Graphical Representation of Time Use Diaries in Stata: ATUS Tempograms

Kamila Kolpashnikova
University of Oxford
kamila.kolpashnikova@sociology.ox.ac.uk

Acknowledgements: This project has received funding from the European Union’s Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 892101 (awardee: Kamila Kolpashnikova).

ver. 08.2020

Introduction

Although Stata is not the best package to use for time use graphical representation, such as for tempograms¹, it is nonetheless possible. In this paper, I will demonstrate how to create tempograms using the original American Time Use Survey data from the US Bureau of Labor Statistics². For this project, the 2003-2018 sample of diaries is used (file names: atusact0318 and atusum0318).

Additionally, I identify the bottleneck, where the performance of Stata’s underlying functions could be optimised to improve the work with time-use data for researchers who use Stata.

Downloading and Preparing Data

The data used for this visualisations are publicly available from the Bureau of Labor Statistics website. The 2003-2018 American Time Use Survey files can be found at the following link: <https://www.bls.gov/tus/data/files-0318.htm>. I use two files from ATUS:

1. atusact0318 (<https://www.bls.gov/tus/special.requests/atusact-0318.zip>) - this file contains diary day activity information. For details on the activity coding and data collection, please visit the BLS website.
2. atusum0318 (<https://www.bls.gov/tus/special.requests/atusum-0318.zip>) - this file contains information about the summary of activity durations. However, for this project, I used it to extract information on weekday and year. The original name for the weekday of the diary day variable is `tudiaryday` and for the year variable—`tuyear`.

BLS provides original dictionary files within the compressed .zip files linked above. Before using the code in this project, please transform data into .dta files using BLS codes in the provided links and save both as .dta extension files.

The biggest bottleneck for the present project was *reshape* command. There are custom solutions to this problem, which can be found online, but it might not solve the problem for the use of the native Stata *reshape*

¹at of the time of this project, R has a faster performance both in wrangling and plotting (TraMineR) of the time use sequences on bigger datasets such as ATUS 2003-2018.

²<https://www.bls.gov/tus/>

command.

Step 1.

- open atusact0318.dta file
- use a new variable called ID for tucaseid
- sort by ID and the diary activity number

```
use "atusact0318.dta", clear
gen ID = tucaseid
sort ID tuactivity_n
```

Step 2.

- create a variable (in minutes) when the activity starts (*start*) and finishes (*stop*) using duration variable and the sequence number of the activity

```
gen start= .

replace start = 0 if tuactivity_n==1

gen stop = .

replace stop = tuactdur24 if tuactivity_n==1

sum tuactivity_n

forvalues i = 1/`r(max)' {
    by ID: replace start = stop[_n-1] if start==.
    by ID: replace stop = start+tuactdur24 if stop==.
}
```

Step 3.

- combine activity codes into larger categories:

```
gen Activity = .
*1 - sleep
replace Activity = 1 if trtier2p==101

*2 - personal care
replace Activity = 2 if trtier2p==102|trtier2p==103|trtier2p==105|trtier2p==199

*3 - sex
replace Activity = 3 if trtier2p==104

*4 - housework
replace Activity = 4 if trtier1p==2

*5 - child care
replace Activity = 5 if trtier2p==301 | trtier2p==302 | trtier2p==303 ///
    |trtier2p==401|trtier2p==402|trtier2p==403

*6 - adult care
replace Activity = 6 if trtier2p==304 | trtier2p==305 | trtier2p==399 ///
```

```

|trtier2p==404|trtier2p==405|trtier2p==499

*7 - work
replace Activity = 7 if trtier1p==5

*8 - education
replace Activity = 8 if trtier1p==6

*9 - shopping
replace Activity = 9 if trtier1p==7

*10 - services
replace Activity = 10 if trtier1p==8|trtier1p==9|trtier1p==10

*11 - eating
replace Activity = 11 if trtier1p==11

*12 - leisure
replace Activity = 12 if (trtier1p==12|trtier1p==13|trtier1p==14|trtier1p==15 ///
|trtier1p==16) & (trcodep!=120303 |trcodep!=120304)

*13 - travel
replace Activity = 13 if trtier1p==18

*14 - other
replace Activity = 14 if trtier1p==50

*15 - TV
replace Activity =15 if trcodep==120303 |trcodep==120304

```

Step 4.

- keep only the variables that will be needed for the next steps

```
keep tucaseid ID tuactivity_n Activity start tuactdur24
```

Step 5.

- create the number of observations 1440 for each ID by expanding the duration variable. The resulting number of observations should be 289,657,440

```
expand tuactdur24
```

Step 6.

- create a minutes step identifier (time slot) by ID

```
sort ID tuactivity_n start
by ID: gen time = _n
```

Step 7.

- delete non-essential variables. Keep only ID, time, and activity variables

```
keep ID time Activity
```

Step 8.

- reshape wide and save

WARNING: This step will take a very long time. It took on Windows laptop (Intel Core i5, 16GB RAM) - 15 hours, and on MacBook Pro (8-Core Intel Core i9, 64GB DDR4) - 6 hours. This is the narrowest bottleneck in the code. There are custom solutions to this problem on online forums, but the solution specific to time use data is needed.³

```
reshape wide Activity, i(ID) j(time)
save "ATUS 0318 sequences.dta", replace
```

Above will save a file in the following form:

	ID	Activity1	Activity2	Activity3	Activity4	Activity5	Activity6	Activity7	Activity8	Activity9	Activity10	Activity11	Activity12	Activity13
1	20030100013280	Leisure	Leisure	Leisure	Leisure	Leisure	Leisure	Leisure	Leisure	Leisure	Leisure	Leisure	Leisure	Leisure
2	20030100013344	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
3	20030100013352	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
4	20030100013848	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
5	20030100014165	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
6	20030100014169	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
7	20030100014209	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
8	20030100014427	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
9	20030100014550	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
10	20030100014758	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
11	20030100014928	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
12	20030100015106	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
13	20030100015322	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
14	20030100015390	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
15	20030100015490	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
16	20030100015890	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
17	20030100015891	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
18	20030100015941	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
19	20030100015986	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
20	20030100016070	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
21	20030101030010	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
22	20030101030056	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
23	20030101030074	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
24	20030101030082	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
25	20030101030093	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep
26	20030101030114	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep	Sleep

Figure 1: Sequences Table

Labeling Activities and Adding Variables

Step 9.

- define and add labels to activity variables
- save changes

```
lab def Activity 1 "Sleep" ///
2 "Personal Care" ///
3 "Sex" ///
4 "Housework" ///
5 "Child Care" ///
6 "Adult Care" ///
7 "Work" ///
8 "Education" ///
9 "Shopping" ///
10 "Services" ///
11 "Eating" ///
12 "Leisure" ///
```

³I will probably develop it soon. Stay tuned.

```

13 "Travel" ///
14 "Other" ///
15 "TV"

forval i = 1/1440{
lab val Activity`i' Activity
}
save "ATUS 0318 sequences.dta", replace

```

Step 10.

- extract year and weekday variables from atussum0318.dta file
- merge with the existing file

```

use "atussum_0318.dta", clear

gen Year = tuyear
gen ID = tucaseid

gen Weekday = tuesday-1
recode Weekday (0=7)

keep tucaseid ID Year Weekday

merge 1:1 ID using "ATUS 0318 sequences.dta", update

drop _merge

recode Weekday (1/5=0)(6/7=1), gen(Weekend)

save "ATUS 0318 sequences and vars.dta", replace

```

Creating Tempogram Data Table

Step 11.

The files for tempograms are based on diary sequences. They contain the time slot variable and the number of observations in each activity. The structure is presented in Figure 2.

```

clear
save temp, replace emptyok

forvalues i = 1(1)1440 {
  use "ATUS 0318 sequences and vars.dta", clear
  quietly tab Activity`i', matcell(a)
  svmat double a
  keep a1
  keep in 1/15
  rename a1 a
  append using temp
  save temp, replace
}

use temp, clear

```

```
recode a (.=0)
```

Step 12.

- install seq package from ssc, if you don't have it installed. This package will help to transform one column variable (from the commands above, temp) into a sequence object.

```
ssc install seq
```

Step 13

- declare a sequence object and reshape wide

```
seq b, f(1) t(15)
```

```
seq x1, f(1440) t(1) b(15)
```

```
order b x1 a
```

```
reshape wide a, i(x1) j(b)
```

Figure 2 shows the resulting tempogram data table.

	x1	a1	a2	a3	a4	a5	a6	a7	a8	a9	a10	a11	a12	a13	a14	a15
1	1	185695	3574	55	1697	915	145	3444	77	33	35	849	1868	919	183	1662
2	2	185529	3631	54	1711	916	141	3456	77	36	35	877	1897	928	184	1686
3	3	185549	3602	53	1677	916	140	3456	77	36	35	888	1910	926	184	1702
4	4	185566	3596	50	1651	916	139	3456	77	37	33	893	1916	925	184	1712
5	5	185575	3598	50	1638	916	139	3456	77	38	33	889	1923	923	183	1713
6	6	185603	3596	47	1525	902	130	3463	79	38	34	910	1957	934	185	1748
7	7	185604	3590	48	1522	901	130	3463	79	38	34	913	1961	932	185	1751
8	8	185605	3583	48	1518	902	129	3465	79	39	34	911	1963	933	185	1757
9	9	185605	3582	48	1515	903	128	3465	79	39	34	913	1961	933	185	1761
10	10	185607	3580	48	1516	901	128	3465	79	39	34	914	1960	932	185	1762
11	11	185680	3527	48	1449	872	131	3483	79	37	35	896	1999	927	181	1807
12	12	185686	3521	48	1441	870	130	3486	79	37	35	895	2006	926	181	1810
13	13	185688	3522	48	1426	871	128	3488	79	35	35	899	2012	928	181	1811
14	14	185690	3518	48	1424	870	127	3489	79	34	35	898	2015	928	181	1815
15	15	185690	3519	48	1419	870	127	3489	79	34	35	901	2014	929	181	1816
16	16	185657	3417	44	1437	809	133	3526	78	36	35	889	2057	983	183	1867
17	17	185658	3407	42	1437	807	131	3531	78	35	35	893	2058	986	182	1871
18	18	185668	3408	42	1426	804	129	3533	78	34	35	892	2059	987	183	1873
19	19	185668	3405	42	1430	802	129	3533	78	34	35	887	2060	990	184	1874
20	20	185668	3406	42	1427	803	129	3533	78	34	35	889	2060	989	184	1874
21	21	185736	3203	42	1422	722	124	3582	78	42	34	901	2108	1049	194	1914

Figure 2: Tempogram Table

Step 14.

- label the time slot variable

```
forval i = 0(1)23 {
    local a = `i'*60+1
    label def tod `a' "`i':00", modify
}
```

```
forval i = 0(1)23 {
    local a = `i'*60+11
    label def tod `a' "`i':10", modify
}
```

```
forval i = 0(1)23 {
```

```

    local a = `i'*60+21
    label def tod `a' "`i':20", modify
}

forval i = 0(1)23 {
    local a = `i'*60+31
    label def tod `a' "`i':30", modify
}

forval i = 0(1)23 {
    local a = `i'*60+41
    label def tod `a' "`i':40", modify
}

forval i = 0(1)23 {
    local a = `i'*60+51
    label def tod `a' "`i':50", modify
}

label val x1 tod

```

Aggregate Activities

Step 15.

We need to aggregate times for activities in the order that we want to present them because *twoway area* plots area graphs over each other. To make areas visible above each other, we need to aggregate them. Rules:

- the activity that is meant to be on the bottom of the tempogram comes first and is not aggregated with others (in my examples, it is a1, sleep) - the activity that is meant to be on the top of the tempogram should come the last and combines all other activities (here, it's a14, other)

```

gen sleep = a1
gen personal_care = sleep+a2
gen sex = personal_care + a3
gen eating = sex + a11
gen work = eating + a7
gen education = work + a8
gen housework = education + a4
gen child_care = housework + a5
gen elder_care = child_care + a6

gen shopping = elder_care + a9
gen services = shopping + a10
gen leisure = services + a12
gen TV = leisure + a15
gen travel = TV + a13
gen other = travel + a14

```

Plotting Tempograms

Example 1. Plotting Tempogram of all activities in a day

- use *twoway area*

- order the entry of activity variables from the top ('other') to the bottom activity ('sleep'). x1 is the time slot activity.
- xlabel allows to add specific ticks

```
graph twoway (area other travel ///
TV leisure services shopping education ///
work elder_care child_care housework eating sex personal_care ///
sleep x1), ///
xlabel(1 "04:00 am" 250 "6:00 am" 370 "9:00 am" ///
490 "12:00 pm" 670 "15:00 pm" 850 "18:00 pm" ///
970 "20:00 pm" 1090 "22:00 pm", angle(90)) ///
ylabel("") ///
title(An Average Day of an American) ///
yttitle () ///
xttitle (time of the day) ///
legend() scheme(economist)
```

In this example, I used the economist style scheme (see Figure 3).

Example 2. Plotting a Select Activity

- to plot only one activity, it's better to use non-aggregated activity variables (a1-a15)

For example, to plot sleeping patterns (Figure 4), use:

```
graph twoway (area a11 x1, color(eltgreen) lcolor(black)), ///
xlabel(1 "04:00 am" 250 "6:00 am" 370 "9:00 am" ///
490 "12:00 pm" 670 "15:00 pm" 850 "18:00 pm" ///
970 "20:00 pm" 1090 "22:00 pm" 1210 "00:00 am", angle(90)) ///
ylabel(10000 "5%" 25000 "12%" 30000 "15%" 40000 "20%") ///
title("American Sleeping Patterns") ///
subtitle("ATUS'03-18") ///
yttitle (% of population) ///
xttitle (time of the day) ///
legend() scheme(lean1)
```

Example 3. Plotting Two Activities

- to compare two activities, also use non-aggregated activity variables (see Figure 5)

```
graph twoway (area a6 x1, color(none) lcolor(black)) ///
(area a5 x1, color(none) lcolor(black) lpattern(dash)), ///
xlabel(1 "04:00 am" 250 "6:00 am" 370 "9:00 am" ///
490 "12:00 pm" 670 "15:00 pm" 850 "18:00 pm" ///
970 "20:00 pm" 1090 "22:00 pm" 1210 "00:00 am", angle(90)) ///
ylabel(2000 "1%" 5000 "2.5%" 10000 "5%") ///
title("Adultcare and Childcare in the US") ///
yttitle (Proportion of Population) ///
xttitle (time of the day) ///
legend(label(1 "Adultcare") label(2 "Childcare")) scheme(lean2)
```

Example 4. Plotting Tempograms for Weekday Sub-sample by Year

The following example makes use of the variables from atussum0318, particularly weekday and year information.

An Average Day of an American

Figure 3: Tempograms: All

Figure 4: Tempograms: All

Figure 5: Tempograms: All

- in order to proceed, first, we need to change the code in **Step 11**

See Figure 6.

```
clear
save temp, replace emptyok

forvalues i = 1(1)1440 {
    use "ATUS 0318 sequences and vars.dta", clear
    quietly tab Activity`i' Year if Weekend==0, matcell(a)
    svmat double a
    keep a1-a16
    keep in 1/15
    append using temp
    save temp, replace
}

use temp, clear
recode a* (.=0)

seq b, f(1) t(15)
seq x1, f(1440) t(1) b(15)

order b x1 a*

rename a1 year2003
rename a2 year2004
rename a3 year2005
rename a4 year2006
rename a5 year2007
rename a6 year2008
rename a7 year2009
rename a8 year2010
rename a9 year2011
rename a10 year2012
rename a11 year2013
rename a12 year2014
rename a13 year2015
rename a14 year2016
rename a15 year2017
rename a16 year2018

reshape wide year20**, i(x1) j(b)

forval i = 0(1)23 {
    local a = `i'*60+1
    label def tod `a' "`i':00", modify
}

forval i = 0(1)23 {
    local a = `i'*60+11
    label def tod `a' "`i':10", modify
}
```

```

}

forval i = 0(1)23 {
    local a = `i'*60+21
    label def tod `a' "`i':20", modify
}

forval i = 0(1)23 {
    local a = `i'*60+31
    label def tod `a' "`i':30", modify
}

forval i = 0(1)23 {
    local a = `i'*60+41
    label def tod `a' "`i':40", modify
}

forval i = 0(1)23 {
    local a = `i'*60+51
    label def tod `a' "`i':50", modify
}

label val x1 tod

foreach i of numlist 2003(1)2018 {
    gen total_year`i' = year`i'1 + year`i'2 + year`i'3 + year`i'4 + year`i'5 + ///
    year`i'6 + year`i'7 + year`i'8 + year`i'9 + year`i'10 + year`i'11 + ///
    year`i'12 + year`i'13 + year`i'14 + year`i'15
}

foreach i of numlist 2003(1)2018 {
    forval j = 1/15 {
        replace year`i'`j' = (year`i'`j'/total_year`i')*100
    }
}

graph twoway ///
    (area year20044 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20054 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20064 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20074 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20084 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20094 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20104 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20114 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20124 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20134 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20144 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20154 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20164 x1, color(none) lcolor(gray) lpattern(dash)) ///
    (area year20174 x1, color(none) lcolor(gray) lpattern(dash)) ///

```

```

(area year20034 x1, color(none) lcolor(black)) ///
(area year20184 x1, color(none) lcolor(red)) ///
, ///
xlabel(1 "04:00 am" 250 "6:00 am" 370 "9:00 am" ///
490 "12:00 pm" 670 "15:00 pm" 850 "18:00 pm" ///
970 "20:00 pm" 1090 "22:00 pm" 1210 "00:00 am", angle(90)) ///
yscale(r(0 21)) ///
title("ATUS: Housework on Weekdays") ///
ytitle (% of Population) ///
xtitle (Time of the Day) ///
legend(order(15 "2003" 2 "2004-2017" 16 "2018")) scheme(lean2)

```

Figure 6: Tempograms: 2003-2018 on Weekdays

.do file can be found on GitHub: <https://github.com/Kolpashnikova/How-to-Make-Tempograms-in-Stata> If you have questions about the code, please contact the author.