Metrics

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Contents

Metrics: labeling factors and exploring scales

Report explains how the response categories from NLSY97 questionnaire are labeled and demonstrates application of labeled factors in data operations and graphing.

Data preliminaries

This section introduces data space.
Data In Initial point of departure - the databox of the selected variables, described in the Methods chapter.

VARIABLE TITLE	Units	Codename															
CV_SAMPLE_TYPE	0/1	*sample*	1997														
PUBID, YOUTH CASE IDENTIFICATION CODE	integers	*id*	1997														
KEY!**SEX**, RS GENDER	m/f	*sex*	1997														
KEY!**RACE**_ETHNICITY, COMBINED RACE AND ETHNICITY	b/h/m/o	*race*	1997														
KEY!BDATE, RS BIRTHDATE **MONTH**/YEAR	01-12	*bmonth*	1997														
KEY!BDATE, RS BIRTHDATE MONTH/**YEAR**	years	*byear*	1997														
HOW OFTEN PR **ATTEND** CHURCH IN LAST YEAR?	1-8	*attendPR*	1997														
WHAT IS **PR**S CURRENT **REL**IGIOUS **PREF**ERENCE?	1-8	*relprefPR*	1997														
WHAT **REL**IGION WAS **PR RAISED** IN?	1-8	*elraisedPR*	1997														
RS **AGE** IN **MON**THS AS OF INTERVIEW DATE	months	*agemon*	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
RS **AGE** AT INTERVIEW DATE	years	*ageyear*	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
# DAYS PER WEEK TYPICALLY **FAM**ILY DOES SOMETHING **REL**IGIOUS	days	*famrel*	1997	1998	1999	2000											
HOW OFTEN R **ATTENDED** WORSHIP SERVICE IN PAST 12 MONTHS	0-7	*attend*				2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
R DOES NOT NEED RELIGION FOR GOOD **VALUES**	y/n	*values*						2002			2005			2008			2011
GOD NOTHING **TO DO** HAPPENS TO R	y/n	*todo*						2002			2005			2008			2011
R BELIEVES RELIGIOUS TEACHINGS ARE TO BE **OBEYED** EXACTLY AS WRITTEN	y/n	*obeyed*						2002			2005			2008			2011
R **PRAY**S MORE THAN ONCE A DAY	y/n	*pray*						2002			2005			2008			2011
R ASKS GOD HELP MAKE **DECISIONS**	y/n	*decisions*						2002			2005			2008			2011
WHAT IS R'S CURRENT **RELIGIOUS** PREFERENCE?	cats:35	*relpref*									2005			2008			2011
R A **BORN-AGAIN** EVANGELICAL CHRISTIAN?	y/n	*bornagain*												2008			2011
IMPORTANCE OF RELIGIOUS **FAITH** IN DAILY LIFE	0-7	*faith*												2008			2011
HOW OFTEN R FELT CALM AND **PEACEFUL** IN PAST MONTH	1-4	*calm*				2000		2002		2004		2006		2008		2010	
HOW OFTEN R FELT DOWN OR **BLUE** IN PAST MONTH	1-4	*blue*				2000		2002		2004		2006		2008		2010	
HOW OFTEN R HAS BEEN A **HAPPY** PERSON IN PAST MONTH	1-4	*happy*				2000		2002		2004		2006		2008		2010	
HOW OFTEN R **DEPRESSED** IN LAST MONTH	1-4	*depressed*				2000		2002		2004		2006		2008		2010	
HOW OFTEN R HAS BEEN A **NERVOUS** PERSON IN PAST MONTH	1-4	*nervous*				2000		2002		2004		2006		2008		2010	
HOW MANY HOURS PER WEEK DOES R WATCH **TELEVISION**	cats:6	*tv*						2002					2007	2008	2009	2010	2011
HOW MANY HOURS PER WEEK DOES R USE A **COMPUTER**	cats:6	*computer*						2002					2007	2008	2009	2010	2011
CURRENTLY HAVE ACCESS TO **INTERNET**?	y/n	*internet*						2002	2003	2004	2005	2006	2007	2008	2009	2010	2011

Figure 3.2 Databox slice of variables selected from NLSY97 for analyses

This databox corresponds to the dataset **dsL** produced by Derive_dsL_from_Extract report, given in the Appendix.

```
dsL<-readRDS("./Data/Derived/dsL.rds")
```

Time Invariant | Time Variant

sample	id	sex	race	bmonth	byear	attendPR	relprefPR	relraisedPR	year	agemon	ageyear	famrel	attend	values	todo	obeyed	pray	decisions	relpref	bornagain	faith	calm	blue	happy	depressed	nervous	tv	computer	internet
1	1	2	4	9	1981	7	21	21	1997	190	15	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	1	2	4	9	1981	7	21	21	1998	206	17	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	1	2	4	9	1981	7	21	21	1999	219	18	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	1	2	4	9	1981	7	21	21	2000	231	19	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	3	3	3	3	3	NA	NA	NA
1	1	2	4	9	1981	7	21	21	2001	243	20	NA	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	1	2	4	9	1981	7	21	21	2002	256	21	NA	2	1	1	1	0	1	NA	NA	NA	4	2	3	2	1	2	5	NA
1	1	2	4	9	1981	7	21	21	2003	266	22	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1
1	1	2	4	9	1981	7	21	21	2004	279	23	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	4	1	4	1	1	NA	NA	0
1	1	2	4	9	1981	7	21	21	2005	290	24	NA	1	0	1	0	0	1	21	NA	NA	NA	NA	NA	NA	NA	NA	NA	1
1	1	2	4	9	1981	7	21	21	2006	302	25	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	4	1	4	1	1	NA	NA	1
1	1	2	4	9	1981	7	21	21	2007	313	26	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	6	1
1	1	2	4	9	1981	7	21	21	2008	325	27	NA	1	0	1	0	0	1	21	NA	3	3	3	3	3	3	NA	NA	1
1	1	2	4	9	1981	7	21	21	2009	337	28	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	2	6	1
1	1	2	4	9	1981	7	21	21	2010	350	29	NA	1	NA	NA	NA	NA	NA	NA	NA	NA	3	3	3	3	3	1	6	1
1	1	2	4	9	1981	7	21	21	2011	360	29	NA	1	0	1	0	0	1	21	NA	1	NA	NA	NA	NA	NA	NA	6	1
1	2	1	2	7	1982	NA	NA	NA	1997	178	14	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1	2	1	2	7	1982	NA	NA	NA	1998	196	16	1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Figure 3.3 Generic dataset used in the current study, view for one respondent

Labeling Factor Levels

Review of the item reference cards shows that initially, all items were recorded on some discrete scale, either counting occasions or assigning an intiger to a category of response. However, data were saved as numerical values or intigers

```
ds<- dsL[,1:(ncol(dsL)/2)]# selects the first half of variables
str(ds)
```

```
'data.frame':   134760 obs. of  30 variables:
 $ sample     : int  1 1 1 1 1 1 1 1 1 1 ...
 $ id         : int  1 1 1 1 1 1 1 1 1 1 ...
 $ sex        : int  2 2 2 2 2 2 2 2 2 2 ...
 $ race       : int  4 4 4 4 4 4 4 4 4 4 ...
 $ bmonth     : int  9 9 9 9 9 9 9 9 9 9 ...
 $ byear      : int  1981 1981 1981 1981 1981 1981 1981 1981 1981 1981 ...
 $ attendPR   : int  7 7 7 7 7 7 7 7 7 7 ...
 $ relprefPR  : int  21 21 21 21 21 21 21 21 21 21 ...
 $ relraisedPR: int  21 21 21 21 21 21 21 21 21 21 ...
 $ year       : int  1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 ...
 $ agemon     : num  190 206 219 231 243 256 266 279 290 302 ...
 $ ageyear    : num  15 17 18 19 20 21 22 23 24 25 ...
 $ famrel     : num  NA NA NA NA NA NA NA NA NA NA ...
 $ attend     : num  NA NA NA 1 6 2 1 1 1 1 ...
 $ values     : num  NA NA NA NA NA 1 NA NA 0 NA ...
 $ todo       : num  NA NA NA NA NA 1 NA NA 1 NA ...
 $ obeyed     : num  NA NA NA NA NA 1 NA NA 0 NA ...
 $ pray       : num  NA NA NA NA NA 0 NA NA 0 NA ...
 $ decisions  : num  NA NA NA NA NA 1 NA NA 1 NA ...
 $ relpref    : num  NA NA NA NA NA NA NA NA 21 NA ...
 $ bornagain  : num  NA NA NA NA NA NA NA NA NA NA ...
 $ faith      : num  NA NA NA NA NA NA NA NA NA NA ...
 $ calm       : num  NA NA NA 3 NA 4 NA 4 NA 4 ...
 $ blue       : num  NA NA NA 3 NA 2 NA 1 NA 1 ...
 $ happy      : num  NA NA NA 3 NA 3 NA 4 NA 4 ...
 $ depressed  : num  NA NA NA 3 NA 2 NA 1 NA 1 ...
 $ nervous    : num  NA NA NA 3 NA 1 NA 1 NA 1 ...
 $ tv         : num  NA NA NA NA NA 2 NA NA NA NA ...
 $ computer   : num  NA NA NA NA NA 5 NA NA NA NA ...
 $ internet   : num  NA NA NA NA NA NA 1 0 1 1 ...
```

LabelingFactorLevels.R sourced at the end of Derive_dsL_from_Extract matches numeric values with response labels from the questionnaire and adds to **dsL** copies of the variables, saved as labeled factors. For estimations routines such as lm4 or graphing functions such as ggplot, the data type (string,numeric, factor) is a meaningful input, so a quick access to both formats frequently proves useful. It is convenient to think that **dsL** contains only

```
ncol(dsL)/2
```

```
[1] 30
```

variables, but each of them has a double, a labeled factor.

```
str(dsL)
```

```
'data.frame':	134760 obs. of  60 variables:
 $ sample       : int  1 1 1 1 1 1 1 1 1 1 ...
 $ id           : int  1 1 1 1 1 1 1 1 1 1 ...
 $ sex          : int  2 2 2 2 2 2 2 2 2 2 ...
 $ race         : int  4 4 4 4 4 4 4 4 4 4 ...
 $ bmonth       : int  9 9 9 9 9 9 9 9 9 9 ...
 $ byear        : int  1981 1981 1981 1981 1981 1981 1981 1981 1981 1981 ...
 $ attendPR     : int  7 7 7 7 7 7 7 7 7 7 ...
 $ relprefPR    : int  21 21 21 21 21 21 21 21 21 21 ...
 $ relraisedPR  : int  21 21 21 21 21 21 21 21 21 21 ...
 $ year         : int  1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 ...
 $ agemon       : num  190 206 219 231 243 256 266 279 290 302 ...
 $ ageyear      : num  15 17 18 19 20 21 22 23 24 25 ...
 $ famrel       : num  NA NA NA NA NA NA NA NA NA NA ...
 $ attend       : num  NA NA NA 1 6 2 1 1 1 1 ...
 $ values       : num  NA NA NA NA NA 1 NA NA 0 NA ...
 $ todo         : num  NA NA NA NA NA 1 NA NA 1 NA ...
 $ obeyed       : num  NA NA NA NA NA 1 NA NA 0 NA ...
 $ pray         : num  NA NA NA NA NA 0 NA NA 0 NA ...
 $ decisions    : num  NA NA NA NA NA 1 NA NA 1 NA ...
 $ relpref      : num  NA NA NA NA NA NA NA NA 21 NA ...
 $ bornagain    : num  NA NA NA NA NA NA NA NA NA NA ...
 $ faith        : num  NA NA NA NA NA NA NA NA NA NA ...
 $ calm         : num  NA NA NA 3 NA 4 NA 4 NA 4 ...
 $ blue         : num  NA NA NA 3 NA 2 NA 1 NA 1 ...
 $ happy        : num  NA NA NA 3 NA 3 NA 4 NA 4 ...
 $ depressed    : num  NA NA NA 3 NA 2 NA 1 NA 1 ...
 $ nervous      : num  NA NA NA 3 NA 1 NA 1 NA 1 ...
 $ tv           : num  NA NA NA NA NA 2 NA NA NA NA ...
 $ computer     : num  NA NA NA NA NA 5 NA NA NA NA ...
 $ internet     : num  NA NA NA NA NA NA 1 0 1 1 ...
 $ sampleF      : Ord.factor w/ 2 levels "Cross-Sectional"<..: 1 1 1 1 1 1 1 1 1 1 ...
 $ idF          : Factor w/ 8984 levels "1","2","3","4",..: 1 1 1 1 1 1 1 1 1 1 ...
 $ sexF         : Ord.factor w/ 3 levels "Male"<"Female"<..: 2 2 2 2 2 2 2 2 2 2 ...
 $ raceF      : Ord.factor w/ 4 levels "Black"<"Hispanic"<..: NA NA NA NA NA NA NA NA NA NA ...
 $ bmonthF      : Ord.factor w/ 12 levels "Jan"<"Feb"<"Mar"<..: 9 9 9 9 9 9 9 9 9 9 ...
 $ byearF       : Factor w/ 5 levels "1980","1981",..: 2 2 2 2 2 2 2 2 2 2 ...
 $ attendPRF    : Ord.factor w/ 8 levels "Never"<"Once or Twice"<..: 7 7 7 7 7 7 7 7 7 7 ...
 $ relprefPRF  : Ord.factor w/ 33 levels "Catholic"<"Baptist"<..: 21 21 21 21 21 21 21 21 21 21 ...
 $ relraisedPRF: Ord.factor w/ 33 levels "Catholic"<"Baptist"<..: 21 21 21 21 21 21 21 21 21 21 ...
```

```
 $ yearF       : Factor w/ 15 levels "1997","1998",..: 1 2 3 4 5 6 7 8 9 10 ...
 $ agemonF    : Factor w/ 244 levels "146","147","148",..: 45 61 74 86 98 111 121 134 145 157 ...
 $ ageyearF    : Factor w/ 21 levels "12","13","14",..: 4 6 7 8 9 10 11 12 13 14 ...
 $ famrelF     : Factor w/ 8 levels "0","1","2","3",..: NA NA NA NA NA NA NA NA NA NA ...
 $ attendF    : Ord.factor w/ 8 levels "Never"<"Once or Twice"<..: NA NA NA 1 6 2 1 1 1 1 ...
 $ valuesF    : Ord.factor w/ 2 levels "FALSE/less Religious"<..: NA NA NA NA NA 2 NA NA 1 NA ...
 $ todoF      : Ord.factor w/ 2 levels "FALSE/less Religious"<..: NA NA NA NA NA 2 NA NA 2 NA ...
 $ obeyedF    : Ord.factor w/ 2 levels "FALSE/less Religious"<..: NA NA NA NA NA 2 NA NA 1 NA ...
 $ prayF      : Ord.factor w/ 2 levels "FALSE/less Religious"<..: NA NA NA NA NA 1 NA NA 1 NA ...
 $ decisionsF  : Ord.factor w/ 2 levels "FALSE/less Religious"<..: NA NA NA NA NA 2 NA NA 2 NA ...
 $ relprefF   : Ord.factor w/ 33 levels "Catholic"<"Baptist"<..: NA NA NA NA NA NA NA NA 21 NA ...
 $ bornagainF  : Ord.factor w/ 2 levels "NO"<"YES": NA NA NA NA NA NA NA NA NA NA ...
 $ faithF     : Ord.factor w/ 5 levels "Exrtemely"<"Very"<..: NA NA NA NA NA NA NA NA NA NA ...
 $ calmF      : Ord.factor w/ 4 levels "All of the time"<..: NA NA NA NA NA NA NA NA NA NA ...
 $ blueF      : Ord.factor w/ 4 levels "All of the time"<..: NA NA NA NA NA NA NA NA NA NA ...
 $ happyF     : Ord.factor w/ 4 levels "All of the time"<..: NA NA NA NA NA NA NA NA NA NA ...
 $ depressedF  : Ord.factor w/ 4 levels "All of the time"<..: NA NA NA NA NA NA NA NA NA NA ...
 $ nervousF    : Ord.factor w/ 4 levels "All of the time"<..: NA NA NA NA NA NA NA NA NA NA ...
 $ tvF         : Ord.factor w/ 6 levels "less than 2"<..: NA NA NA NA NA 2 NA NA NA NA ...
 $ computerF   : Ord.factor w/ 6 levels "None"<"less than 1"<..: NA NA NA NA NA 5 NA NA NA NA ...
 $ internetF   : Ord.factor w/ 2 levels "No"<"Yes": NA NA NA NA NA NA 2 1 2 2 ...
```

This give a certain flexibity to assemble needed dataset quickly and have access to factor labels. One can alternate between the raw metric and labeled factor by adding “F” suffix to the end of the variable name:

```
selectCols<-c("year","id","byear","attend","attendF") # select the columns with these names
ds<-dsL[,selectCols] # select all rows for the columns listed  selectCols
print(ds[ds$id==1,]) # print all availible data for respondent with ID 1
```

```
   year id byear attend         attendF
1  1997  1  1981     NA            <NA>
2  1998  1  1981     NA            <NA>
3  1999  1  1981     NA            <NA>
4  2000  1  1981      1           Never
5  2001  1  1981      6 About once/week
6  2002  1  1981      2   Once or Twice
7  2003  1  1981      1           Never
8  2004  1  1981      1           Never
9  2005  1  1981      1           Never
10 2006  1  1981      1           Never
11 2007  1  1981      1           Never
12 2008  1  1981      1           Never
13 2009  1  1981      1           Never
14 2010  1  1981      1           Never
15 2011  1  1981      1           Never
```

Having quick access to factor labels will be especially useful during graph production. For the grammer rules of operations with relevant data see Data Manipulation Guide.

Time metrics : Age, Period, Cohort

NLSY97 sample includes individuals from five cohorts, born between 1980 and 1984.The following graphics shows how birth cohort, age of respondents, and round of observation are related in NSLY97.

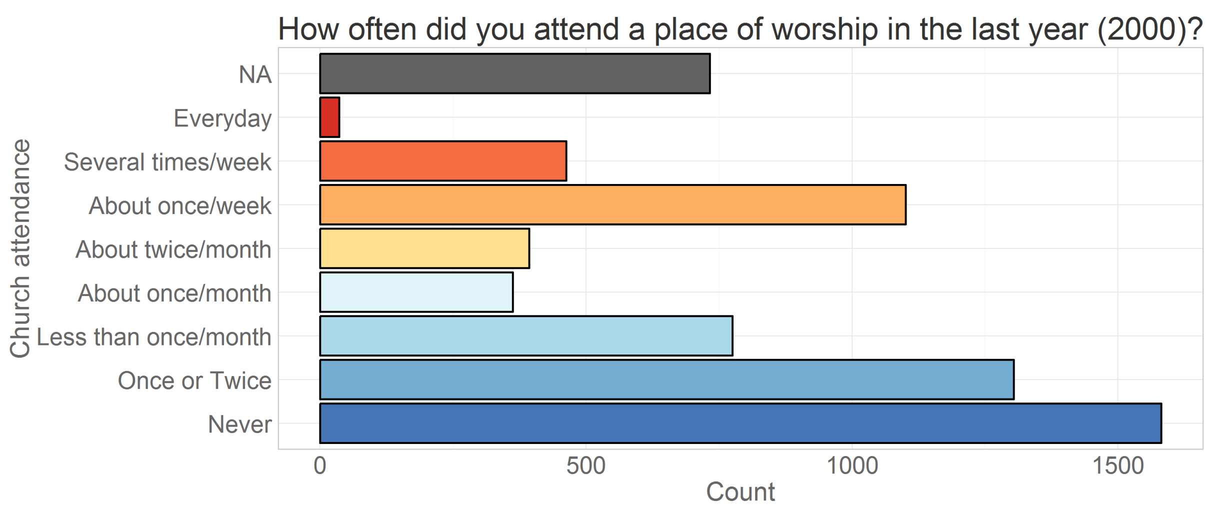
There are several indicators of age in NSLY97 that vary in precision. Birth cohort (**byear**) is the most general one, it was recorded once. Two age variables were recorded at each interview: age at the time of the interview in months (**agemon**) and in years (**ageyear**). Those are not derivatives of each other, but are are closely related. The variable **ageyear** records the full number of years a respondent reached at the time of the interview. Due to difficulties of administering the survey, time intervals between the waves could differ. For example, for one person **id** = 25 the age was recorded as 21 years for both 2003 and 2004 (see **ageyear**). However, when you examine age in months (**agemon**) you can see this rounding issue disappears once a more precise scale is used. To avoid this potentially confusing peculiarity, age in years will be calculated as (**age** = **year** - **byear**) or as (**ageALT** = **agemon**/12).

```
ds<-dsL[dsL$year %in% c(2000:2011),c('id',"byear","year","attend","ageyear","agemon")]
ds<- ds[ds$id %in% c(25),]
ds$age<-ds$year-ds$byear
ds$ageALT<- ds$agemon/12
print(ds)
```

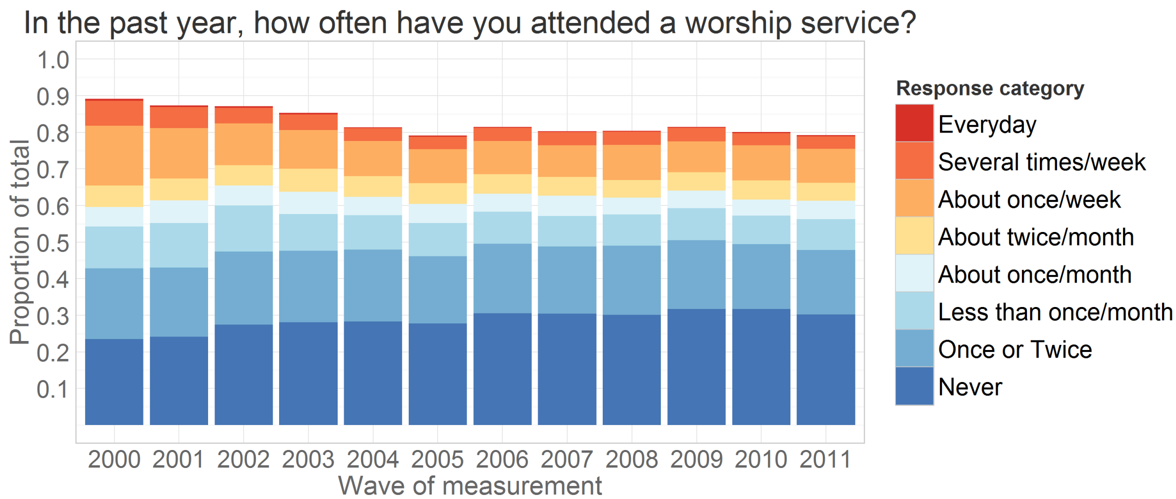
```
     id byear year attend ageyear agemon age ageALT
364 25  1983 2000      5      17    214  17  17.83
365 25  1983 2001      7      18    226  18  18.83
366 25  1983 2002      7      19    236  19  19.67
367 25  1983 2003      2      21    254  20  21.17
368 25  1983 2004      7      21    261  21  21.75
369 25  1983 2005      5      22    272  22  22.67
370 25  1983 2006      7      23    284  23  23.67
371 25  1983 2007      5      24    295  24  24.58
372 25  1983 2008      7      25    307  25  25.58
373 25  1983 2009      7      26    319  26  26.58
374 25  1983 2010      7      27    332  27  27.67
375 25  1983 2011      7      28    342  28  28.50
```

Mapping Church Attendance

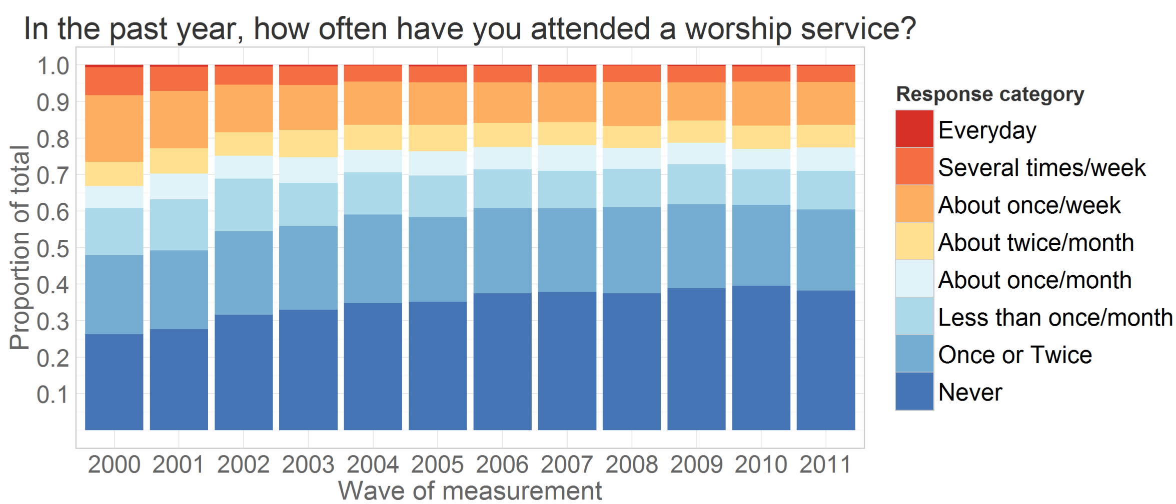
The focal variable of interest is **attend**, an item measuring church attendance in the current year. The questionnaire recorded the responses on the ordinal scale.



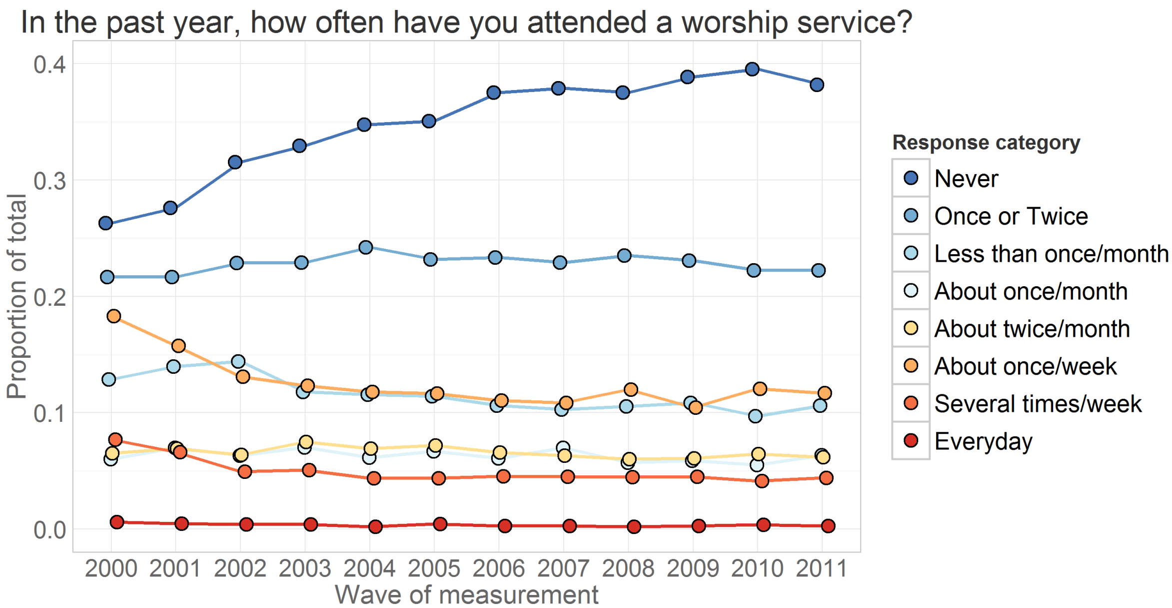
Creating frequency distributions for each of the measurement wave we have:



Missing values are used in the calculation of total responses to show the natural attrition in the study. Assumming that attrition is not significantly associated with the outcome measure, we can remove missing values from the calculation of the total and look at prevalence of endorsements over time.



Tracing the rate of change of prevalence in a line graph, we see more clearly which categores increase over time (e.g. “Never”), which decline (e.g. “”About once/week), and which stay relatively stable (e.g. “About twice/month”)

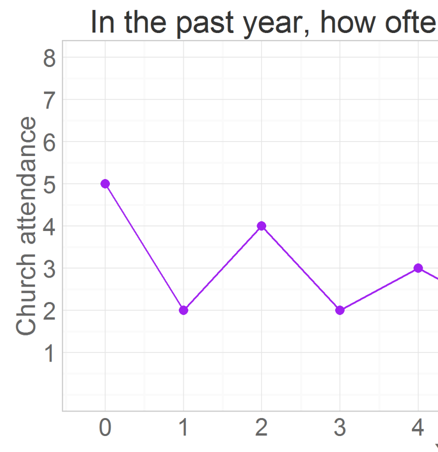


Graphs above shows change in the cross-sectional distribution of responses over the years. Modeling the change in these response frequencies is handled well by Markov models. LCM, however, works with longitudinal data, modeling the trajectory of each individual and treating attendance as a continuous outcome.

To demonstrate mapping of individual trajectories to time, let's select a dataset that would include personal identifyer (**id**), cohort indicator (**byear**), wave of measurement (**year**) and the focal variable of interest - worship attendance (**attend**).

```
ds<- dsL %>%  dplyr::filter(year %in% c(2000:2011), id==47) %>%
              dplyr:: select(id, byear, year, attend, attendF)
print(ds)
```

```
   id byear year attend              attendF
1  47  1982 2000      5    About twice/month
2  47  1982 2001      2        Once or Twice
3  47  1982 2002      4     About once/month
4  47  1982 2003      2        Once or Twice
5  47  1982 2004      3 Less than once/month
6  47  1982 2005      2        Once or Twice
7  47  1982 2006      2        Once or Twice
8  47  1982 2007      3 Less than once/month
9  47  1982 2008      2        Once or Twice
10 47  1982 2009      1                Never
11 47  1982 2010      1                Never
12 47  1982 2011      1                Never
```



The view above lists attendance data for subjust with id = 47. Mapping his attendance to time we have

where vertical dimension maps the outcome value and the horizontal maps the time. There will be a trajecory for each of the

```
length(unique(dsL$id))
```

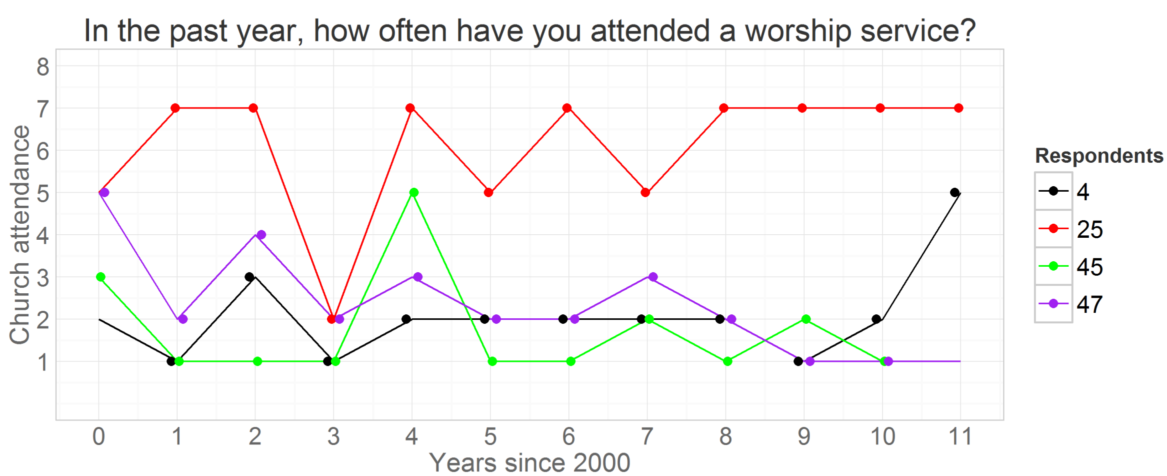
```
[1] 8984
```

subjects in total. Unless specified otherwise, only individuals from the cross-sample will be used in the model to increase external validity.

```
ds<- dsL %>% dplyr::filter(sample==1)
```

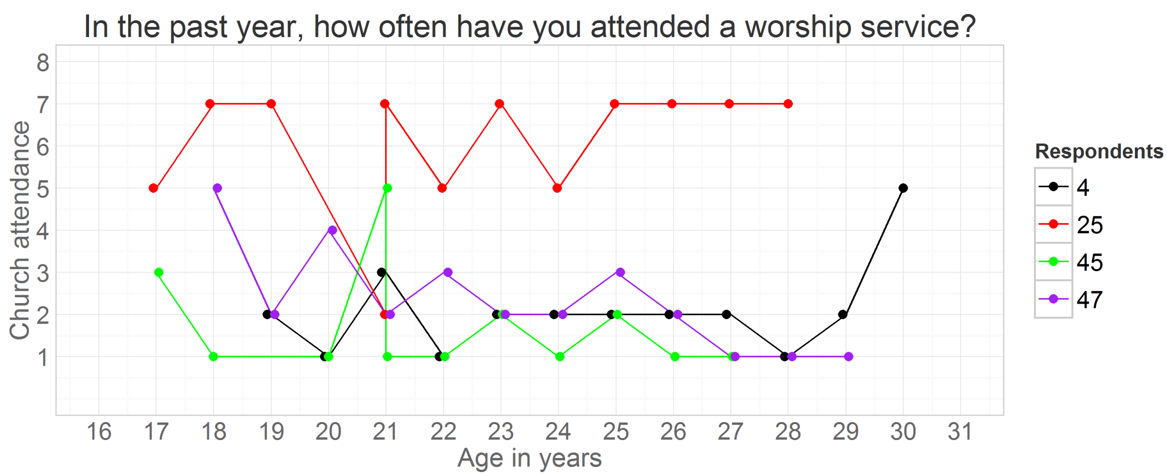
Each of such trajectories imply a story, a life scenario. Why one person grows in his religious involvement, while other declines, or never develops an interest in the first place? To demostrate how interpretations of trajectories can vary among individuals consider the following scenario.

Attendance trajectories of subjects with **id**s 4, 25, 35, and 47 are plotted in the next graph



The respondent **id**=35 reported attending no worship services in any of the years, while respodent **id**=25 seemed to frequent it, indicating weekly attendance in 8 out of the 12 years. Individual **id**=47 started as a fairly regular attendee of religious services in 2000 (5= “about twice a month”), then gradually declined his involvement to nill in 2009 and on. Respondent **id**=4, on the other hand started off with a rather passive involvement, reporting attended church only "Once or twice" in 2000, maintained a low level of participation throughout the years, only to surge his attendance in 2011. Latent curve models will describe intraindividual trajectories of change, while summarizinig the interindividual similarities and trends.

Previous research in religiousity indicated that age might be one of the primary factors explaining interindividual differences in church attendance. To examine the role of age, we change the metric of time from waves of measurement, as in the previous graph, to biological age.

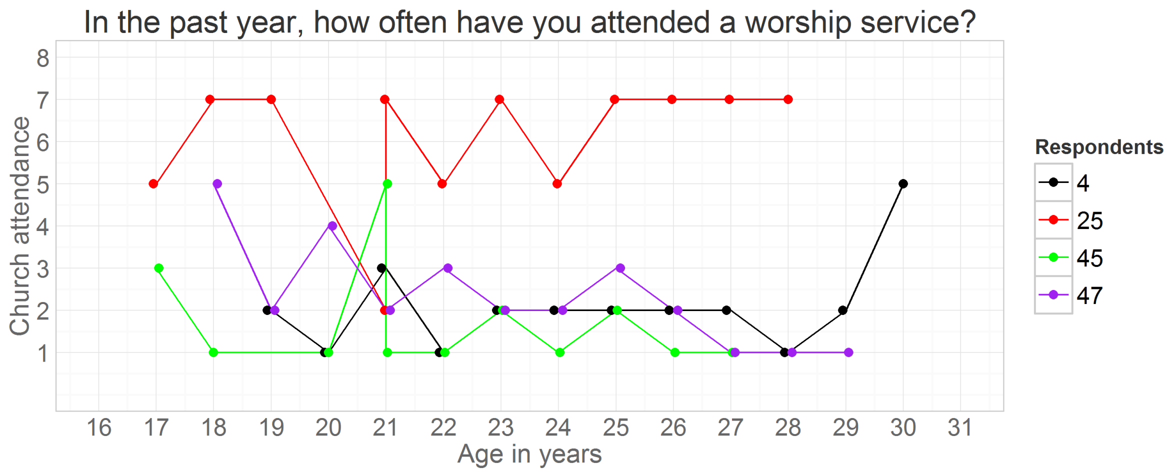


Persons **id** = 35 and **id** = 25 are peers, in 2000 they were both 17. Respondent **id** = 47 is a year older, in 2000 he was 18. The oldest is **id** = 4, who by the last round of measurement in 2011 is 30 years of age. Perhaps, his increased church attendance could be explained by starting a family of his own?

Note that for person **id** = 25 the age was recorded as 21 years for both 2003 and 2004. However, when you examine age in months (**agemon**) you can see this is rounding issue that disappears once a more precise scale is used. To avoid this potentially confusing peculiarity, age in years will be either calculated as (**age** = **year** - **byear**)

```
ds<- dsL %>% dplyr::filter(id %in% c(4,25,45,47),year %in% c(2000:2011)) %>%
  dplyr::select(idF,year,attend,agemon,ageyear) %>%
  mutate(time=year-2000, age=ageyear)
head(ds,12)
```

```
   idF year attend agemon ageyear time age
1    4 2000      2    238      19    0  19
2    4 2001      1    251      20    1  20
3    4 2002      3    262      21    2  21
4    4 2003      1    276      22    3  22
5    4 2004      2    287      23    4  23
6    4 2005      2    297      24    5  24
7    4 2006      2    309      25    6  25
8    4 2007      2    320      26    7  26
9    4 2008      2    336      27    8  27
10   4 2009      1    344      28    9  28
11   4 2010      2    357      29   10  29
12   4 2011      5    368      30   11  30
```



or as (**age** = **agemon**/12).

```
ds<- dsL %>% dplyr::filter(id %in% c(4,25,45,47),year %in% c(2000:2011)) %>%
  dplyr::select(idF,year,attend,agemon,ageyear,byear) %>%
  mutate(time=year-2000, age=agemon/12)
head(ds,12)
```

```
   idF year attend agemon ageyear byear time   age
1    4 2000      2    238      19  1981    0 19.83
2    4 2001      1    251      20  1981    1 20.92
3    4 2002      3    262      21  1981    2 21.83
4    4 2003      1    276      22  1981    3 23.00
5    4 2004      2    287      23  1981    4 23.92
6    4 2005      2    297      24  1981    5 24.75
7    4 2006      2    309      25  1981    6 25.75
8    4 2007      2    320      26  1981    7 26.67
9    4 2008      2    336      27  1981    8 28.00
10   4 2009      1    344      28  1981    9 28.67
11   4 2010      2    357      29  1981   10 29.75
12   4 2011      5    368      30  1981   11 30.67
```