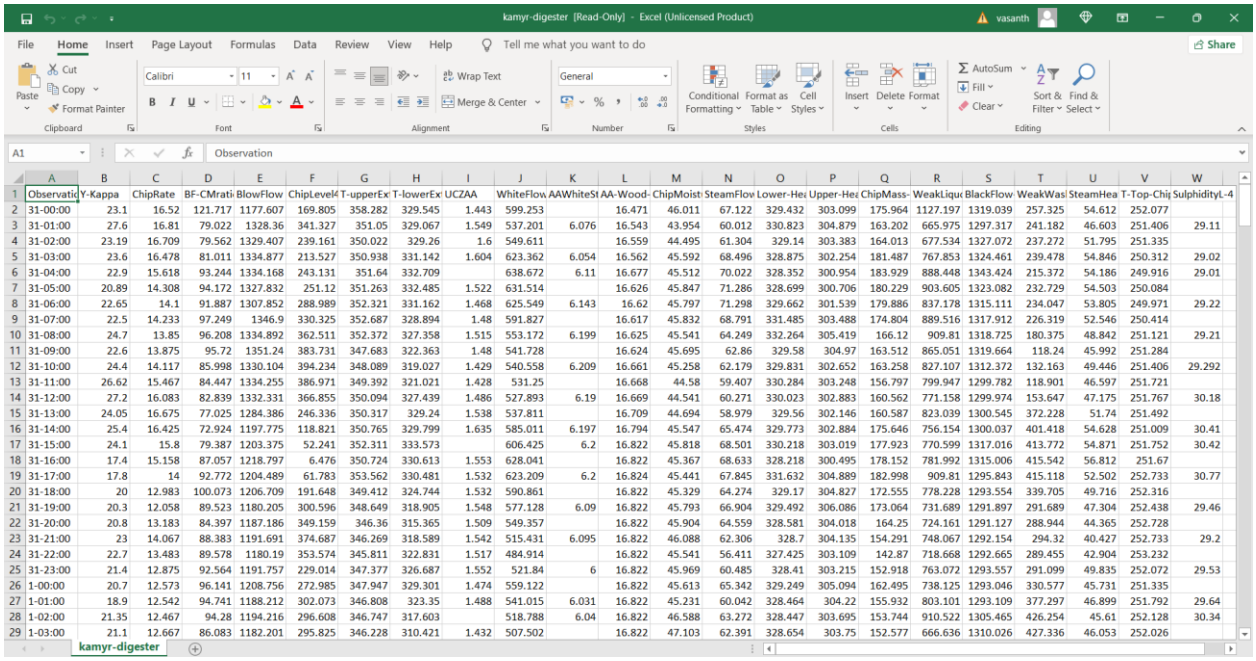
Submitted Date: 04/10/2021

Course Instructor: Dr. Anthoniraj A

Retrieve the data set from the following URL,

https://openmv.net/file/kamyr-digester.csv

THE DATA SET:



kamyr-digester [Read-Only] - Excel (Unlicensed Product)

Observation	Y-Kappa	ChipRate	BF-CMrati	BlowFlow	ChipLevel4	T-upperEx	T-lowerEx	UCZAA	WhiteFlow	AAWhiteSt	AA-Wood-	ChipMoist	SteamFlow	Lower-Hea	Upper-Hea	ChipMass-	WeakLiqu	BlackFlow	WeakWas	SteamHea	T-Top-Chi	SulphidityL-4
31-00:00	23.1	16.52	121.717	1177.607	169.805	358.282	329.545	1.443	599.253		16.471	46.011	67.122	329.432	303.099	175.964	1127.197	1319.039	257.325	54.612	252.077	
31-01:00	27.6	16.81	79.022	1328.36	341.327	351.05	329.067	1.549	537.201	6.076	16.543	43.954	60.012	330.823	304.879	163.202	665.975	1297.317	241.182	46.603	251.406	29.11
31-02:00	23.19	16.709	79.562	1329.407	239.161	350.022	329.26	1.6	549.611		16.559	44.495	61.304	329.14	303.383	164.013	677.534	1327.072	237.272	51.795	251.335	
31-03:00	23.6	16.478	81.011	1334.877	213.527	350.938	331.142	1.604	623.362	6.054	16.562	45.592	68.496	328.875	302.254	181.487	767.853	1324.461	239.478	54.846	250.312	29.02
31-04:00	22.9	15.618	93.244	1334.168	243.131	351.64	332.709		638.672	6.11	16.677	45.512	70.022	328.352	300.954	183.929	888.448	1343.424	215.372	54.186	249.916	29.01
31-05:00	20.89	14.308	94.172	1327.832	251.12	351.263	332.485	1.522	631.514		16.626	45.847	71.286	328.699	300.706	180.229	903.605	1323.082	232.729	54.503	250.084	
31-06:00	22.65	14.1	91.887	1307.852	288.989	352.321	331.162	1.468	625.549	6.143	16.62	45.797	71.298	329.662	301.539	179.886	837.178	1315.111	234.047	53.805	249.971	29.22
31-07:00	22.5	14.233	97.249	1346.9	330.325	352.687	328.894	1.48	591.827		16.617	45.832	68.791	331.485	303.488	174.804	889.516	1317.912	226.319	52.546	250.414	
31-08:00	24.7	13.85	96.208	1334.892	362.511	352.372	327.358	1.515	553.172	6.199	16.625	45.541	64.249	332.264	305.419	166.12	909.81	1318.725	180.375	48.842	251.121	29.21
31-09:00	22.6	13.875	95.72	1351.24	383.731	347.683	322.363	1.48	541.728		16.624	45.695	62.86	329.58	304.97	163.512	865.051	1319.664	118.24	45.992	251.284	
31-10:00	24.4	14.117	85.998	1330.104	394.234	348.089	319.027	1.429	540.558	6.209	16.661	45.258	62.179	329.831	302.652	163.258	827.107	1312.372	132.163	49.446	251.406	29.292
31-11:00	26.62	15.467	84.447	1334.255	386.971	349.392	321.021	1.428	531.25		16.668	44.58	59.407	330.284	303.248	156.797	799.947	1299.782	118.901	46.597	251.721	
31-12:00	27.2	16.083	82.839	1332.331	366.855	350.094	327.439	1.486	527.893	6.19	16.669	44.541	60.271	330.023	302.883	160.562	771.158	1299.974	153.647	47.175	251.767	30.18
31-13:00	24.05	16.675	77.025	1284.386	246.336	350.317	329.24	1.538	537.811		16.709	44.694	58.979	329.56	302.146	160.587	823.039	1300.545	372.228	51.74	251.492	
31-14:00	25.4	16.425	72.924	1197.775	118.821	350.765	329.799	1.635	585.011	6.197	16.794	45.547	65.474	329.773	302.884	175.646	756.154	1300.037	401.418	54.628	251.009	30.41
31-15:00	24.1	15.8	79.387	1203.375	52.241	352.311	333.573		606.425	6.2	16.822	45.818	68.501	330.218	303.019	177.923	770.599	1317.016	413.772	54.871	251.752	30.42
31-16:00	17.4	15.158	87.057	1218.797	6.476	350.724	330.613	1.553	628.041		16.822	45.367	68.633	328.218	300.495	178.152	781.992	1315.006	415.542	56.812	251.67	
31-17:00	17.8	14	92.772	1204.489	61.783	353.562	330.481	1.532	623.209	6.2	16.824	45.441	67.845	331.632	304.889	182.998	909.81	1295.843	415.118	52.502	252.733	30.77
31-18:00	20	12.983	100.073	1206.709	191.648	349.412	324.744	1.532	590.861		16.822	45.329	64.274	329.17	304.827	172.555	778.228	1293.554	339.705	49.716	252.316	
31-19:00	20.3	12.058	89.523	1180.205	300.596	348.649	318.905	1.548	577.128	6.09	16.822	45.793	66.904	329.492	306.086	173.064	731.689	1291.897	291.689	47.304	252.438	29.46
31-20:00	20.8	13.183	84.397	1187.186	349.159	346.36	315.365	1.509	549.357		16.822	45.904	64.559	328.581	304.018	164.25	724.161	1291.127	288.944	44.365	252.728	
31-21:00	23	14.067	88.383	1191.691	374.687	346.269	318.589	1.542	515.431	6.095	16.822	46.088	62.306	328.7	304.135	154.291	748.067	1292.154	294.32	40.427	252.733	29.2
31-22:00	22.7	13.483	89.578	1180.19	353.574	345.811	322.831	1.517	484.914		16.822	45.541	56.411	327.425	303.109	142.87	718.668	1292.665	289.455	42.904	253.232	
31-23:00	21.4	12.875	92.564	1191.757	229.014	347.377	326.687	1.552	521.84	6	16.822	45.969	60.485	328.41	303.215	152.918	763.072	1293.557	291.099	49.835	252.072	29.53
1-00:00	20.7	12.573	96.141	1208.756	272.985	347.947	329.301	1.474	559.122		16.822	45.613	65.342	329.249	305.094	162.495	738.125	1293.046	330.577	45.731	251.335	
1-01:00	18.9	12.542	94.741	1188.212	302.073	346.808	323.35	1.488	541.015	6.031	16.822	45.231	60.042	328.464	304.22	155.932	803.101	1293.109	377.297	46.899	251.792	29.64
1-02:00	21.35	12.467	94.28	1194.216	296.608	346.747	317.603		518.788	6.04	16.822	46.588	63.272	328.447	303.695	153.744	910.522	1305.465	426.254	45.61	252.128	30.34
1-03:00	21.1	12.667	86.083	1182.201	295.825	346.228	310.421	1.432	507.502		16.822	47.103	62.391	328.654	303.75	152.577	666.636	1310.026	427.336	46.053	252.026	

kamyr-digester

ACTIVITY DESCRIPTION:

- Read the data set from the URL and converting it into data frame
- summarize the data set for checking number of NA's
- check for structural errors
- Replace empty cells with NA
- Remove the columns and rows having missing data more than 60%
- Apply Mean or Median for Imputing Missing Values in remaining columns
- Apply any other standard algorithm for imputing missing values (for at least one column).

SAMPLE CODE:

```
#-------------------------------------------------------------------------------------------------------------------------------
#WRITING META DATA

#USER INFROMATION : 19BDS0083 D VASANTH KUMAR

#DATA SOURCE : Kamyr digester

#OWNED BY: OpenMV.net Datasets

#Description:Pulp quality is measured by the lignin content remaining in the pulp: the Kappa number. This data set is used to understand
            # which variables in the process influence the Kappa number,and if it can be predicted accurately enough for an
            # inferential sensor application.Variables with a number at the end have been lagged by that number of hours to line up the data.

#Data shape:    301 rows and 22 columns
#TAGS FOR THE DATA SET : MULTIVARIATE,MISSING-DATA,TIME-SERIES

#-------------------------------------------------------------------------------------------------------------------------------

#LIBRARIES USED
library(rvest)
library(dplyr)
library(tidyr)
library(utils)

#DETERMINING THE SIZE OF THE DATA SET IN MY DIRECTORY

file.info("C:/Users/vasanth kumar/Downloads/kamyr-digester.csv")$size

#READING THE DATA SET

df <-read.csv("https://openmv.net/file/kamyr-digester.csv")
#STORING THE DATA SET IN NEW VARIABLE KEEPS THE ORIGINALITY OF THE DATA SET BEFORE CLEANING
df1 <-data.frame(df)

#AN INITIAL LOOK AT THE DATA FRAME
str(df1)
#checking the observation,resulting in 301 obs. of 23 variables and 22 columns
View(df1)
#summarizing the data set for checking number of NA's
summary(df1)


#CHECKING FOR STRUCTURAL ERRORS

#RENAMING MISSLABLED VARIABLES
library(janitor)
df1 <- clean_names(df1)
#CHECKING FOR FAULTY DATA TYPES
str(df1) # all columns are in numeric datatype except the observation columns which is char in datatype
```

```r

#ROUNDING OFF THE VALUES IN COLUMN bf_c_mratio because it has 4 decimal places
df1$bf_c_mratio <- round(df1$bf_c_mratio,digits = 2)
#DEALING WITH NA/MISPLACED/EMPTY VALUES

#replacing empty cells with NA
df1[df1==""] <- NA

#Removing the columns and rows having missing data more than 60%
#initializing a variable with the percentage value
#REMOVING ROWS WITH MORE THAN 60% NA
threshold <- 0.6 # for 60%
df1 <- df1 %>% filter(rowMeans(is.na(.))< threshold)
#REMOVING COLUMNS WITH MORE THAN 60% NA
df1 <- df1[,which(colMeans(!is.na(df1))>threshold)] #column SulphidityL_4 and AAWhiteSt_4is removed because it had more than 60% NA


summary(df1)

#Imputing the missing value

#-----------------------------------------------------------#KNN-IMPUTATION ------------------------------------------------------------------------

#The k nearest neighbours is an algorithm that is used for simple classification

#This can be very useful in making predictions about the missing values by finding the k's closest neighbours to the observation with missing data
# and then imputing them based on the non-missing values in the neighbourhood

# This KNN imputation is used in statistical data so that the NA columns are filled with appropriate nearby value,so that the calculations are made easier.

# This is a standard method used in imputing the missing values.

# The main reason of using KNN for this data set is it creates a basic mean impute then uses the resulting complete list to construct a KDTree. Then, it uses the resulting KDTree to compute nearest neighbours
#After it finds the k-NNs, it takes the weighted average of them.

#install.packages("VIM")

library(VIM)


df1 <- kNN(df1,variable = c('uczaa'),metric=NULL,k=6)
df1 <- subset(df1,select =1:21)
View(df1)


#for a particular column replacing NA with median of the column  eg:chip_rate
df1$chip_rate <- ifelse(is.na(df1$chip_rate),median(df1$chip_rate,na.rm = TRUE),df1$chip_rate)

#Applying Mean or Median for Imputing Missing Values in remaining columns[mean is used in continuous data]
```

```r
for(i in 1:ncol(df1)){
  df1[is.na(df1[,i]), i] <- mean(df1[,i], na.rm = TRUE)
}

summary(df1)
#ADDITIONAL INFORMATION
#INORDER TO CREATE A DATA SET WITH NA'S LIBRARY(missForest) provides a function called prodNA(file,noNA=0.6)


```

SAMPLE DATA SET:

Filter

	Observation	Y.Kappa	ChipRate	BF.CMratio	BlowFlow	ChipLevel4	T.upperExt.2	T.lowerExt.2	UCZAA	WhiteFlow.4	AAWhiteSt.4	AA.Wood.4	ChipMoisture.4	SteamFlow.4
1	31-00:00	23.10	16.520	121.717	1177.607	169.805	358.282	329.545	1.443	599.253	NA	16.471	46.011	67
2	31-01:00	27.60	16.810	79.022	1328.360	341.327	351.050	329.067	1.549	537.201	6.076	16.543	43.954	60
3	31-02:00	23.19	16.709	79.562	1329.407	239.161	350.022	329.260	1.600	549.611	NA	16.559	44.495	61
4	31-03:00	23.60	16.478	81.011	1334.877	213.527	350.938	331.142	1.604	623.362	6.054	16.562	45.592	68
5	31-04:00	22.90	15.618	93.244	1334.168	243.131	351.640	332.709	NA	638.672	6.110	16.677	45.512	70
6	31-05:00	20.89	14.308	94.172	1327.832	251.120	351.263	332.485	1.522	631.514	NA	16.626	45.847	71
7	31-06:00	22.65	14.100	91.887	1307.852	288.989	352.321	331.162	1.468	625.549	6.143	16.620	45.797	71
8	31-07:00	22.50	14.233	97.249	1346.900	330.325	352.687	328.894	1.480	591.827	NA	16.617	45.832	68
9	31-08:00	24.70	13.850	96.208	1334.892	362.511	352.372	327.358	1.515	553.172	6.199	16.625	45.541	64
10	31-09:00	22.60	13.875	95.720	1351.240	383.731	347.683	322.363	1.480	541.728	NA	16.624	45.695	62
11	31-10:00	24.40	14.117	85.998	1330.104	394.234	348.089	319.027	1.429	540.558	6.209	16.661	45.258	62
12	31-11:00	26.62	15.467	84.447	1334.255	386.971	349.392	321.021	1.428	531.250	NA	16.668	44.580	59
13	31-12:00	27.20	16.083	82.839	1332.331	366.855	350.094	327.439	1.486	527.893	6.190	16.669	44.541	60
14	31-13:00	24.05	16.675	77.025	1284.386	246.336	350.317	329.240	1.538	537.811	NA	16.709	44.694	58
15	31-14:00	25.40	16.425	72.924	1197.775	118.821	350.765	329.799	1.635	585.011	6.197	16.794	45.547	65
16	31-15:00	24.10	15.800	79.387	1203.375	52.241	352.311	333.573	NA	606.425	6.200	16.822	45.818	68
17	31-16:00	17.40	15.158	87.057	1218.797	6.476	350.724	330.613	1.553	628.041	NA	16.822	45.367	68
18	31-17:00	17.80	14.000	92.772	1204.489	61.783	353.562	330.481	1.532	623.209	6.200	16.824	45.441	67
19	31-18:00	20.00	12.983	100.073	1206.709	191.648	349.412	324.744	1.532	590.861	NA	16.822	45.329	64
20	31-19:00	20.30	12.058	89.523	1180.205	300.596	348.649	318.905	1.548	577.128	6.090	16.822	45.793	66
21	31-20:00	20.80	13.183	84.397	1187.186	349.159	346.360	315.365	1.509	549.357	NA	16.822	45.904	64
22	31-21:00	23.00	14.067	88.383	1191.691	374.687	346.269	318.589	1.542	515.431	6.095	16.822	46.088	62
23	31-22:00	22.70	13.483	89.578	1180.190	353.574	345.811	322.831	1.517	484.914	NA	16.822	45.541	56
24	31-23:00	21.40	12.875	92.564	1191.757	229.014	347.377	326.687	1.552	521.840	6.000	16.822	45.969	60

CODE IN R STUDIO:

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#ROUNDING OFF THE VALUES IN COLUMN bf_c_mratio because it has 4 decimal places

df1$bf_c_mratio <- round(df1$bf_c_mratio,digits = 2)

#DEALING WITH NA/MISPLACED/EMPTY VALUES


#replacing empty cells with NA

df1[df1==""] <- NA
```

#Removing the columns and rows having missing data more than 60%

#initializing a variable with the percentage value

#REMOVING ROWS WITH MORE THAN 60% NA

threshold <- 0.6 # for 60%

df1 <- df1 %>% filter(rowMeans(is.na(.))< threshold)

#REMOVING COLUMNS WITH MORE THAN 60% NA

df1 <- df1[,which(colMeans(!is.na(df1))>threshold)] #column SulphidityL_4 and AAWhiteSt_4is removed because it had more than 60% NA

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#----------#KNN-IMPUTATION ----------

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and then imputing them based on the non-missing values in the neighbourhood

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This is a standard method used in imputing the missing values.

The main reason of using KNN for this data set is it creates a basic mean impute then uses the resulting complete list to construct a KDTree. Then, it uses the resulting KDTree to compute nearest neighbours (NN).

#After it finds the k-NNs, it takes the weighted average of them.

#install.packages("VIM")

```
library(VIM)

df1 <- kNN(df1,variable = c('uczaa'),metric=NULL,k=6)

df1 <- subset(df1,select =1:21)

View(df1)

#for a particular column replacing NA with median of the column  eg:chip_rate

df1$chip_rate <- ifelse(is.na(df1$chip_rate),median(df1$chip_rate,na.rm = TRUE),df1$chip_rate)

#Applying Mean or Median for Imputing Missing Values in remaining columns[mean is used in continuous data]

for(i in 1:ncol(df1)){

  df1[is.na(df1[,i]), i] <- mean(df1[,i], na.rm = TRUE)

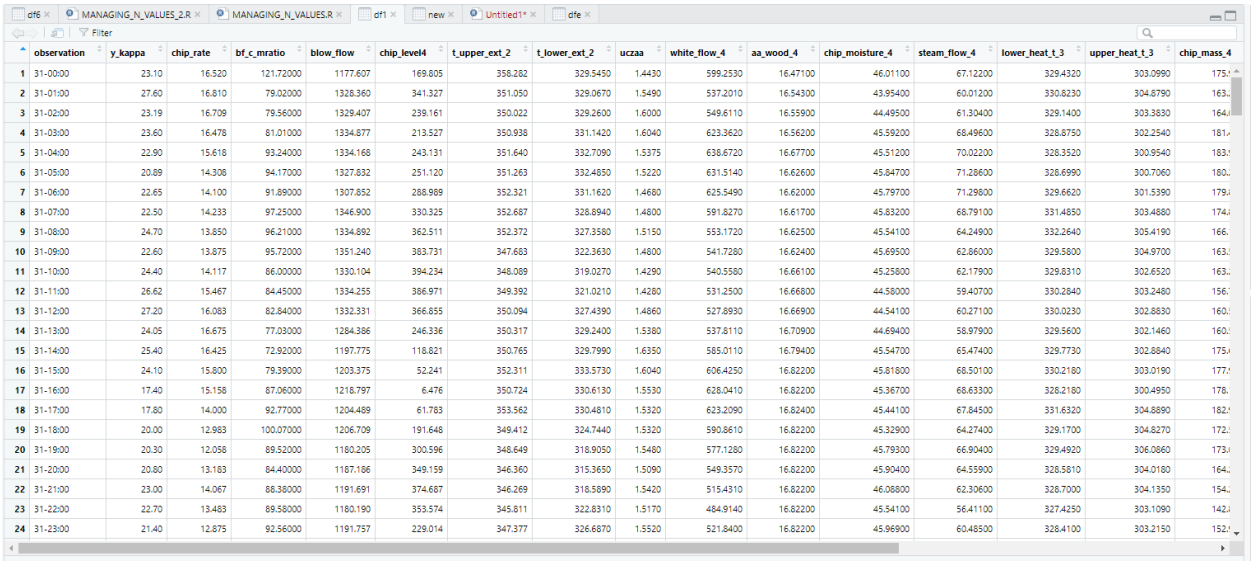
}

summary(df1)

#ADDITIONAL INFORMATION

#INORDER TO CREATE A DATA SET WITH NA'S LIBRARY(missForest) provides a function called prodNA(file,noNA=0.6)
```

OUTPUT AFTER DEALING WITH NA’s:



	observation	y_kappa	chip_rate	bf_c_mratio	blow_flow	chip_level4	t_upper_ext_2	t_lower_ext_2	uczaa	white_flow_4	aa_wood_4	chip_moisture_4	steam_flow_4	lower_heat_t_3	upper_heat_t_3	chip_mass_4
1	31-00:00	23.10	16.520	121.72000	1177.607	169.805	358.282	329.5450	1.4430	599.2530	16.47100	46.01100	67.12200	329.4320	303.0990	175.
2	31-01:00	27.60	16.810	79.02000	1328.360	341.327	351.050	329.0670	1.5490	537.2010	16.54300	43.95400	60.01200	330.8230	304.8790	163.
3	31-02:00	23.19	16.709	79.56000	1329.407	239.161	350.022	329.2600	1.6000	549.6110	16.55900	44.49500	61.30400	329.1400	303.3830	164.
4	31-03:00	23.60	16.478	81.01000	1334.877	213.527	350.938	331.1420	1.6040	623.3620	16.56200	45.59200	68.49600	328.8750	302.2540	181.
5	31-04:00	22.90	15.618	93.24000	1334.168	243.131	351.640	332.7090	1.5375	638.6720	16.67700	45.51200	70.02200	328.3520	300.9540	183.
6	31-05:00	20.89	14.308	94.17000	1327.832	251.120	351.263	332.4850	1.5220	631.5140	16.62600	45.84700	71.28600	328.6990	300.7060	180.
7	31-06:00	22.65	14.100	91.89000	1307.652	288.989	352.321	331.1620	1.4680	625.5490	16.62000	45.79700	71.29800	329.6620	301.5390	179.
8	31-07:00	22.50	14.233	97.25000	1346.900	330.325	352.687	328.8940	1.4800	591.8270	16.61700	45.83200	68.79100	331.4850	303.4880	174.
9	31-08:00	24.70	13.850	96.21000	1334.892	362.511	352.372	327.3580	1.5150	553.1720	16.62500	45.54100	64.24900	332.2640	305.4190	166.
10	31-09:00	22.60	13.875	95.72000	1351.240	383.731	347.683	322.3630	1.4800	541.7280	16.62400	45.69500	62.86000	329.5800	304.9700	163.
11	31-10:00	24.40	14.117	86.00000	1330.104	394.234	348.089	319.0270	1.4290	540.5580	16.66100	45.25800	62.17900	329.8310	302.6520	163.
12	31-11:00	26.62	15.467	84.45000	1334.255	386.971	349.392	321.0210	1.4280	531.2500	16.66800	44.58000	59.40700	330.2840	303.2480	156.
13	31-12:00	27.20	16.083	82.84000	1332.331	366.855	350.094	327.4390	1.4860	527.8930	16.66900	44.54100	60.27100	330.0230	302.8830	160.
14	31-13:00	24.05	16.675	77.03000	1284.386	246.336	350.317	329.2400	1.5380	537.8110	16.70900	44.69400	58.97900	329.5600	302.1460	160.
15	31-14:00	25.40	16.425	72.92000	1197.775	118.821	350.765	329.7990	1.6350	585.0110	16.79400	45.54700	65.47400	329.7730	302.8840	175.
16	31-15:00	24.10	15.800	79.39000	1203.375	52.241	352.311	333.5730	1.6040	606.4250	16.82200	45.81800	68.50100	330.2180	303.0190	177.
17	31-16:00	17.40	15.158	87.06000	1218.797	6.476	350.724	330.6130	1.5530	628.0410	16.82200	45.36700	68.63300	328.2180	300.4950	178.
18	31-17:00	17.80	14.000	92.77000	1204.489	61.783	353.562	330.4810	1.5320	623.2090	16.82400	45.44100	67.84500	331.6320	304.8890	182.
19	31-18:00	20.00	12.983	100.07000	1206.709	191.648	349.412	324.7440	1.5320	590.8610	16.82200	45.32900	64.27400	329.1700	304.8270	172.
20	31-19:00	20.30	12.058	89.52000	1180.205	300.596	348.649	318.9050	1.5480	577.1280	16.82200	45.79300	66.90400	329.4920	306.0860	173.
21	31-20:00	20.80	13.183	84.40000	1187.186	349.159	346.360	315.3650	1.5090	549.3570	16.82200	45.90400	64.55900	328.5810	304.0180	164.
22	31-21:00	23.00	14.067	88.38000	1191.691	374.687	346.269	318.5890	1.5420	515.4310	16.82200	46.08800	62.30600	328.7000	304.1350	154.
23	31-22:00	22.70	13.483	89.58000	1180.190	353.574	345.811	322.8310	1.5170	484.9140	16.82200	45.54100	56.41100	327.4250	303.1090	142.
24	31-23:00	21.40	12.875	92.56000	1191.757	229.014	347.377	326.6870	1.5520	521.8400	16.82200	45.96900	60.48500	328.4100	303.2150	152.