```
#pragma TextEncoding = "UTF-8"
#pragma rtGlobals=3      // Use modern global access method and strict wave acces

Structure Problem2Structure

   Wave time_p
   Wave time_r
   wave Temp_r
   wave sleep_ph_r
   Wave time_th
   wave Temp_th


   Variable offset
   Variable cycler_sleep_hours
   Variable hours_tolerance // allowed variation in sleep time before measurement
   Variable Warmup // time for ring to thermalize after started measuring/initial
   Variable Cooldown // time ring measures for after it is removed

   Wave night_start
   wave night_stop

   wave cleaned_time
   wave cleaned_temperature
   wave cleaned_sleep_ph
   wave cleaned_length



EndStructure



//**************************

Function analyse_nights_ring()

STRUCT Problem2Structure s
   s.offset = 0 //timezone
   s.cycler_sleep_hours = 9 //user defined
   s.hours_tolerance = 2
   s.warmup = 0 //minutes
   s.cooldown = 0// minutes

Wave s.time_r = root:raw_data:Timestamp_ring
Wave s.temp_r = root:raw_data:Temp_ring
wave s.sleep_ph_r = root:raw_data:sleep_ph_ring
```

```
Wave s.time_th = root:raw_data:datestamp_thermometer
wave s.Temp_th = root:raw_data:Temp_thermometer
Wave s.time_p = root:raw_data:datestamp_period


    rescale_timestamps(s)
    Get_night_start_stop(s)

    Get_timestamp_length_night(s)

    reject_ring_fail(s)
    Get_night_start_stop(s)

    Get_mean_T_SlPh_night(s)

    wave s.cleaned_sleep_ph = mean_phase_night
    wave s.cleaned_time = time_night
    wave s.cleaned_length = length_night

    Wave s.cleaned_temperature = mean_temp_night
    Correllation_thermo_vs_clean(s,"raw mean nightly temerature : ",0)
    wave temp_clean_copy,temp_th_copy
    duplicate/o temp_clean_copy clean_mean_temp_ring1
    duplicate/o temp_th_copy temp_thermometer1

    wave s.cleaned_temperature = median_temp_night
    Correllation_thermo_vs_clean(s,"raw median nightly temerature : ",1)

    Get_sleeping_mean_T(s)
    wave s.cleaned_temperature = asleep_temp_night
    Correllation_thermo_vs_clean(s,"mean temerature of sleep phase < 4: "


    Get_waking_Temp(s)
    wave s.cleaned_temperature = waking_temp_night
    Correllation_thermo_vs_clean(s,"mean temerature over 20 minutes before waking:

    Wave s.cleaned_temperature = mean_temp_night
    reject_wakefull_night(s)
    reject_long_short_night(s)
    Correllation_thermo_vs_clean(s,"mean nightly temerature wakefull long/short ni
    duplicate/o temp_clean_copy clean_mean_temp_ring2
    duplicate/o temp_th_copy temp_thermometer2
    killwaves/z temp_clean_copy,themp_th_copy

End
```

```
Function rescale_timestamps(S) //  to display timestamps in igor with correct abs
STRUCT Problem2Structure &S


   make/d/o/n=(dimsize(s.time_th,0)) time_thermometer
   make/d/o/n=(dimsize(s.time_r,0)) time_ring
   make/d/o/n=(dimsize(s.time_p,0)) time_period
   SetScale d 0,0,"dat", time_thermometer,time_ring,time_period

   time_thermometer = s.time_th[p] + S.offset//imported with time relative to 01/
   time_ring = s.time_r[p]+date2secs(1970,01,01)
   time_period= s.time_p[p] + S.offset

   wave s.time_r = time_ring
   wave s.time_th = time_thermometer
   wave s.time_p = time_period

end

Function Get_night_start_stop(s)
STRUCT  problem2structure &s

variable delta_time = 0
variable i_start = 0
variable i_stop = 0
variable i = 1
   make/d/o/n=0 night_start,night_stop
night_start = 0
night_stop = 0
variable delta_threshold_s = 60*60*3
   Do
      delta_time = s.time_r[i]-s.time_r[i-1]

      if(delta_time>delta_threshold_s)
         i_stop = i-1
         insertpoints/M=0 dimsize(night_start,0),1, night_start,night_stop
         night_start[dimsize(night_start,0)-1]=i_start
         night_stop[dimsize(night_start,0)-1]=i_stop
         i_start = i
      endif

      i+=1

   While(i<dimsize(s.time_r,0))

   i_stop = dimsize(s.time_r,0)-1
   insertpoints/M=0 dimsize(night_start,0),1, night_start,night_stop
```

```
   night_start[dimsize(night_start,0)-1]=i_start
   night_stop[dimsize(night_start,0)-1]=i_stop

   wave s.night_start = night_start
   wave s.night_stop = night_stop
End

Function Get_timestamp_length_night(s)
STRUCT PROBLEM2STRUCTURE &s

   make/d/o/n=(dimsize(s.night_stop,0)) time_night,length_night
   SetScale d 0,0,"dat", time_night
   time_night = (s.time_r[s.night_stop[p]]-mod(s.time_r[s.night_stop[p]],60*60*24
   length_night = (s.night_stop[p]-s.night_start[p])/60 // in hours since there i
duplicate/o time_night time_night_raw
duplicate/o length_night length_night_raw
End

Function Get_mean_T_SlPh_night(s)
STRUCT problem2structure &s

   variable num_nights = dimsize(s.night_stop,0)
   make/d/o/n=(num_nights) mean_temp_night,mean_phase_night,median_temp_night

   variable i = 0

   Do
      make/d/o/n=(s.night_stop[i]-s.cooldown-(s.night_start[i]+s.warmup)+1) temp_
      temp_night_i = s.temp_r[p+s.night_start[i]+s.warmup]
      mean_temp_night[i]=mean(temp_night_i)
      median_temp_night[i]=median(temp_night_i)

      phase_night_i = s.sleep_ph_r[p+s.night_start[i]+s.warmup]
      mean_phase_night[i]=mean(phase_night_i)

      i+=1
   While(i<num_nights)
   duplicate/o mean_temp_night mean_temp_night_raw
   duplicate/o mean_phase_night mean_phase_night_raw
killwaves/z temp_night_i,phase_night_i
End

Function reject_long_short_night(s)//reject a night (do not include in cleaned te
STRUCT problem2structure &s

   variable num_nights = dimsize(s.cleaned_temperature,0)
   variable i = 0
```

```
   variable csh = s.cycler_sleep_hours
   variable ht = s.hours_tolerance
   //reject nights that are too long or too short
   Do
      if(s.cleaned_length[i]>(csh+ht)||s.cleaned_length[i]<(csh-ht))
         deletepoints i,1,s.cleaned_length,s.cleaned_temperature,s.cleaned_time,s
         i-=1
         num_nights-=1
      endif
      i+=1
   While(i<num_nights)

End

Function reject_wakefull_night(s)//reject a night (do not include in cleaned temp
STRUCT problem2structure &s

   variable num_nights = dimsize(s.cleaned_temperature,0)
   variable i = 0
   variable awake_test = 2.7
   //reject nights where mean sleep phase is above some threshold (not smart, but
   Do
      if(s.cleaned_sleep_ph[i]>awake_test)
         deletepoints i,1,s.cleaned_length,s.cleaned_temperature,s.cleaned_time,s
         i-=1
         num_nights-=1
      endif
      i+=1
   While(i<num_nights)

End

function Correllation_thermo_vs_clean(s,infostr,killcopy)
STRUCT problem2structure &s
variable killcopy
string infostr

   duplicate/o s.temp_th temp_th_copy
   duplicate/o s.time_th time_th_copy
   duplicate/o s.cleaned_temperature temp_clean_copy
   duplicate/o s.cleaned_time time_clean_copy

   //fwd sense
   downsample2(s.cleaned_time,s.time_th,temp_clean_copy)
   downsample2(s.cleaned_time,s.time_th,time_clean_copy)
   //back sense
   downsample2(s.time_th,s.cleaned_time,temp_th_copy)
```

```
   downsample2(s.time_th,s.cleaned_time,time_th_copy)


   StatsRankCorrelationTest/T=1/Q temp_clean_copy,temp_th_copy
   wave W_StatsRankCorrelationTest
   variable spearman_r = W_StatsRankCorrelationTest[4]
   variable criticalvalue = W_StatsRankCorrelationTest[5]


   if(spearman_r>criticalvalue)
         print infostr+" : Null Hypothesis rejected, Spearmans Correlation Coeffi
      else
         print infostr+" : Null Hypothesis cannot be rejected (spearman) for:"
   endif
   dowindow/k WMRankCorrelationTable
   killwaves/z W_StatsRankCorrelationTest

   StatsLinearCorrelationTest/T=1/Q temp_clean_copy,temp_th_copy
   wave W_StatsLinearCorrelationTest
    variable linear_r = W_StatsLinearCorrelationTest[4]
   variable t_value = W_StatsLinearCorrelationTest[5]
   variable t_critical = W_StatsLinearCorrelationTest[9]
   variable F_value = W_StatsLinearCorrelationTest[10]
   variable F_critical = W_StatsLinearCorrelationTest[11]

   if(t_value>t_critical&&F_value>f_critical)
         print infostr+" : Null Hypothesis rejected, Linear Correlation Coefficie
      else
         print infostr+" : Null Hypothesis cannot be rejected (linear) for:"
   endif

   if(killcopy==1)
      killwaves/z temp_th_copy,temp_clean_copy
   endif
   dowindow/k WMLinearCorrelationTable
   Killwaves/z W_StatsLinearCorrelationTest
End

function downsample2(time_more,time_less,temp_more)// downsamples cleaned waves
wave time_more,time_less,temp_more
variable more_num_nights = dimsize(time_more,0)
variable i = more_num_nights-1
variable j = 0

   do
      findvalue/V=(time_more[i])/T=0.0 time_less
      //point stored in v_value variable
```

```
      if(v_value==-1)
         deletepoints i,1,temp_more
         j+=1
      endif
      i-=1
   while(i>=0)
end

Function reject_ring_fail(s)
STRUCT problem2structure &s

   variable fail = 32.5//30.05
   variable i=0
   variable num_points = dimsize(s.temp_r,0)

   duplicate/o s.temp_r temp_ring_nofail
   duplicate/o s.time_r time_ring_nofail
   duplicate/o s.sleep_ph_r sleep_ph_ring_nofail

   variable j = 0
   Do

      if(temp_ring_nofail[i]<fail)
      deletepoints i,1,temp_ring_nofail,time_ring_nofail,sleep_ph_ring_nofail
            i-=1
            num_points-=1
            j+=1
      endif
   i+=1
   While(i<num_points)
   wave s.temp_r = temp_ring_nofail
   wave s.time_r = time_ring_nofail
   wave s.sleep_ph_r = sleep_ph_ring_nofail
End

Function Get_waking_Temp(s)
STRUCT problem2structure &s

Variable minutes = 60
   variable num_nights = dimsize(s.night_stop,0)

   make/d/o/n=(num_nights) waking_temp_night

   variable i = 0
   Do
      make/d/o/n=(minutes) temp_night_i
      temp_night_i = s.temp_r[p+s.night_stop[i]-minutes-s.cooldown]
```

```
      waking_temp_night[i]=mean(temp_night_i)
      i+=1
   While(i<num_nights)

killwaves/z temp_night_i,phase_night_i

End

Function Get_sleeping_mean_T(s)
STRUCT problem2structure &s

   variable num_nights = dimsize(s.night_stop,0)
   make/d/o/n=(num_nights) asleep_temp_night
   variable i = 0
   variable j = 0
   Do
      make/d/o/n=(s.night_stop[i]-s.cooldown-(s.night_start[i]+s.warmup)+1) temp_
      temp_night_i = s.temp_r[p+s.night_start[i]+s.warmup]
      phase_night_i = s.sleep_ph_r[p+s.night_start[i]+s.warmup]
time_i = s.time_r[p+s.night_start[i]+s.warmup]
      make/d/o/n=0 sleeping_night,time_sleeping
      SetScale d 0,0,"dat", time_i,time_sleeping

      j=0
      Do

         if(phase_night_i[j]<4)
         insertpoints 0,1, sleeping_night,time_sleeping
         sleeping_night[0] = temp_night_i[j]
         time_sleeping[0] = time_i[j]

         endif
         j+=1
      While(j<dimsize(phase_night_i,0))

      asleep_temp_night[i]=mean(sleeping_night)

      i+=1
   While(i<num_nights)

End



variable num_nights = dimsize(s.night_stop,0)
   make/d/o/n=(num_nights) mean_temp_night,mean_phase_night,median_temp_night
```

```
	variable i = 0

	Do
		make/d/o/n=(s.night_stop[i]-s.cooldown-(s.night_start[i]+s.warmup)+1) temp_
		temp_night_i = s.temp_r[p+s.night_start[i]+s.warmup]
		mean_temp_night[i]=mean(temp_night_i)
		median_temp_night[i]=median(temp_night_i)

		phase_night_i = s.sleep_ph_r[p+s.night_start[i]+s.warmup]
		mean_phase_night[i]=mean(phase_night_i)

		i+=1
	While(i<num_nights)
	duplicate/o mean_temp_night mean_temp_night_raw
	duplicate/o mean_phase_night mean_phase_night_raw
killwaves/z temp_night_i,phase_night_i
```