Odus C

July 24, 2020

Table of Contents

[1]:
```
# %load_ext autoreload
# %autoreload 2
```

1 Introduction

ODUS (for Older Drug User Study) contains data and tools to study the drug use of older drug users.

Essentially, there are these are tools:

- To get prepared data on the 119 “trajectories” describing 31 variables (drug use, social, etc.) over time of 119 different respondents.

- To vizualize these trajectories in various ways

- To create pdfs of any selection of these trajectories and variables
- To make count tables for any combinations of the variables: Essential step of any Markovian or Bayesian analysis.
- To make probability (joint or conditional) tables from any combination of the variables
- To operate on these count and probability tables, thus enabling inference operations

2 Installation

You need to have python 3.7+ to run this notebook.

And you'll need to have `odus`, which you get by doing

```
pip install odus
```

(And if you don't have pip then, well… how to put it… ha ha ha!)

But if you're the type, you can also just get the source from `https://github.com/thorwhalen/odus`.

Oh, and pull requests etc. are welcome!

Stars, likes, references, and coffee also welcome.

And if you want to donate: Donate to a charity that will help the people understand and make policies surrounding the use of substances.

A simple flowchart about the architecture:

3 Getting some resources

[1]:

```
from matplotlib.pylab import *
from numpy import *
import seaborn as sns

import os
from py2store.stores.local_store import RelativePathFormatStore
from py2store.mixins import ReadOnlyMixin
from py2store.base import Store


from io import BytesIO
from spyn.ppi.pot import Pot, ProbPot
from collections import UserDict, Counter
import numpy as np
import pandas as pd

from ut.ml.feature_extraction.sequential_var_sets import PVar, VarSet, DfData,␣
 ↪VarSetFactory
from IPython.display import Image
from odus.analysis_utils import *

from odus.dacc import DfStore, counts_of_kps, Dacc, VarSetCountsStore, \
    mk_pvar_struct, PotStore, _commun_columns_of_dfs, Struct,␣
 ↪mk_pvar_str_struct, VarStr

from odus.plot_utils import plot_life_course
```

[2]:
```
from odus import data_dir, data_path_of
survey_dir = data_dir
data_dir
```

[2]:
```
'/D/Dropbox/dev/p3/proj/odus/odus/data'
```

[3]:
```
df_store = DfStore(data_dir + '/{}.xlsx')
len(df_store)
cstore = VarSetCountsStore(df_store)
v = mk_pvar_struct(df_store, only_for_cols_in_all_dfs=True)
s = mk_pvar_str_struct(v)
f, df = cstore.df_store.head()
pstore = PotStore(df_store)
```

4 Poking around

4.1 df_store

A df_store is a key-value store where the key is the xls file and the value is the prepared dataframe

[4]:
```
len(df_store)
```

[4]:
```
119
```

[5]:
```
it = iter(df_store.values())
for i in range(5):  # skip five first
    _ = next(it)
df = next(it)  # get the one I want
df.head(3)
```

[5]:
```
category  RURAL  SUBURBAN  URBAN/CITY  HOMELESS  INCARCERATION  WORK  \
age
11            0         1           0         0              0     0
12            0         1           0         0              0     0
13            0         1           0         0              0     0

category  SON/DAUGHTER  SIBLING  FATHER/MOTHER  SPOUSE  …  METHAMPHETAMINE  \
age                                                     …
```

```
11                   1        1              0       0  …                0
12                   1        1              0       0  …                0
13                   1        1              0       0  …                0

category  AS PRESCRIBED OPIOID  NOT AS PRESCRIBED OPIOID  HEROIN  \
age
11                           0                         0       0
12                           1                         0       0
13                           0                         0       0

category  OTHER OPIOID  INJECTED  IN TREATMENT  Selects States below  Georgia  \
age
11                   0         0             0                     1        1
12                   0         0             0                     1        1
13                   0         0             0                     1        1

category  Pennsylvania
age
11                   0
12                   0
13                   0

[3 rows x 31 columns]
```

[6]:

```
print(df.columns.values)
```

```
['RURAL' 'SUBURBAN' 'URBAN/CITY' 'HOMELESS' 'INCARCERATION' 'WORK'
 'SON/DAUGHTER' 'SIBLING' 'FATHER/MOTHER' 'SPOUSE'
 'OTHER (WHO?, FILL IN BRACKETS HERE)' 'FRIEND USER' 'FRIEND NON USER'
 'MENTAL ILLNESS' 'PHYSICAL ILLNESS' 'LOSS OF LOVED ONE' 'TOBACCO'
 'MARIJUANA' 'ALCOHOL' 'HAL/LSD/XTC/CLUBDRUG' 'COCAINE/CRACK'
 'METHAMPHETAMINE' 'AS PRESCRIBED OPIOID' 'NOT AS PRESCRIBED OPIOID'
 'HEROIN' 'OTHER OPIOID' 'INJECTED' 'IN TREATMENT' 'Selects States below'
 'Georgia' 'Pennsylvania']
```

[7]:

```
t = df[['ALCOHOL', 'TOBACCO']]
t.head(3)
```

[7]:

```
category  ALCOHOL  TOBACCO
age
11              0        0
12              0        0
13              0        0
```

[8]:

```
c = Counter()
for i, r in t.iterrows():
    c.update([tuple(r.to_list())])
```

```
c
```

[8]:

```
Counter({(0, 0): 6, (1, 0): 4, (1, 1): 9, (0, 1): 2})
```

[9]:

```
def count_tuples(dataframe):
    c = Counter()
    for i, r in dataframe.iterrows():
        c.update([tuple(r.to_list())])
    return c
```

[10]:

```
fields = ['ALCOHOL', 'TOBACCO']
# do it for every one
c = Counter()
for df in df_store.values():
    c.update(count_tuples(df[fields]))
c
```

[10]:

```
Counter({(0, 1): 903, (1, 1): 1343, (0, 0): 240, (1, 0): 179})
```

[11]:

```
pd.Series(c)
```

[11]:

```
0  1     903
1  1    1343
0  0     240
1  0     179
dtype: int64
```

[12]:

```
# Powerful! You can use that with several pairs and get some nice probabilities.
 ↪ Look up Naive Bayes.
```

4.2 Viewing trajectories

[13]:

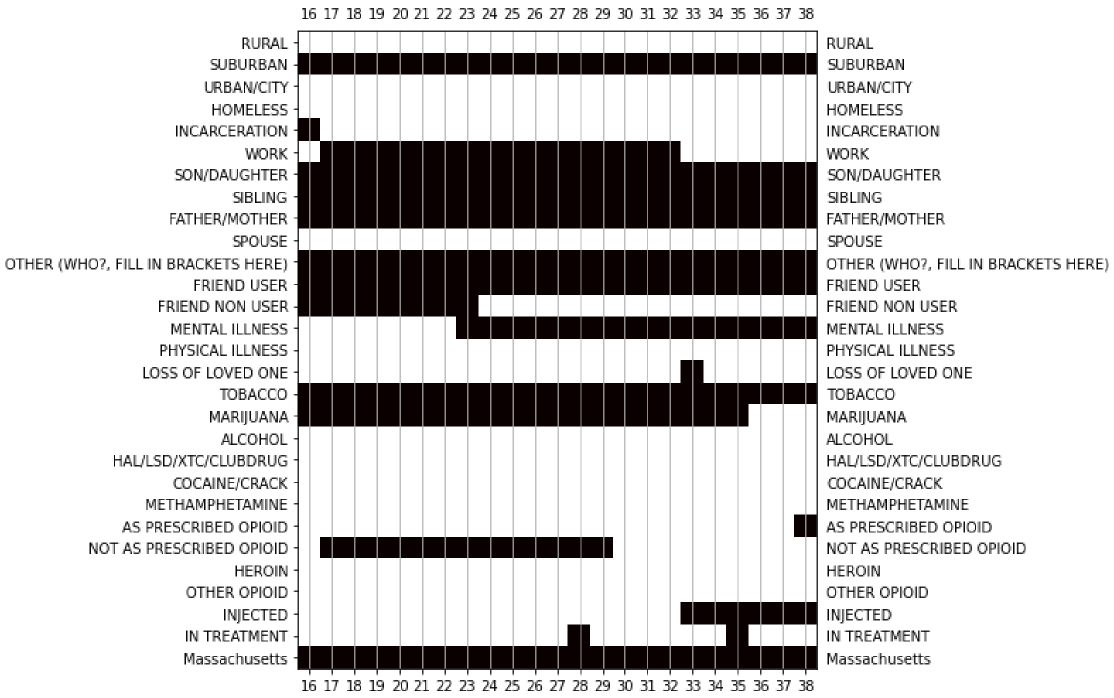
```
import itertools
from functools import partial
from odus.util import write_images
from odus.plot_utils import plot_life, life_plots, write_trajectories_to_file

ihead = lambda it: itertools.islice(it, 0, 5)
```

4.2.1 Viewing a single trajectory

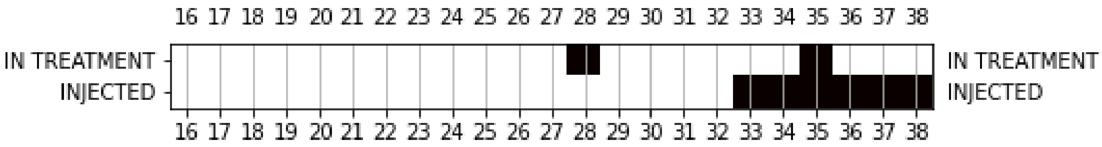
[14]:

```
k = next(iter(df_store))  # get the first key
print(f"k: {k}")  # print it
plot_life(df_store[k])  # plot the trajectory
```

```
k: surveys/B24.xlsx
```



[15]:
```
plot_life(df_store[k], fields=[s.in_treatment, s.injected])  # only want two fields
```

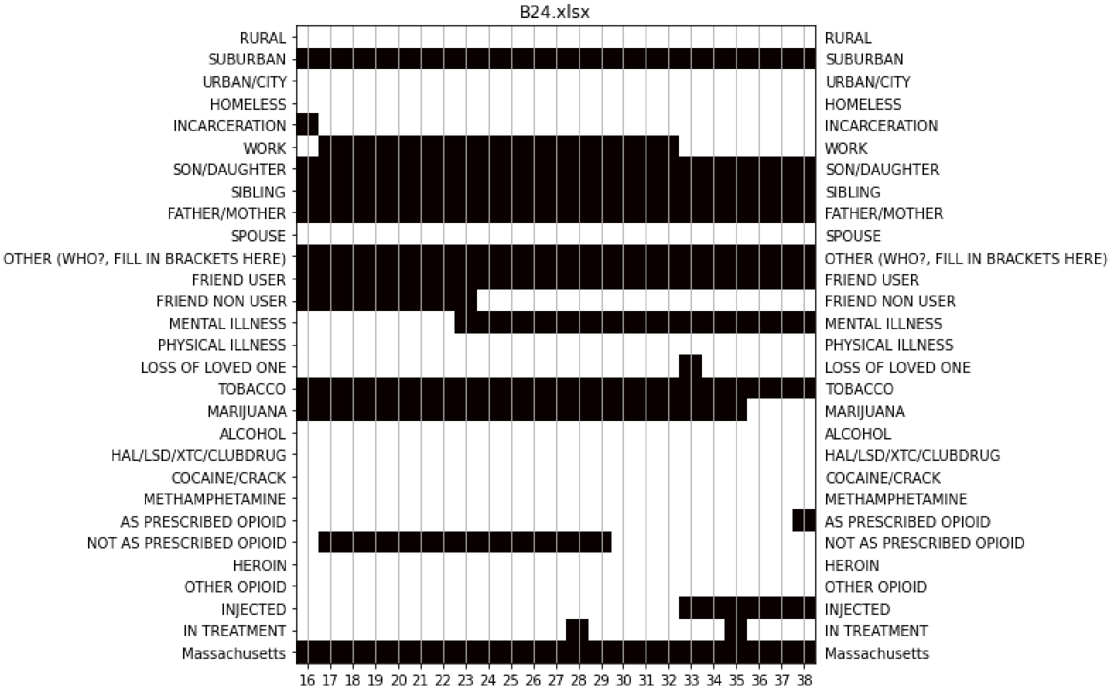


4.2.2 Flip over all (or some) trajectories

[16]:
```
gen = life_plots(df_store)
```

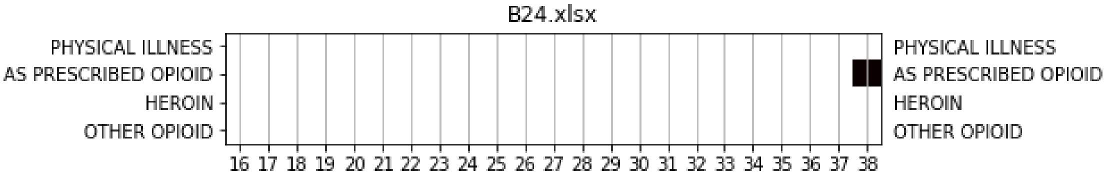
[17]:
```
next(gen)  # launch to get the next trajectory
```

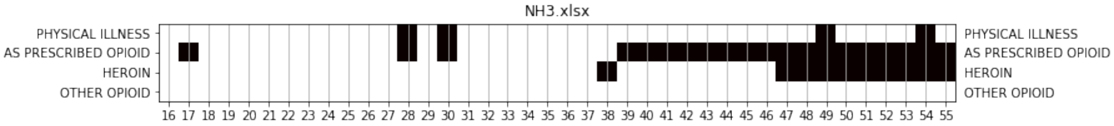
[17]:
```
<matplotlib.axes._subplots.AxesSubplot at 0x12b21f070>
```

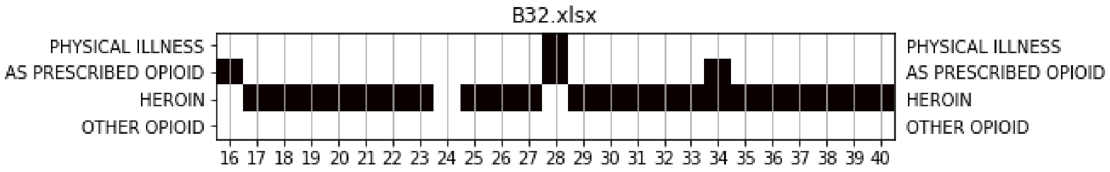


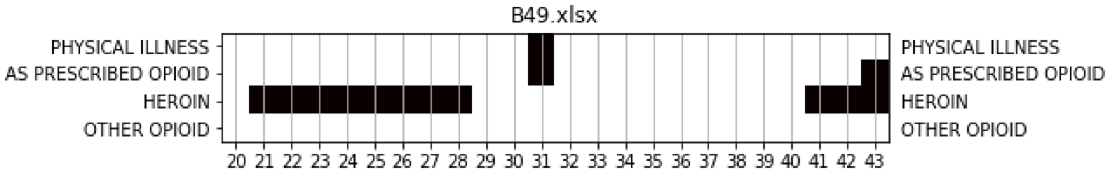
Get three trajectories, but only over two fields.

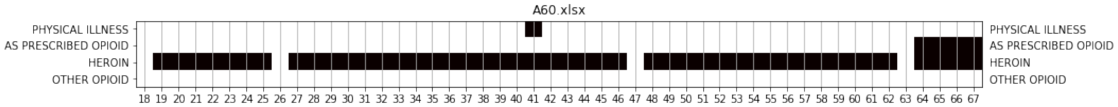
[18]:
```
# fields = [s.in_treatment, s.injected]
fields = [s.physical_illness, s.as_prescribed_opioid, s.heroin, s.other_opioid]
keys = list(df_store)[:10]
# print(f"keys={keys}")
axs = [x for x in life_plots(df_store, fields, keys=keys)];
```

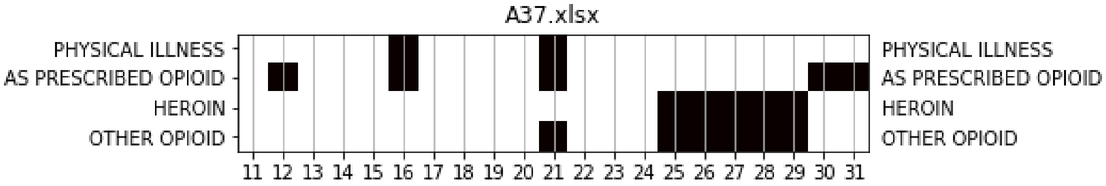


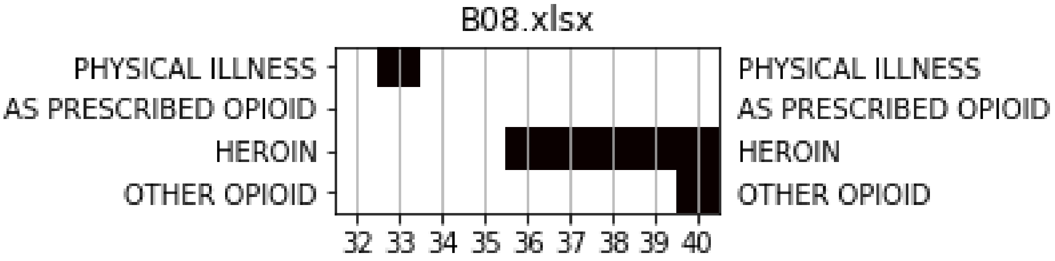


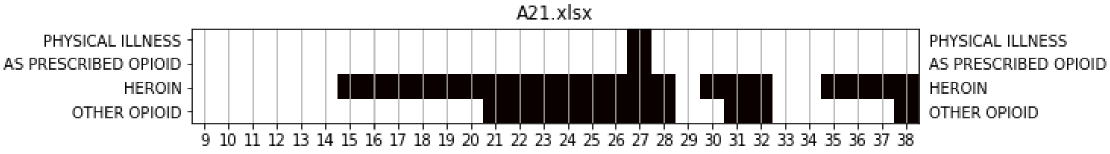

B32.xlsx
PHYSICAL ILLNESS
AS PRESCRIBED OPIOID
HEROIN
OTHER OPIOID
16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

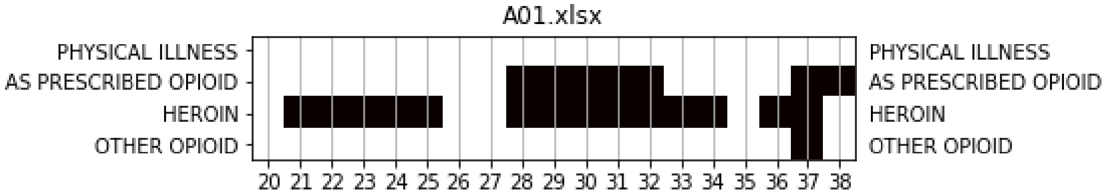

B49.xlsx
PHYSICAL ILLNESS
AS PRESCRIBED OPIOID
HEROIN
OTHER OPIOID
20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43

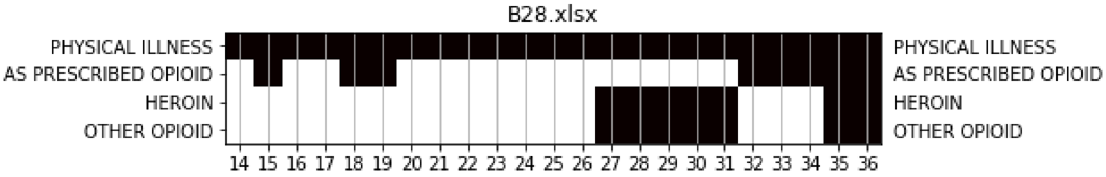

A60.xlsx
PHYSICAL ILLNESS
AS PRESCRIBED OPIOID
HEROIN
OTHER OPIOID
18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67


A37.xlsx
PHYSICAL ILLNESS
AS PRESCRIBED OPIOID
HEROIN
OTHER OPIOID
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31


B08.xlsx
PHYSICAL ILLNESS
AS PRESCRIBED OPIOID
HEROIN
OTHER OPIOID
32 33 34 35 36 37 38 39 40


A21.xlsx
PHYSICAL ILLNESS
AS PRESCRIBED OPIOID
HEROIN
OTHER OPIOID
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38





4.3 Making a pdf of trajectories

[26]:
```
write_trajectories_to_file(df_store, fields, keys,␣
 ↪fp='three_respondents_two_fields.pdf');
```

[ ]:
```
write_trajectories_to_file(df_store, fp='all_respondents_all_fields.pdf');
```

[ ]:
```

```

4.4 Demo s and v

[21]:
```
print(list(filter(lambda x: not x.startswith('__'), dir(s))))
```

```
['alcohol', 'as_prescribed_opioid', 'cocaine_crack', 'father_mother',
'hal_lsd_xtc_clubdrug', 'heroin', 'homeless', 'in_treatment', 'incarceration',
'injected', 'loss_of_loved_one', 'marijuana', 'mental_illness',
'methamphetamine', 'not_as_prescribed_opioid', 'other_opioid',
'physical_illness', 'rural', 'sibling', 'son_daughter', 'suburban', 'tobacco',
'urban_city', 'work']
```

[22]:
```
s.heroin
```

[22]:
```
'HEROIN'
```

[23]:
```
v.heroin
```

[23]:
```
PVar('HEROIN', 0)
```

```
[24]: v.heroin - 1
```

```
[24]: PVar('HEROIN', -1)
```

4.5 cstore

```
[21]: # cstore[v.alcohol, v.tobacco]
      cstore[v.as_prescribed_opioid-1, v.heroin]
```

```
[21]: Counter({(0, 0): 1026, (1, 0): 264, (0, 1): 1108, (1, 1): 148})
```

```
[22]: pd.Series(cstore[v.as_prescribed_opioid-1, v.heroin])
```

```
[22]: 0  0    1026
      1  0     264
      0  1    1108
      1  1     148
      dtype: int64
```

```
[23]: cstore[v.alcohol, v.tobacco, v.heroin]
```

```
[23]: Counter({(0, 0, 1): 427,
               (1, 0, 1): 656,
               (1, 1, 1): 687,
               (0, 0, 0): 189,
               (0, 1, 1): 476,
               (0, 1, 0): 51,
               (1, 0, 0): 133,
               (1, 1, 0): 46})
```

```
[24]: cstore[v.alcohol-1, v.alcohol]
```

```
[24]: Counter({(0, 0): 994, (1, 1): 1375, (1, 0): 90, (0, 1): 87})
```

```
[25]: cstore[v.alcohol-1, v.alcohol, v.tobacco]
```

```
[25]: Counter({(0, 0, 1): 807,
               (1, 1, 1): 1220,
               (1, 0, 0): 26,
               (0, 1, 1): 76,
               (0, 0, 0): 187,
               (1, 1, 0): 155,
               (0, 1, 0): 11,
               (1, 0, 1): 64})
```

```
[45]: t = pd.Series(cstore[v.alcohol-1, v.alcohol, v.tobacco])
      t.loc[t.index]
```

```
[45]: <pandas.core.indexing._LocIndexer at 0x130955db0>
```

4.6 pstore

```
[36]: t = pstore[s.alcohol-1, s.alcohol]
      t
```

```
[36]:                     pval
      ALCOHOL-1 ALCOHOL
      0         0          994
                1           87
      1         0           90
                1         1375
```

```
[38]: t.tb
```

```
[38]:   ALCOHOL-1  ALCOHOL  pval
                0        0   994
                0        1    87
                1        0    90
                1        1  1375
```

```
[40]: t / []
```

```
[40]:                         pval
      ALCOHOL-1 ALCOHOL
      0         0         0.390416
                1         0.034171
      1         0         0.035350
                1         0.540063
```

```
[41]: t[s.alcohol-1]
```

```
[41]:            pval
      ALCOHOL-1
      0          1081
      1          1465
```

```
[32]: t / t[s.alcohol-1]  # cond prob!
```

```
[32]:                         pval
      ALCOHOL-1 ALCOHOL
      0         0         0.919519
                1         0.080481
      1         0         0.061433
                1         0.938567
```

[33]:

```
tt = pstore[s.alcohol, s.tobacco]
tt
```

[33]:

```
                  pval
ALCOHOL TOBACCO
0       0          240
        1          903
1       0          179
        1         1343
```

[34]:

```
tt / tt[s.alcohol]
```

[34]:

```
                      pval
ALCOHOL TOBACCO
0       0         0.209974
        1         0.790026
1       0         0.117608
        1         0.882392
```

[35]:

```
tt / tt[s.tobacco]
```

[35]:

```
                      pval
ALCOHOL TOBACCO
0       0         0.572792
1       0         0.427208
0       1         0.402048
1       1         0.597952
```

[ ]:

```

```

4.7 Scrap place

[50]:

```
t = pstore[s.as_prescribed_opioid-1, s.heroin-1, s.heroin]
t
```

[50]:

```
                                          pval
AS PRESCRIBED OPIOID-1 HEROIN-1 HEROIN
0                      0        0          927
                                1          172
                       1        0           99
                                1          936
1                      0        0          249
                                1           33
                       1        0           15
                                1          115
```

```
[51]: tt = t / t[s.as_prescribed_opioid-1, s.heroin-1]  # cond prob!
      tt
```

```
[51]:                                                 pval
      AS PRESCRIBED OPIOID-1 HEROIN-1 HEROIN
      0                      0        0       0.843494
                                      1       0.156506
                             1        0       0.095652
                                      1       0.904348
      1                      0        0       0.882979
                                      1       0.117021
                             1        0       0.115385
                                      1       0.884615
```

```
[55]: tt.tb
```

```
[55]:   AS PRESCRIBED OPIOID-1  HEROIN-1  HEROIN      pval
                             0         0       0  0.843494
                             0         0       1  0.156506
                             0         1       0  0.095652
                             0         1       1  0.904348
                             1         0       0  0.882979
                             1         0       1  0.117021
                             1         1       0  0.115385
                             1         1       1  0.884615
```

```
AS PRESCRIBED OPIOID-1  HEROIN-1    HEROIN
0    0    0    0.843494
0    0    1    0.156506
1    0    0    0.882979
1    0    1    0.117021
```

```
[56]: 0.117021 / 0.156506
```

```
[56]: 0.7477093529960512
```

```
[ ]:
```

```
[48]: prob_of_heroin_given_presc_op = 0.359223
      prob_of_heroin_given_not_presc_op = 0.519213

      prob_of_heroin_given_presc_op / prob_of_heroin_given_not_presc_op
```

```
[48]: 0.6918605658949217
```

```
[49]: prob_of_heroin_given_not_presc_op / prob_of_heroin_given_presc_op
```

```
[49]: 1.4453779407220584
```

5 Potential Calculus Experimentations

```
[36]: # survey_dir = '/D/Dropbox/others/Miriam/python/ProcessedSurveys'
      df_store = DfStore(survey_dir + '/{}.xlsx')
      len(df_store)
```

```
[36]: 119
```

```
[37]: cstore = VarSetCountsStore(df_store)
      v = mk_pvar_struct(df_store, only_for_cols_in_all_dfs=True)
      s = mk_pvar_str_struct(v)
      f, df = cstore.df_store.head()
      df.head(3)
```

```
[37]: category  RURAL  SUBURBAN  URBAN/CITY  HOMELESS  INCARCERATION  WORK  \
      age
      16            0         1           0         0              1     0
      17            0         1           0         0              0     1
      18            0         1           0         0              0     1

      category  SON/DAUGHTER  SIBLING  FATHER/MOTHER  SPOUSE  ...  \
      age                                                     ...
      16                   1        1              1       0  ...
      17                   1        1              1       0  ...
      18                   1        1              1       0  ...

      category  HAL/LSD/XTC/CLUBDRUG  COCAINE/CRACK  METHAMPHETAMINE  \
      age
      16                           0              0                0
      17                           0              0                0
      18                           0              0                0

      category  AS PRESCRIBED OPIOID  NOT AS PRESCRIBED OPIOID  HEROIN  \
      age
      16                           0                         0       0
      17                           0                         1       0
      18                           0                         1       0

      category  OTHER OPIOID  INJECTED  IN TREATMENT  Massachusetts
      age
      16                   0         0             0              1
      17                   0         0             0              1
      18                   0         0             0              1

      [3 rows x 29 columns]
```

[38]:

```
cstore = VarSetCountsStore(df_store)
cstore.mk_pvar_attrs()
```

[39]:

```
from odus.dacc import DfStore, counts_of_kps, Dacc, plot_life_course,␣
 ↪VarSetCountsStore, mk_pvar_struct, PotStore
pstore = PotStore(df_store)
pstore.mk_pvar_attrs()
p = pstore[v.homeless - 1, v.incarceration]
p
```

[39]:

```
                             pval
HOMELESS-1  INCARCERATION
0           0                1690
            1                 577
1           0                 192
            1                  87
```

[40]:

```
p / []
```

[40]:

```
                                 pval
HOMELESS-1  INCARCERATION
0           0                0.663786
            1                0.226630
1           0                0.075412
            1                0.034171
```

[41]:

```
pstore[v.incarceration]
```

[41]:

```
               pval
INCARCERATION
0              1989
1               676
```

[42]:

```
pstore[v.alcohol-1, v.loss_of_loved_one]
```

[42]:

```
                              pval
ALCOHOL-1 LOSS OF LOVED ONE
0         0                    990
          1                     91
1         0                   1321
          1                    144
```

[43]:

```
tw = pstore[v.tobacco, v.work]
mw = pstore[v.marijuana, v.work]
aw = pstore[v.alcohol, v.work]
w = pstore[v.work]
```

[44]:

```
evid_t = Pot.from_hard_evidence(**{s.tobacco: 1})
evid_m = Pot.from_hard_evidence(**{s.marijuana: 1})
evid_a = Pot.from_hard_evidence(**{s.alcohol: 1})
evid_a
```

[44]:

```
         pval
ALCOHOL
1           1
```

[45]:

```
aw
```

[45]:

```
              pval
ALCOHOL WORK
0       0      431
        1      712
1       0      448
        1     1074
```

[46]:

```
w / []
```

[46]:

```
          pval
WORK
0     0.329831
1     0.670169
```

[47]:

```
(evid_m * mw) / []
```

[47]:

```
                    pval
MARIJUANA WORK
1         0     0.350603
          1     0.649397
```

[48]:

```
(evid_t * tw) / []
```

[48]:

```
                  pval
TOBACCO WORK
1       0     0.313001
        1     0.686999
```

[49]:

```
(evid_a * aw) / []
```

[49]:

```
                 pval
ALCOHOL WORK
1       0     0.29435
        1     0.70565
```

6 Extra scrap

```
[22]: # from graphviz import Digraph
      # Digraph(body="""
      # raw -> data -> count -> prob
      # raw [label="excel files (one per respondent)" shape=folder]
      # data [label="dataframes" shape=folder]
      # count [label="counts for any combinations of the variables in the data"␣
       ↪shape=box3d]
      # prob [label="probabilities for any combinations of the variables in the data"␣
       ↪shape=box3d]
      # """.split('\n'))
```

```
[ ]:
```