# MATLAB Routines for Moving Median with Trend and Seasonality for Time Series Prediction

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## Abstract

In this paper we provide a simple MATLAB routine which computes the moving median with trend and seasonality. This approach is linear and for this reason has its disadvantages. So this routine can be improved by combining Monte-Carlo simulations, genetic algorithms simulations and wavelets decomposition.

**Keywords:** moving median, MATLAB

## Introduction

We present three MATLAB routines which replicate the moving median with trend and seasonality with hourly data, 4-hourly data and daily data. These routines can be modified in a way to take data of higher frequency, as 15-minute or 30-minute, as low frequency data, like weekly, monthly and quarterly. But, in order to estimate data of different frequency, modifications have to be made in the settings each time. We just present below three routines as an example, which can be improved by wavelets decomposition, Monte-Carlo simulations or genetic algorithms and with neural networks.

## MATLAB routines

Scripts accept one vector or column of data with variable name y.

### Script one, hourly data

```
clear all;
% Replicates the moving median method 1-Hourly data
load file.mat

  median_option=24

  next_day=16      % Set up the hour you want to estimate


t=length(y)
```

```
x1=y(1:median_option,:)
x2=y(median_option+1:2*median_option,:)
x3=y(2*median_option+1:3*median_option,:)

x4=y(end-2*median_option+1:end-median_option,:)
x5=y(end-3*median_option+1:end-2*median_option,:)
x6=y(end-median_option+1:end,:)


T=2*median_option

X1=median(x1)
X2=median(x2)
X3=median(x3)
X4=median(x4)
X5=median(x5)
X6=median(x6)


%trend=(X1-X2)/T

trend1=(X1+X2+X3)
trend2=(X4+X5+X6)
trend=(trend1-trend2)/T
constant=(median_option+1)/2

trend_smoothing=y+constant*trend

column1=y./trend_smoothing

low_hourly1= 1;
high_hourly1=t;
incr_hourly1=24;
grid_hourly1=[low_hourly1:incr_hourly1:high_hourly1]
grid_hourly1=grid_hourly1'
t_hourly1=length(grid_hourly1)

low_hourly2= 2;
high_hourly2=t;
incr_hourly2=24;
grid_hourly2=[low_hourly2:incr_hourly2:high_hourly2]
grid_hourly2=grid_hourly2'
t_hourly2=length(grid_hourly2)

low_hourly3= 3;
high_hourly3=t;
incr_hourly3=24;
grid_hourly3=[low_hourly3:incr_hourly3:high_hourly3]
grid_hourly3=grid_hourly3'
```

```
t_hourly3=length(grid_hourly3)

low_hourly4= 4;
high_hourly4=t;
incr_hourly4=24;
grid_hourly4=[low_hourly4:incr_hourly4:high_hourly4]
grid_hourly4=grid_hourly4'
t_hourly4=length(grid_hourly4)

low_hourly5= 5;
high_hourly5=t;
incr_hourly5=24;
grid_hourly5=[low_hourly5:incr_hourly5:high_hourly5]
grid_hourly5=grid_hourly5'
t_hourly5=length(grid_hourly5)

low_hourly6= 6;
high_hourly6=t;
incr_hourly6=24;
grid_hourly6=[low_hourly6:incr_hourly6:high_hourly6]
grid_hourly6=grid_hourly6'
t_hourly6=length(grid_hourly6)

low_hourly7= 7;
high_hourly7=t;
incr_hourly7=24;
grid_hourly7=[low_hourly7:incr_hourly7:high_hourly7]
grid_hourly7=grid_hourly7'
t_hourly7=length(grid_hourly7)

low_hourly8= 8;
high_hourly8=t;
incr_hourly8=24;
grid_hourly8=[low_hourly8:incr_hourly8:high_hourly8]
grid_hourly8=grid_hourly8'
t_hourly8=length(grid_hourly8)

low_hourly9=9;
high_hourly9=t;
incr_hourly9=24;
grid_hourly9=[low_hourly9:incr_hourly9:high_hourly9]
grid_hourly9=grid_hourly9'
t_hourly9=length(grid_hourly9)

low_hourly10= 10;
high_hourly10=t;
incr_hourly10=24;
grid_hourly10=[low_hourly10:incr_hourly10:high_hourly10]
grid_hourly10=grid_hourly10'
t_hourly10=length(grid_hourly10)
```

```
low_hourly11= 11;
high_hourly11=t;
incr_hourly11=24;
grid_hourly11=[low_hourly11:incr_hourly11:high_hourly11]
grid_hourly11=grid_hourly11'
t_hourly11=length(grid_hourly11)

low_hourly12= 12;
high_hourly12=t;
incr_hourly12=24;
grid_hourly12=[low_hourly12:incr_hourly12:high_hourly12]
grid_hourly12=grid_hourly12'
t_hourly12=length(grid_hourly12)

low_hourly13= 13;
high_hourly13=t;
incr_hourly13=24;
grid_hourly13=[low_hourly13:incr_hourly13:high_hourly13]
grid_hourly13=grid_hourly13'
t_hourly13=length(grid_hourly13)

low_hourly14= 14;
high_hourly14=t;
incr_hourly14=24;
grid_hourly14=[low_hourly14:incr_hourly14:high_hourly14]
grid_hourly14=grid_hourly14'
t_hourly14=length(grid_hourly14)

low_hourly15= 15;
high_hourly15=t;
incr_hourly15=24;
grid_hourly15=[low_hourly15:incr_hourly15:high_hourly15]
grid_hourly15=grid_hourly15'
t_hourly15=length(grid_hourly15)

low_hourly16= 16;
high_hourly16=t;
incr_hourly16=24;
grid_hourly16=[low_hourly16:incr_hourly16:high_hourly16]
grid_hourly16=grid_hourly16'
t_hourly16=length(grid_hourly16)

low_hourly17= 17;
high_hourly17=t;
incr_hourly17=24;
grid_hourly17=[low_hourly17:incr_hourly17:high_hourly17]
grid_hourly17=grid_hourly17'
t_hourly17=length(grid_hourly17)
```

```
low_hourly18= 18;
high_hourly18=t;
incr_hourly18=24;
grid_hourly18=[low_hourly18:incr_hourly18:high_hourly18]
grid_hourly18=grid_hourly18'
t_hourly18=length(grid_hourly18)


low_hourly19= 19;
high_hourly19=t;
incr_hourly19=24;
grid_hourly19=[low_hourly19:incr_hourly19:high_hourly19]
grid_hourly19=grid_hourly19'
t_hourly19=length(grid_hourly19)

low_hourly20= 20;
high_hourly20=t;
incr_hourly20=24;
grid_hourly20=[low_hourly20:incr_hourly20:high_hourly20]
grid_hourly20=grid_hourly20'
t_hourly20=length(grid_hourly20)

low_hourly21= 21;
high_hourly21=t;
incr_hourly21=24;
grid_hourly21=[low_hourly21:incr_hourly21:high_hourly21]
grid_hourly21=grid_hourly21'
t_hourly21=length(grid_hourly21)

low_hourly22= 22;
high_hourly22=t;
incr_hourly22=24;
grid_hourly22=[low_hourly22:incr_hourly22:high_hourly22]
grid_hourly22=grid_hourly22'
t_hourly22=length(grid_hourly22)

low_hourly23= 23;
high_hourly233=t;
incr_hourly23=24;
grid_hourly23=[low_hourly23:incr_hourly23:high_hourly233]
grid_hourly23=grid_hourly23'
t_hourly23=length(grid_hourly23)

low_hourly24= 1;
high_hourly24=t;
incr_hourly24=24;
grid_hourly24=[low_hourly24:incr_hourly24:high_hourly24]
grid_hourly24=grid_hourly24'
t_hourly24=length(grid_hourly24)
```

HOURLY1=y(t_hourly1)

HOURLY2=y(t_hourly2)

HOURLY3=y(t_hourly3)

HOURLY4=y(t_hourly4)

HOURLY5=y(t_hourly5)

HOURLY6=y(t_hourly6)

HOURLY7=y(t_hourly7)

HOURLY8=y(t_hourly8)

HOURLY9=y(t_hourly9)

HOURLY10=y(t_hourly10)

HOURLY11=y(t_hourly11)

HOURLY12=y(t_hourly12)

HOURLY13=y(t_hourly13)

HOURLY14=y(t_hourly14)

HOURLY15=y(t_hourly15)

HOURLY16=y(t_hourly16)

HOURLY17=y(t_hourly17)

HOURLY18=y(t_hourly18)

HOURLY19=y(t_hourly9)

HOURLY20=y(t_hourly20)

HOURLY21=y(t_hourly21)

HOURLY22=y(t_hourly22)

HOURLY23=y(t_hourly23)

HOURLY24=y(t_hourly24)

seas_1=sum(HOURLY1)/t_hourly1

seas_2=sum(HOURLY2)/t_hourly2

seas_3=sum(HOURLY3)/t_hourly3

seas_4=sum(HOURLY4)/t_hourly4

seas_5=sum(HOURLY5)/t_hourly5

seas_6=sum(HOURLY6)/t_hourly6

seas_7=sum(HOURLY7)/t_hourly7

seas_8=sum(HOURLY8)/t_hourly8

seas_9=sum(HOURLY9)/t_hourly9

seas_10=sum(HOURLY10)/t_hourly10

seas_11=sum(HOURLY11)/t_hourly11

seas_12=sum(HOURLY12)/t_hourly12

seas_13=sum(HOURLY13)/t_hourly13

seas_14=sum(HOURLY14)/t_hourly14

seas_15=sum(HOURLY15)/t_hourly15

seas_16=sum(HOURLY16)/t_hourly16

seas_17=sum(HOURLY17)/t_hourly17

seas_18=sum(HOURLY18)/t_hourly18

seas_19=sum(HOURLY19)/t_hourly19

seas_20=sum(HOURLY20)/t_hourly20

seas_21=sum(HOURLY21)/t_hourly21

seas_22=sum(HOURLY22)/t_hourly22

seas_23=sum(HOURLY23)/t_hourly23

seas_24=sum(HOURLY24)/t_hourly24

SEAS=seas_1+seas_2+seas_3+seas_4+seas_5+seas_6+seas_7+seas_8+seas_9+seas_10+seas_11+seas_12+seas_13+seas_14+seas_15+seas_16+seas_17+seas_18+seas_19+seas_20+seas_21+seas_22+seas_23+seas_24

SEAS_adjust=24/SEAS

seas_HOURLY1=SEAS_adjust*seas_1

seas_HOURLY2=SEAS_adjust*seas_2

seas_HOURLY3=SEAS_adjust*seas_3

seas_HOURLY4=SEAS_adjust*seas_4

seas_HOURLY5=SEAS_adjust*seas_5

seas_HOURLY6=SEAS_adjust*seas_6

seas_HOURLY7=SEAS_adjust*seas_7

seas_HOURLY8=SEAS_adjust*seas_8

seas_HOURLY9=SEAS_adjust*seas_9

seas_HOURLY10=SEAS_adjust*seas_10

seas_HOURLY11=SEAS_adjust*seas_11

seas_HOURLY12=SEAS_adjust*seas_12

seas_HOURLY13=SEAS_adjust*seas_13

seas_HOURLY14=SEAS_adjust*seas_14

seas_HOURLY15=SEAS_adjust*seas_15

seas_HOURLY16=SEAS_adjust*seas_16

seas_HOURLY17=SEAS_adjust*seas_17

seas_HOURLY18=SEAS_adjust*seas_18

seas_HOURLY19=SEAS_adjust*seas_19

seas_HOURLY20=SEAS_adjust*seas_20

seas_HOURLY21=SEAS_adjust*seas_21

```
seas_HOURLY22=SEAS_adjust*seas_22

seas_HOURLY23=SEAS_adjust*seas_23

seas_HOURLY24=SEAS_adjust*seas_24



if next_day==1
   forecast=y(end,:)+ trend*seas_HOURLY1

elseif next_day==2
   forecast=y(end,:)+ trend*seas_HOURLY2

elseif next_day==3
   forecast=y(end,:)+ trend*seas_HOURLY3

elseif next_day==4
   forecast= y(end,:)+ trend*seas_HOURLY4

elseif next_day==5
   forecast= y(end,:)+ trend*seas_HOURLY5

elseif next_day==6
   forecast= y(end,:)+ trend*seas_HOURLY6

   elseif next_day==8
   forecast= y(end,:)+ trend*seas_HOURLY8

elseif next_day==9
  forecast=  y(end,:)+ trend*seas_HOURLY9

elseif next_day==10
   forecast= y(end,:)+ trend*seas_HOURLY10

elseif next_day==11
   forecast= y(end,:)+ trend*seas_HOURLY11

elseif next_day==12
    forecast=y(end,:)+ trend*seas_HOURLY12

   elseif next_day==13
   forecast= y(end,:)+ trend*seas_HOURLY13

elseif next_day==14
   forecast= y(end,:)+ trend*seas_HOURLY14

elseif next_day==15
   forecast= y(end,:)+ trend*seas_HOURLY15
```

```matlab
elseif next_day==16
    forecast= y(end,:)+ trend*seas_HOURLY16

elseif next_day==17
    forecast= y(end,:)+ trend*seas_HOURLY17

    elseif next_day==18
    forecast= y(end,:)+ trend*seas_HOURLY18

elseif next_day==19
    forecast= y(end,:)+ trend*seas_HOURLY19

elseif next_day==20
    forecast=  y(end,:)+ trend*seas_HOURLY20

elseif next_day==21
    forecast= y(end,:)+ trend*seas_HOURLY21

elseif next_day==22
    forecast=  y(end,:)+ trend*seas_HOURLY22

    elseif next_day==23
    forecast= y(end,:)+ trend*seas_HOURLY23

elseif next_day==24
    forecast= y(end,:)+ trend*seas_HOURLY24

end
```

**Script two, 4-hourly data**

```matlab
clear all;
% Replicates the moving median method 4-Hourly data
load file.mat


median_option=6

next_day=4   % Forecasting period 1 00:00-04:00, 2 for 04:00-08:00, 3 for 08:00-
             % 12:00, 4 for 12:00-16:00, 5 for 16:00-20:00, 6 for 20:00-00:00
             % For example if you want prediction for time period
             % 08:00-12:00 you have to set up next_day=3

t=length(y)

x1=y(1:median_option,:)
x2=y(end-median_option+1:end,:)
```

```
T=2*median_option

X1=median(x1)
X2=median(x2)

trend=(X1-X2)/T
constant=(median_option+1)/2

trend_smoothing=y+constant*trend

column1=y./trend_smoothing

low_four_hourly1= 1;
high_four_hourly1=t;
incr_four_hourly1=6;
grid_four_hourly1=[low_four_hourly1:incr_four_hourly1:high_four_hourly1]
grid_four_hourly1=grid_four_hourly1'
t_four_hourly1=length(grid_four_hourly1)


low_four_hourly2= 2;
high_four_hourly2=t;
incr_four_hourly2=6;
grid_four_hourly2=[low_four_hourly2:incr_four_hourly2:high_four_hourly2]
grid_four_hourly2=grid_four_hourly2'
t_four_hourly2=length(grid_four_hourly2)


low_four_hourly3= 3;
high_four_hourly3=t;
incr_four_hourly3=6;
grid_four_hourly3=[low_four_hourly3:incr_four_hourly3:high_four_hourly3]
grid_four_hourly3=grid_four_hourly3'
t_four_hourly3=length(grid_four_hourly3)


low_four_hourly4= 4;
high_four_hourly4=t;
incr_four_hourly4=6;
grid_four_hourly4=[low_four_hourly4:incr_four_hourly4:high_four_hourly4]
grid_four_hourly4=grid_four_hourly4'
t_four_hourly4=length(grid_four_hourly4)


low_four_hourly5= 5;
high_four_hourly5=t;
incr_four_hourly5=6;
grid_four_hourly5=[low_four_hourly5:incr_four_hourly5:high_four_hourly5]
```

```
grid_four_hourly5=grid_four_hourly5'
t_four_hourly5=length(grid_four_hourly5)


low_four_hourly6= 6;
high_four_hourly6=t;
incr_four_hourly6=6;
grid_four_hourly6=[low_four_hourly6:incr_four_hourly6:high_four_hourly6]
grid_four_hourly6=grid_four_hourly6'
t_four_hourly6=length(grid_four_hourly6)


FOUR_HOURLY1=y(t_four_hourly1)

FOUR_HOURLY2=y(t_four_hourly2)

FOUR_HOURLY3=y(t_four_hourly3)

FOUR_HOURLY4=y(t_four_hourly4)

FOUR_HOURLY5=y(t_four_hourly5)

FOUR_HOURLY6=y(t_four_hourly6)


seas_1=sum(FOUR_HOURLY1)/t_four_hourly1

seas_2=sum(FOUR_HOURLY2)/t_four_hourly2

seas_3=sum(FOUR_HOURLY3)/t_four_hourly3

seas_4=sum(FOUR_HOURLY4)/t_four_hourly4

seas_5=sum(FOUR_HOURLY5)/t_four_hourly5

seas_6=sum(FOUR_HOURLY6)/t_four_hourly6


SEAS=seas_1+seas_2+seas_3+seas_4+seas_5+seas_6
SEAS_adjust=6/SEAS

seas_FOUR_HOURLY1=SEAS_adjust*seas_1

seas_FOUR_HOURLY2=SEAS_adjust*seas_2

seas_FOUR_HOURLY3=SEAS_adjust*seas_3

seas_FOUR_HOURLY4=SEAS_adjust*seas_4

seas_FOUR_HOURLY5=SEAS_adjust*seas_5
```

seas_FOUR_HOURLY6=SEAS_adjust*seas_6

```
if next_day==1
   y(end,:)+ trend*seas_FOUR_HOURLY1

elseif next_day==2
   y(end,:)+ trend*seas_FOUR_HOURLY2

elseif next_day==3
   y(end,:)+ trend*seas_FOUR_HOURLY3

elseif next_day==4
   y(end,:)+ trend*seas_FOUR_HOURLY4

elseif next_day==5
   y(end,:)+ trend*seas_FOUR_HOURLY5

elseif next_day==6
   y(end,:)+ trend*seas_FOUR_HOURLY6


end
```

**Script three, daily data**

```
clear all;
  % Replicates the moving median method  Daily data
load file.mat

   median_option=5

     next_day=3   % 1 for Monday, 2 for Tuesday, 3 for Wednsday, 4 for Thursday
                  % and 5 for Friday



t=length(y)

x1=y(1:median_option,:)
x2=y(median_option+1:2*median_option,:)
x3=y(2*median_option+1:3*median_option,:)
x4=y(end-3*median_option+1:end-2*median_option,:)
x5=y(end-2*median_option+1:end-median_option,:)
x6=y(end-median_option+1:end,:)

T=3*median_option
```

```
X1=median(x1)
X2=median(x2)
X3=median(x3)
X4=median(x4)
X5=median(x5)
X6=median(x6)

%trend=(X1-X2)/T
trend1=(X1+X2)
trend2=(X4+X5)
trend=(trend1-trend2)/T

constant=(median_option+1)/2

trend_smoothing=y+constant*trend

column1=y./trend_smoothing

low_day1= 1;
high_day1=t;
incr_day1=5;
grid_day1=[low_day1:incr_day1:high_day1]
grid_day1=grid_day1'
t_day1=length(grid_day1)


low_day2= 2;
high_day2=t;
incr_day2=5;
grid_day2=[low_day2:incr_day2:high_day2]
grid_day2=grid_day2'
t_day2=length(grid_day2)

low_day3= 3;
high_day3=t;
incr_day3=5;
grid_day3=[low_day3:incr_day3:high_day3]
grid_day3=grid_day3'
t_day3=length(grid_day3)


low_day4= 4;
high_day4=t;
incr_day4=5;
grid_day4=[low_day4:incr_day4:high_day4]
grid_day4=grid_day4'
t_day4=length(grid_day4)


low_day5= 5;
```

```
high_day5=t;
incr_day5=5;
grid_day5=[low_day5:incr_day5:high_day5]
grid_day5=grid_day5'
t_day5=length(grid_day5)

DAY1=y(grid_day1)

DAY2=y(grid_day2)

DAY3=y(grid_day3)

DAY4=y(grid_day4)

DAY5=y(grid_day5)


seas_1=sum(DAY1)/t_day1

seas_2=sum(DAY2)/t_day2

seas_3=sum(DAY3)/t_day3

seas_4=sum(DAY4)/t_day4

seas_5=sum(DAY5)/t_day5

SEAS=seas_1+seas_2+seas_3+seas_4+seas_5
SEAS_adjust=2/SEAS

seas_DAY1=SEAS_adjust*seas_1

seas_DAY2=SEAS_adjust*seas_2

seas_DAY3=SEAS_adjust*seas_3

seas_DAY4=SEAS_adjust*seas_4

seas_DAY5=SEAS_adjust*seas_5


if next_day==1
    y(end,:)+ trend*seas_DAY1

elseif next_day==2
    y(end,:)+ trend*seas_DAY2

elseif next_day==3
    y(end,:)+ trend*seas_DAY3
```

```
elseif next_day==4
    y(end,:)+ trend*seas_DAY4

elseif next_day==5
    y(end,:)+ trend*seas_DAY5

end
```

## References

Giovanis, E. (2008), Moving Median With Trend and Seasonality, working paper,
http://papers.ssrn.com/sol3/papers.cfm?abstract_id=969012