lab_2

March 14, 2022

[ ]:
```
from cmdstanpy import CmdStanModel
import pandas as pd
import arviz as az
import numpy as np
import matplotlib.pyplot as plt
import scipy.stats as stats
```

0.1 Excercise 1 - Generated Quantities Block

[ ]:
```
gen_quant = CmdStanModel(stan_file='code_1.stan')
```

```
INFO:cmdstanpy:compiling stan file C:\Users\norbe\Desktop\DataAnalytics\Lab
2\code_1.stan to exe file C:\Users\norbe\Desktop\DataAnalytics\Lab 2\code_1.exe
INFO:cmdstanpy:compiled model executable:
C:\Users\norbe\Desktop\DataAnalytics\Lab 2\code_1.exe
WARNING:cmdstanpy:Stan compiler has produced 1 warnings:
WARNING:cmdstanpy:
--- Translating Stan model to C++ code ---
bin/stanc.exe  --o=C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_1.hpp
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_1.stan
Warning in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_1.stan', line 7, column
3: Declaration
    of arrays by placing brackets after a variable name is deprecated and
    will be removed in Stan 2.32.0. Instead use the array keyword before the
    type. This can be changed automatically using the auto-format flag to
    stanc

--- Compiling, linking C++ code ---
g++ -std=c++1y -m64 -D_REENTRANT -Wall -Wno-unused-function -Wno-uninitialized
-Wno-unused-but-set-variable -Wno-unused-variable -Wno-sign-compare -Wno-unused-
local-typedefs -Wno-int-in-bool-context -Wno-attributes -Wno-ignored-attributes
-I stan/lib/stan_math/lib/tbb_2020.3/include    -O3 -I src -I stan/src -I
lib/rapidjson_1.1.0/ -I lib/CLI11-1.9.1/ -I stan/lib/stan_math/ -I
stan/lib/stan_math/lib/eigen_3.3.9 -I stan/lib/stan_math/lib/boost_1.75.0 -I
stan/lib/stan_math/lib/sundials_6.0.0/include -I
stan/lib/stan_math/lib/sundials_6.0.0/src/sundials  -D_USE_MATH_DEFINES
-DBOOST_DISABLE_ASSERTS          -c  -x c++ -o
```

```
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_1.o
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_1.hpp
g++ -std=c++1y -m64 -D_REENTRANT -Wall -Wno-unused-function -Wno-uninitialized
-Wno-unused-but-set-variable -Wno-unused-variable -Wno-sign-compare -Wno-unused-
local-typedefs -Wno-int-in-bool-context -Wno-attributes -Wno-ignored-attributes
-I stan/lib/stan_math/lib/tbb_2020.3/include    -O3 -I src -I stan/src -I
lib/rapidjson_1.1.0/ -I lib/CLI11-1.9.1/ -I stan/lib/stan_math/ -I
stan/lib/stan_math/lib/eigen_3.3.9 -I stan/lib/stan_math/lib/boost_1.75.0 -I
stan/lib/stan_math/lib/sundials_6.0.0/include -I
stan/lib/stan_math/lib/sundials_6.0.0/src/sundials  -D_USE_MATH_DEFINES
-DBOOST_DISABLE_ASSERTS                -Wl,-
L,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/lib/t
bb" -Wl,-
rpath,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/l
ib/tbb"      C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_1.o src/cmdstan/main.o
-static-libgcc -static-libstdc++      -Wl,-
L,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/lib/t
bb" -Wl,-
rpath,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/l
ib/tbb"   stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_nvecserial.a
stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_cvodes.a
stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_idas.a
stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_kinsol.a
stan/lib/stan_math/lib/tbb/tbb.dll -o
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_1.exe
rm -f C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_1.o
```

[ ]:
```
samples = gen_quant.sample(data={'M':10},
                           fixed_param=True,
                           iter_sampling=1000,
                           iter_warmup=0,
                           chains = 1)
```

```
INFO:cmdstanpy:CmdStan start processing
chain 1 |      | 00:00 Sampling completed



INFO:cmdstanpy:CmdStan done processing.
```

[ ]:
```
df = samples.draws_pd()
df
```

[ ]:
```
     lp__  accept_stat__     lambda  y_sim[1]  y_sim[2]  y_sim[3]  y_sim[4]  \
0     0.0            0.0   81.90380      78.0      81.0      79.0      70.0
```

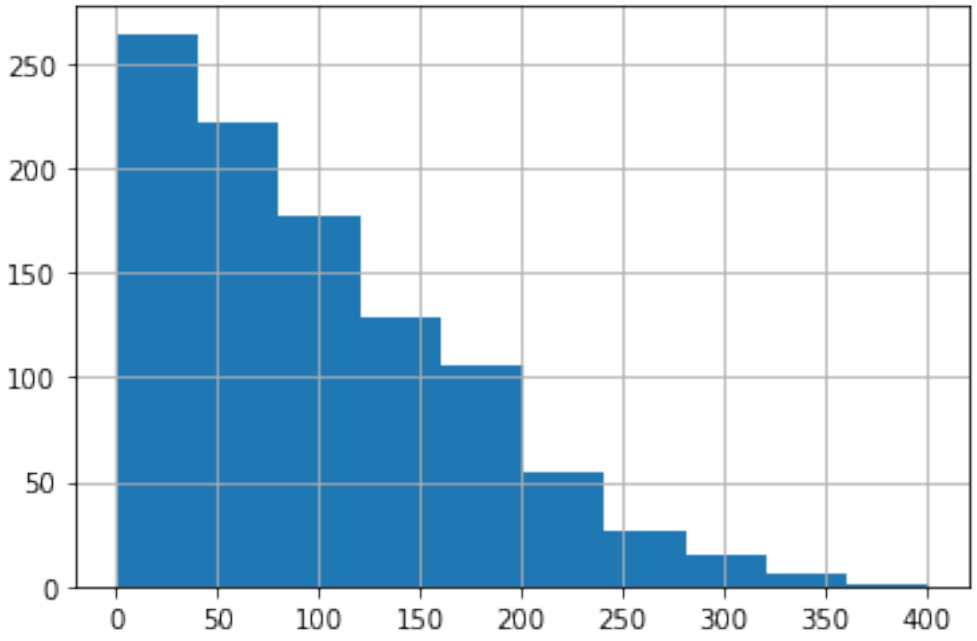
```
1     0.0            0.0  119.84200     125.0     135.0     152.0     121.0
2     0.0            0.0  113.41400     113.0     114.0     100.0     134.0
3     0.0            0.0    8.56135       9.0       4.0      13.0       7.0
4     0.0            0.0   68.15710      78.0      67.0      59.0      71.0
..    …              …        …       …        …         …         …
995   0.0            0.0   76.48220      80.0      62.0      94.0      76.0
996   0.0            0.0  122.62300     110.0     136.0     129.0     103.0
997   0.0            0.0    9.21561      12.0       6.0      12.0       6.0
998   0.0            0.0  251.08300     240.0     244.0     260.0     249.0
999   0.0            0.0  142.06900     145.0     138.0     151.0     136.0

     y_sim[5]  y_sim[6]  y_sim[7]  y_sim[8]  y_sim[9]  y_sim[10]
0        78.0      84.0      87.0      87.0      62.0       78.0
1       136.0     119.0     113.0     123.0     117.0      117.0
2        98.0     114.0     125.0     107.0     128.0      110.0
3         9.0      13.0       3.0       6.0       2.0       14.0
4        72.0      76.0      70.0      74.0      77.0       76.0
..        …         …         …         …         …
995      69.0      89.0      78.0      87.0      78.0       74.0
996     106.0     130.0     121.0     140.0     132.0      114.0
997       9.0      10.0      12.0       8.0      11.0       12.0
998     229.0     240.0     250.0     246.0     269.0      240.0
999     122.0     135.0     124.0     172.0     129.0      135.0

[1000 rows x 13 columns]
```

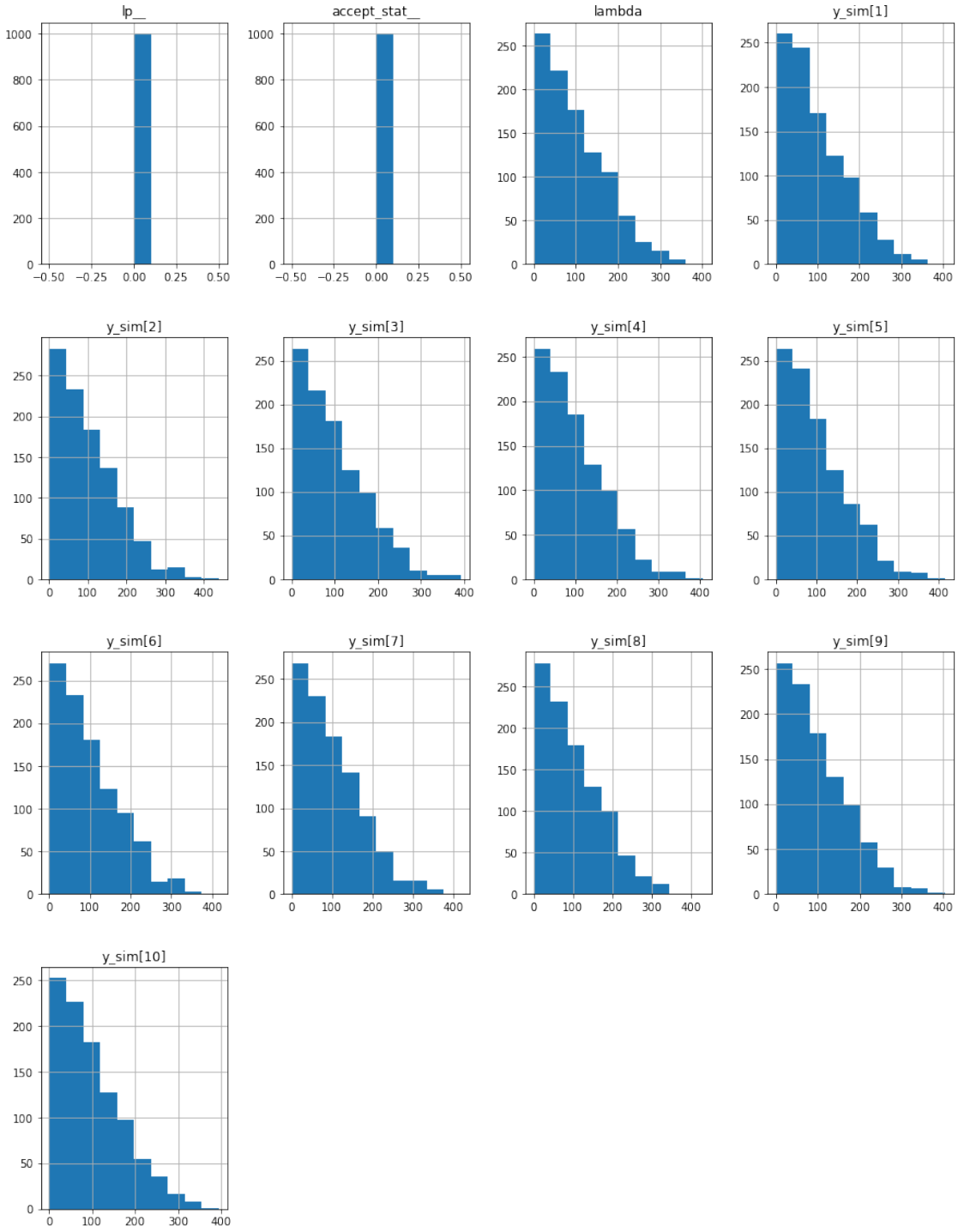
[ ]:
```
df["lambda"].hist()
```

[ ]:
```
<AxesSubplot:>
```



[ ]:
```
fig = plt.figure(figsize = (15,20))
ax = fig.gca()
df.hist(ax=ax)
plt.show()
```

```
C:\Users\norbe\AppData\Local\Temp\ipykernel_15056\371514143.py:3: UserWarning:
To output multiple subplots, the figure containing the passed axes is being
cleared.
  df.hist(ax=ax)
```


lp__
accept_stat__
lambda
y_sim[1]
y_sim[2]
y_sim[3]
y_sim[4]
y_sim[5]
y_sim[6]
y_sim[7]
y_sim[8]
y_sim[9]
y_sim[10]

0.2 Excercise 2 - Constraints on the data

[ ]:
```
bern1 = CmdStanModel(stan_file='code_2.stan')
samp_bern1 = bern1.sample(data={'N':2, 'y':[0,2]})
```

```
INFO:cmdstanpy:found newer exe file, not recompiling
INFO:cmdstanpy:CmdStan start processing
chain 1 |          | 00:00 Status


ERROR:cmdstanpy:Chain [1] error: error during processing Operation not
permitted
ERROR:cmdstanpy:Chain [3] error: error during processing Operation not permitted
ERROR:cmdstanpy:Chain [4] error: error during processing Operation not permitted
ERROR:cmdstanpy:Chain [2] error: error during processing Operation not permitted
chain 1 |      | 00:00 Sampling completed
chain 2 |      | 00:00 Sampling completed
chain 3 |      | 00:00 Sampling completed
chain 4 |      | 00:00 Sampling completed



INFO:cmdstanpy:CmdStan done processing.
```

```
---------------------------------------------------------------------------
RuntimeError                              Traceback (most recent call last)
c:\Users\norbe\Desktop\DataAnalytics\Lab 2\lab_2.ipynb Cell 9' in <cell line:␣
 ↪2>()
      <a href='vscode-notebook-cell:/c%3A/Users/norbe/Desktop/DataAnalytics/
 ↪Lab%202/lab_2.ipynb#ch0000004?line=0'>1</a> bern1 =␣
 ↪CmdStanModel(stan_file='code_2.stan')
----> <a href='vscode-notebook-cell:/c%3A/Users/norbe/Desktop/DataAnalytics/
 ↪Lab%202/lab_2.ipynb#ch0000004?line=1'>2</a> samp_bern1 = bern1.
 ↪sample(data={'N':2, 'y':[0,2]})

File ~\.conda\envs\myenv\lib\site-packages\cmdstanpy\model.py:1089, in␣
 ↪CmdStanModel.sample(self, data, chains, parallel_chains, threads_per_chain,␣
 ↪seed, chain_ids, inits, iter_warmup, iter_sampling, save_warmup, thin,␣
 ↪max_treedepth, metric, step_size, adapt_engaged, adapt_delta,␣
 ↪adapt_init_phase, adapt_metric_window, adapt_step_size, fixed_param,␣
 ↪output_dir, sig_figs, save_latent_dynamics, save_profile, show_progress,␣
 ↪show_console, refresh, time_fmt, force_one_process_per_chain)
   <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
 ↪cmdstanpy/model.py?line=1084'>1085</a>         msg = 'Error during sampling:
 ↪\n{}'.format(runset.get_err_msgs())
   <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
 ↪cmdstanpy/model.py?line=1085'>1086</a>         msg = '{}Command and output␣
 ↪files:\n{}'.format(
```

```
   <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
 ↪cmdstanpy/model.py?line=1086'>1087</a>             msg, runset.__repr__()
   <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
 ↪cmdstanpy/model.py?line=1087'>1088</a>         )
-> <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
 ↪cmdstanpy/model.py?line=1088'>1089</a>         raise RuntimeError(msg)
   <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
 ↪cmdstanpy/model.py?line=1090'>1091</a>     mcmc = CmdStanMCMC(runset)
   <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
 ↪cmdstanpy/model.py?line=1091'>1092</a> return mcmc

RuntimeError: Error during sampling:
Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1] (in 'C /
 ↪Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to column␣
 ↪24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
 ↪column 24)
```

```
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
```

```
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
```

```
    Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
↪column 24)
    Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
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        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
  ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
  ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
  ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t␣
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Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1] (in 'C /
  ↪Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to column␣
  ↪24)
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↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
↪column 24)
```

```
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 t
↪column 24)
```

```
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
       Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]
↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to
↪column 24)
```

```
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)
        Exception: bernoulli_lpmf: n[2] is 2, but must be in the interval [0, 1]␣
 ↪(in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_2.stan', line 10, column 3 to␣
 ↪column 24)Command and output files:
RunSet: chains=4, chain_ids=[1, 2, 3, 4], num_processes=4
 cmd (chain 1):
        ['C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab 2\\code_2.exe', 'id=1',␣
 ↪'random', 'seed=23402', 'data', 'file=C:
 ↪\\Users\\norbe\\AppData\\Local\\Temp\\tmpi7pxcsdr\\slex2ibw.json', 'output',␣
 ↪'file=C:
 ↪\\Users\\norbe\\AppData\\Local\\Temp\\tmpi7pxcsdr\\code_2-20220309114857_1.
 ↪csv', 'method=sample', 'algorithm=hmc', 'adapt', 'engaged=1']
 retcodes=[1, 1, 1, 1]
 per-chain output files (showing chain 1 only):
 csv_file:
        C:\Users\norbe\AppData\Local\Temp\tmpi7pxcsdr\code_2-20220309114857_1.csv
 console_msgs (if any):
```

```
        C:
↪\Users\norbe\AppData\Local\Temp\tmpi7pxcsdr\code_2-20220309114857_0-stdout.tx
```

[ ]:
```
bern2 = CmdStanModel(stan_file='code_3.stan')
samp_bern2 = bern2.sample(data={'N':2, 'y':[0,2]})
```

```
INFO:cmdstanpy:found newer exe file, not recompiling
INFO:cmdstanpy:CmdStan start processing
chain 1 |          | 00:00 Status


ERROR:cmdstanpy:Chain [2] error: error during processing Operation not
permitted
ERROR:cmdstanpy:Chain [1] error: error during processing Operation not permitted
ERROR:cmdstanpy:Chain [3] error: error during processing Operation not permitted
ERROR:cmdstanpy:Chain [4] error: error during processing Operation not permitted
chain 1 |      | 00:00 Sampling completed
chain 2 |      | 00:00 Sampling completed
chain 3 |      | 00:00 Sampling completed
chain 4 |      | 00:00 Sampling completed



INFO:cmdstanpy:CmdStan done processing.
```

```
---------------------------------------------------------------------------
RuntimeError                              Traceback (most recent call last)
c:\Users\norbe\Desktop\DataAnalytics\Lab 2\lab_2.ipynb Cell 10' in <cell line:␣
↪2>()
     <a href='vscode-notebook-cell:/c%3A/Users/norbe/Desktop/DataAnalytics/
↪Lab%202/lab_2.ipynb#ch0000006?line=0'>1</a> bern2 =␣
↪CmdStanModel(stan_file='code_3.stan')
----> <a href='vscode-notebook-cell:/c%3A/Users/norbe/Desktop/DataAnalytics/
↪Lab%202/lab_2.ipynb#ch0000006?line=1'>2</a> samp_bern2 = bern2.
↪sample(data={'N':2, 'y':[0,2]})

File ~\.conda\envs\myenv\lib\site-packages\cmdstanpy\model.py:1089, in␣
↪CmdStanModel.sample(self, data, chains, parallel_chains, threads_per_chain,␣
↪seed, chain_ids, inits, iter_warmup, iter_sampling, save_warmup, thin,␣
↪max_treedepth, metric, step_size, adapt_engaged, adapt_delta,␣
↪adapt_init_phase, adapt_metric_window, adapt_step_size, fixed_param,␣
↪output_dir, sig_figs, save_latent_dynamics, save_profile, show_progress,␣
↪show_console, refresh, time_fmt, force_one_process_per_chain)
  <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
↪cmdstanpy/model.py?line=1084'>1085</a>         msg = 'Error during sampling:
↪\n{}'.format(runset.get_err_msgs())
```

```
  <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
↪cmdstanpy/model.py?line=1085'>1086</a>         msg = '{}Command and output␣
↪files:\n{}'.format(
  <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
↪cmdstanpy/model.py?line=1086'>1087</a>             msg, runset.__repr__()
  <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
↪cmdstanpy/model.py?line=1087'>1088</a>         )
-> <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
↪cmdstanpy/model.py?line=1088'>1089</a>         raise RuntimeError(msg)
  <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
↪cmdstanpy/model.py?line=1090'>1091</a>     mcmc = CmdStanMCMC(runset)
  <a href='file:///c%3A/Users/norbe/.conda/envs/myenv/lib/site-packages/
↪cmdstanpy/model.py?line=1091'>1092</a> return mcmc

RuntimeError: Error during sampling:
Exception: code_3_model_namespace::code_3_model: y[2] is 2, but must be less␣
↪than or equal to 1.000000 (in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_3.
↪stan', line 3, column 4 to column 30)
Exception: code_3_model_namespace::code_3_model: y[2] is 2, but must be less␣
↪than or equal to 1.000000 (in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_3.
↪stan', line 3, column 4 to column 30)
Exception: code_3_model_namespace::code_3_model: y[2] is 2, but must be less␣
↪than or equal to 1.000000 (in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_3.
↪stan', line 3, column 4 to column 30)
Exception: code_3_model_namespace::code_3_model: y[2] is 2, but must be less␣
↪than or equal to 1.000000 (in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_3.
↪stan', line 3, column 4 to column 30)Command and output files:
RunSet: chains=4, chain_ids=[1, 2, 3, 4], num_processes=4
 cmd (chain 1):
        ['C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab 2\\code_3.exe', 'id=1',
↪'random', 'seed=92865', 'data', 'file=C:
↪\\Users\\norbe\\AppData\\Local\\Temp\\tmpi7pxcsdr\\qvzx88ws.json', 'output',␣
↪'file=C:
↪\\Users\\norbe\\AppData\\Local\\Temp\\tmpi7pxcsdr\\code_3-20220309114909_1.
↪csv', 'method=sample', 'algorithm=hmc', 'adapt', 'engaged=1']
 retcodes=[1, 1, 1, 1]
 per-chain output files (showing chain 1 only):
 csv_file:
        C:\Users\norbe\AppData\Local\Temp\tmpi7pxcsdr\code_3-20220309114909_1.csv
 console_msgs (if any):
        C:
↪\Users\norbe\AppData\Local\Temp\tmpi7pxcsdr\code_3-20220309114909_0-stdout.tx
```

0.3 Excercise 3 - Constraints on parameters

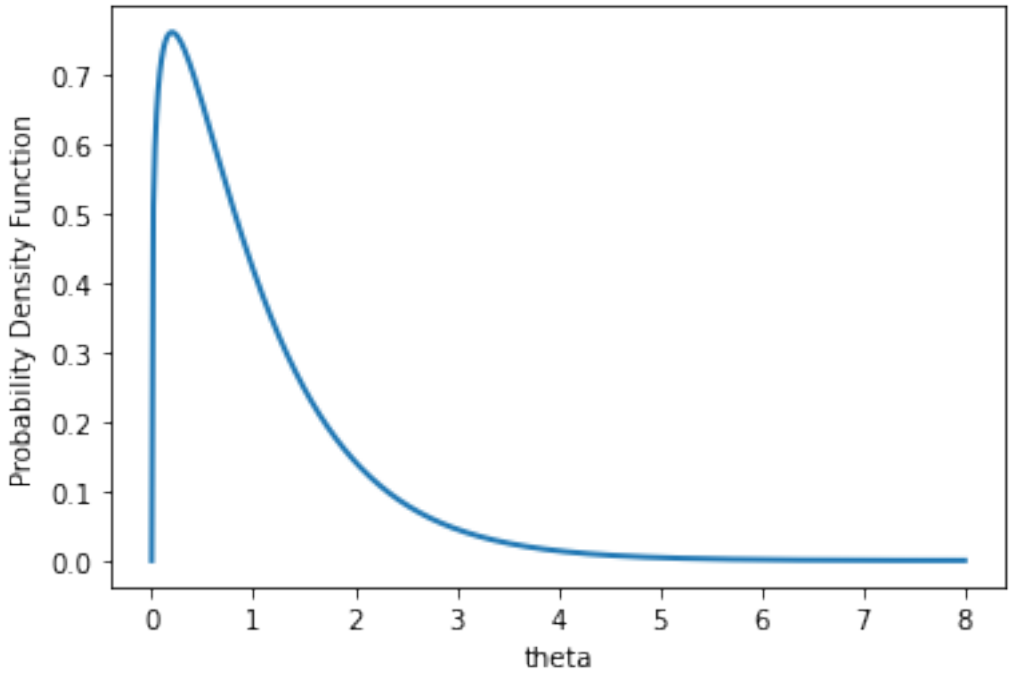
0.3.1 Unconstrained parameters

[ ]:
```
model_gm1 = CmdStanModel(stan_file='code_4.stan')
out_gamma1 = model_gm1.
  ↪sample(output_dir='samples',iter_sampling=6000,iter_warmup=1000,␣
  ↪seed=4838282)
out_gamma1.diagnose()
```

```
INFO:cmdstanpy:compiling stan file C:\Users\norbe\Desktop\DataAnalytics\Lab
2\code_4.stan to exe file C:\Users\norbe\Desktop\DataAnalytics\Lab 2\code_4.exe
INFO:cmdstanpy:compiled model executable:
C:\Users\norbe\Desktop\DataAnalytics\Lab 2\code_4.exe
INFO:cmdstanpy:created output directory:
C:\Users\norbe\Desktop\DataAnalytics\Lab 2\samples
INFO:cmdstanpy:CmdStan start processing
chain 1 |          | 00:00 Status


chain 1 |          | 00:00 Status


chain 1 |         | 00:00 Iteration: 1100 / 7000 [ 15%]  (Sampling)


chain 1 |        | 00:00 Iteration: 2100 / 7000 [ 30%]  (Sampling)


chain 1 |        | 00:00 Iteration: 3300 / 7000 [ 47%]  (Sampling)


chain 1 |       | 00:00 Iteration: 4700 / 7000 [ 67%]  (Sampling)
chain 1 |      | 00:00 Iteration: 5900 / 7000 [ 84%]  (Sampling)
chain 1 |     | 00:00 Sampling completed
chain 2 |     | 00:00 Sampling completed
chain 3 |     | 00:00 Sampling completed


chain 4 |     | 00:00 Sampling completed




INFO:cmdstanpy:CmdStan done processing.
```

[ ]:
```
"Processing csv files: C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab
2\\samples\\code_4-20220309114252_1.csv,
C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab
2\\samples\\code_4-20220309114252_2.csv,
C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab
2\\samples\\code_4-20220309114252_3.csv,
C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab
2\\samples\\code_4-20220309114252_4.csv\n\nChecking sampler transitions
treedepth.\nTreedepth satisfactory for all transitions.\n\nChecking sampler
transitions for divergences.\n8638 of 24000 (35.99%) transitions ended with a
divergence.\nThese divergent transitions indicate that HMC is not fully able to
explore the posterior distribution.\nTry increasing adapt delta closer to 1.\nIf
this doesn't remove all divergences, try to reparameterize the
model.\n\nChecking E-BFMI - sampler transitions HMC potential energy.\nE-BFMI
satisfactory.\n\nEffective sample size satisfactory.\n\nSplit R-hat values
satisfactory all parameters.\n\nProcessing complete.\n"
```

[ ]:
```
N=500
xs = np.linspace(0,8,N)
pdfs = stats.gamma.pdf(xs, 1.25, scale = 1 / 1.25)

plt.plot(xs, pdfs, linewidth=2)

## add histogram of theta samples with 160 bins

plt.gca().set_xlabel("theta")
plt.gca().set_ylabel("Probability Density Function")
plt.show()
```



0.3.2 Constrained parameter

```
[ ]: model_gm2 = CmdStanModel(stan_file='code_5.stan')
     out_gamma2 = model_gm2.
       ↪sample(output_dir='samples',iter_sampling=6000,iter_warmup=1000,␣
       ↪seed=4838282)
     out_gamma2.diagnose()
```

```
INFO:cmdstanpy:compiling stan file C:\Users\norbe\Desktop\DataAnalytics\Lab
2\code_5.stan to exe file C:\Users\norbe\Desktop\DataAnalytics\Lab 2\code_5.exe
INFO:cmdstanpy:compiled model executable:
C:\Users\norbe\Desktop\DataAnalytics\Lab 2\code_5.exe
INFO:cmdstanpy:CmdStan start processing
chain 1 |          | 00:00 Status
```

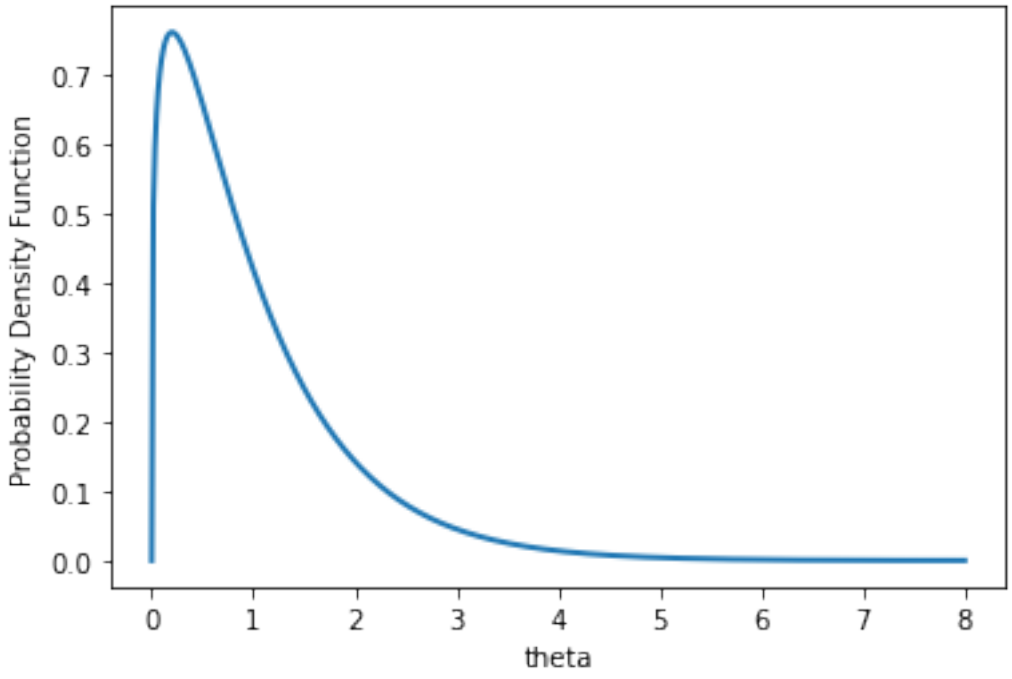
```
chain 1 |          | 00:00 Status
```

```
chain 1 |        | 00:00 Iteration: 2200 / 7000 [ 31%]  (Sampling)
```

```
chain 1 |       | 00:00 Iteration: 3700 / 7000 [ 52%]  (Sampling)


chain 1 |       | 00:00 Iteration: 5200 / 7000 [ 74%]  (Sampling)

chain 1 |      | 00:00 Sampling completed
chain 2 |      | 00:00 Sampling completed

chain 3 |      | 00:00 Sampling completed
chain 4 |      | 00:00 Sampling completed



INFO:cmdstanpy:CmdStan done processing.
```

[ ]:
```
"Processing csv files: C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab
2\\samples\\code_5-20220309114457_1.csv,
C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab
2\\samples\\code_5-20220309114457_2.csv,
C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab
2\\samples\\code_5-20220309114457_3.csv,
C:\\Users\\norbe\\Desktop\\DataAnalytics\\Lab
2\\samples\\code_5-20220309114457_4.csv\n\nChecking sampler transitions
treedepth.\nTreedepth satisfactory for all transitions.\n\nChecking sampler
transitions for divergences.\n1 of 24000 (0.00%) transitions ended with a
divergence.\nThese divergent transitions indicate that HMC is not fully able to
explore the posterior distribution.\nTry increasing adapt delta closer to 1.\nIf
this doesn't remove all divergences, try to reparameterize the
model.\n\nChecking E-BFMI - sampler transitions HMC potential energy.\nE-BFMI
satisfactory.\n\nEffective sample size satisfactory.\n\nSplit R-hat values
satisfactory all parameters.\n\nProcessing complete.\n"
```

[ ]:
```
N=500
xs = np.linspace(0,8,N)
pdfs = stats.gamma.pdf(xs, 1.25, scale = 1 / 1.25)

plt.plot(xs, pdfs, linewidth=2)

## add histogram of theta samples from the second model with 160 bins

plt.gca().set_xlabel("theta")
plt.gca().set_ylabel("Probability Density Function")
plt.show()
```



0.4 Excercise 4 - Selection of parameters using equation solving

[ ]:
```
model_tune = CmdStanModel(stan_file='code_6.stan')

F = 7 # number of letters in the first name
L = 3 # number of letters in the last name
y0 = 1 # initial guess for the equation solving

data={'y_guess':[y0],
        'theta':[(F+L)/2]}
tunes = model_tune.sample(data=data, fixed_param=True, iter_sampling=1,␣
 ↪iter_warmup=0, chains = 1)
```

```
INFO:cmdstanpy:compiling stan file C:\Users\norbe\Desktop\DataAnalytics\Lab
2\code_6.stan to exe file C:\Users\norbe\Desktop\DataAnalytics\Lab 2\code_6.exe
INFO:cmdstanpy:compiled model executable:
C:\Users\norbe\Desktop\DataAnalytics\Lab 2\code_6.exe
WARNING:cmdstanpy:Stan compiler has produced 5 warnings:
WARNING:cmdstanpy:
--- Translating Stan model to C++ code ---
bin/stanc.exe  --o=C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.hpp
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.stan
Warning in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.stan', line 2, column
45: Declaration
    of arrays by placing brackets after a type is deprecated and will be
```

```
    removed in Stan 2.32.0. Instead use the array keyword before the type.
    This can be changed automatically using the auto-format flag to stanc
Warning in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.stan', line 2, column
57: Declaration
    of arrays by placing brackets after a type is deprecated and will be
    removed in Stan 2.32.0. Instead use the array keyword before the type.
    This can be changed automatically using the auto-format flag to stanc
Warning in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.stan', line 14, column
3: Declaration
    of arrays by placing brackets after a variable name is deprecated and
    will be removed in Stan 2.32.0. Instead use the array keyword before the
    type. This can be changed automatically using the auto-format flag to
    stanc
Warning in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.stan', line 15, column
3: Declaration
    of arrays by placing brackets after a variable name is deprecated and
    will be removed in Stan 2.32.0. Instead use the array keyword before the
    type. This can be changed automatically using the auto-format flag to
    stanc
Warning in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.stan', line 4, column
24: Use
    of normal_cdf without a vertical bar (|) between the first two arguments
    of a CDF is deprecated and will be removed in Stan 2.32.0. This can be
    automatically changed using the canonicalize flag for stanc

--- Compiling, linking C++ code ---
g++ -std=c++1y -m64 -D_REENTRANT -Wall -Wno-unused-function -Wno-uninitialized
-Wno-unused-but-set-variable -Wno-unused-variable -Wno-sign-compare -Wno-unused-
local-typedefs -Wno-int-in-bool-context -Wno-attributes -Wno-ignored-attributes
-I stan/lib/stan_math/lib/tbb_2020.3/include    -O3 -I src -I stan/src -I
lib/rapidjson_1.1.0/ -I lib/CLI11-1.9.1/ -I stan/lib/stan_math/ -I
stan/lib/stan_math/lib/eigen_3.3.9 -I stan/lib/stan_math/lib/boost_1.75.0 -I
stan/lib/stan_math/lib/sundials_6.0.0/include -I
stan/lib/stan_math/lib/sundials_6.0.0/src/sundials  -D_USE_MATH_DEFINES
-DBOOST_DISABLE_ASSERTS          -c  -x c++ -o
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.o
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.hpp
g++ -std=c++1y -m64 -D_REENTRANT -Wall -Wno-unused-function -Wno-uninitialized
-Wno-unused-but-set-variable -Wno-unused-variable -Wno-sign-compare -Wno-unused-
local-typedefs -Wno-int-in-bool-context -Wno-attributes -Wno-ignored-attributes
-I stan/lib/stan_math/lib/tbb_2020.3/include    -O3 -I src -I stan/src -I
lib/rapidjson_1.1.0/ -I lib/CLI11-1.9.1/ -I stan/lib/stan_math/ -I
stan/lib/stan_math/lib/eigen_3.3.9 -I stan/lib/stan_math/lib/boost_1.75.0 -I
stan/lib/stan_math/lib/sundials_6.0.0/include -I
stan/lib/stan_math/lib/sundials_6.0.0/src/sundials  -D_USE_MATH_DEFINES
-DBOOST_DISABLE_ASSERTS                -Wl,-
L,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/lib/t
bb" -Wl,-
```

```
rpath,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/l
ib/tbb"      C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.o src/cmdstan/main.o
-static-libgcc -static-libstdc++      -Wl,-
L,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/lib/t
bb" -Wl,-
rpath,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/l
ib/tbb"   stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_nvecserial.a
stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_cvodes.a
stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_idas.a
stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_kinsol.a
stan/lib/stan_math/lib/tbb/tbb.dll -o
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.exe
rm -f C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_6.o

INFO:cmdstanpy:CmdStan start processing
chain 1 |      | 00:00 Sampling completed



INFO:cmdstanpy:CmdStan done processing.
```

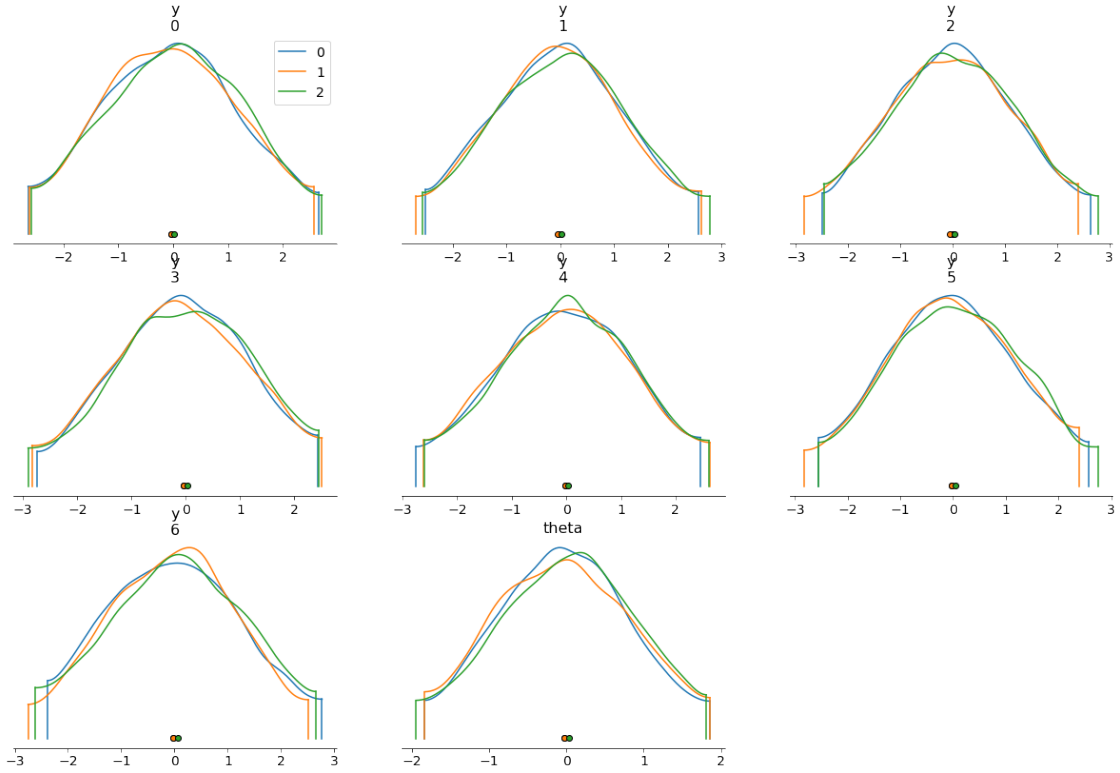
0.5 Excercise 5 - different methods of defining models

[ ]:
```
model_samp_st = CmdStanModel(stan_file='code_7.stan')
model_log_target = CmdStanModel(stan_file='code_8.stan')
model_log_target_ind = CmdStanModel(stan_file='code_9.stan')
data = {'N': F}
seed = 11111999 #integer, your date of birth in the DDMMYYYY format without␣
 ↪leading zero (or if you are GPRD weary, use any other date you wish)
result_1 = model_samp_st.sample(data=data,seed=seed)
result_2 = model_log_target.sample(data=data,seed=seed)
result_3 = model_log_target_ind.sample(data=data,seed=seed)
```

```
INFO:cmdstanpy:found newer exe file, not recompiling
INFO:cmdstanpy:found newer exe file, not recompiling
INFO:cmdstanpy:found newer exe file, not recompiling
INFO:cmdstanpy:CmdStan start processing
chain 1 |          | 00:00 Status


chain 1 |        | 00:00 Iteration:  700 / 2000 [ 35%]  (Warmup)



chain 1 |      | 00:00 Iteration: 1700 / 2000 [ 85%]  (Sampling)
```

```
chain 1 |      | 00:00 Sampling completed
chain 2 |      | 00:00 Sampling completed
chain 3 |      | 00:00 Sampling completed
chain 4 |      | 00:00 Sampling completed



INFO:cmdstanpy:CmdStan done processing.


INFO:cmdstanpy:CmdStan start processing
chain 1 |          | 00:00 Status


chain 1 |         | 00:00 Iteration:  300 / 2000 [ 15%]  (Warmup)


chain 1 |       | 00:00 Iteration: 1400 / 2000 [ 70%]  (Sampling)


chain 1 |      | 00:00 Sampling completed
chain 2 |      | 00:00 Sampling completed
chain 3 |      | 00:00 Sampling completed
chain 4 |      | 00:00 Sampling completed


INFO:cmdstanpy:CmdStan done processing.


INFO:cmdstanpy:CmdStan start processing
chain 1 |          | 00:00 Status


chain 1 |         | 00:00 Iteration:  400 / 2000 [ 20%]  (Warmup)


chain 1 |       | 00:00 Iteration: 1500 / 2000 [ 75%]  (Sampling)


chain 1 |      | 00:00 Sampling completed
chain 2 |      | 00:00 Sampling completed
chain 3 |      | 00:00 Sampling completed
chain 4 |      | 00:00 Sampling completed



INFO:cmdstanpy:CmdStan done processing.
```

[ ]:
```
az.plot_density([result_1,result_2,result_3])
plt.show()
```



0.6 Excercise 6 - generated quantities post sampling

[ ]:
```
model_gq = CmdStanModel(stan_file='code_10.stan')
# fill in with chosen result from previous excercise
mean_of_y = model_gq.generate_quantities(data=data,
                                         mcmc_sample = result_3)
# investigate the output and plot histogram of mean_y variable
```

```
INFO:cmdstanpy:compiling stan file C:\Users\norbe\Desktop\DataAnalytics\Lab
2\code_10.stan to exe file C:\Users\norbe\Desktop\DataAnalytics\Lab
2\code_10.exe
INFO:cmdstanpy:compiled model executable:
C:\Users\norbe\Desktop\DataAnalytics\Lab 2\code_10.exe
WARNING:cmdstanpy:Stan compiler has produced 1 warnings:
WARNING:cmdstanpy:
--- Translating Stan model to C++ code ---
bin/stanc.exe  --o=C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_10.hpp
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_10.stan
```

```
Warning in 'C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_10.stan', line 5, column
4: Declaration
    of arrays by placing brackets after a variable name is deprecated and
    will be removed in Stan 2.32.0. Instead use the array keyword before the
    type. This can be changed automatically using the auto-format flag to
    stanc

--- Compiling, linking C++ code ---
g++ -std=c++1y -m64 -D_REENTRANT -Wall -Wno-unused-function -Wno-uninitialized
-Wno-unused-but-set-variable -Wno-unused-variable -Wno-sign-compare -Wno-unused-
local-typedefs -Wno-int-in-bool-context -Wno-attributes -Wno-ignored-attributes
-I stan/lib/stan_math/lib/tbb_2020.3/include    -O3 -I src -I stan/src -I
lib/rapidjson_1.1.0/ -I lib/CLI11-1.9.1/ -I stan/lib/stan_math/ -I
stan/lib/stan_math/lib/eigen_3.3.9 -I stan/lib/stan_math/lib/boost_1.75.0 -I
stan/lib/stan_math/lib/sundials_6.0.0/include -I
stan/lib/stan_math/lib/sundials_6.0.0/src/sundials  -D_USE_MATH_DEFINES
-DBOOST_DISABLE_ASSERTS          -c  -x c++ -o
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_10.o
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_10.hpp
g++ -std=c++1y -m64 -D_REENTRANT -Wall -Wno-unused-function -Wno-uninitialized
-Wno-unused-but-set-variable -Wno-unused-variable -Wno-sign-compare -Wno-unused-
local-typedefs -Wno-int-in-bool-context -Wno-attributes -Wno-ignored-attributes
-I stan/lib/stan_math/lib/tbb_2020.3/include    -O3 -I src -I stan/src -I
lib/rapidjson_1.1.0/ -I lib/CLI11-1.9.1/ -I stan/lib/stan_math/ -I
stan/lib/stan_math/lib/eigen_3.3.9 -I stan/lib/stan_math/lib/boost_1.75.0 -I
stan/lib/stan_math/lib/sundials_6.0.0/include -I
stan/lib/stan_math/lib/sundials_6.0.0/src/sundials  -D_USE_MATH_DEFINES
-DBOOST_DISABLE_ASSERTS                -Wl,-
L,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/lib/t
bb" -Wl,-
rpath,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/l
ib/tbb"      C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_10.o src/cmdstan/main.o
-static-libgcc -static-libstdc++      -Wl,-
L,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/lib/t
bb" -Wl,-
rpath,"C:/Users/norbe/.conda/envs/myenv/Library/bin/cmdstan/stan/lib/stan_math/l
ib/tbb"   stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_nvecserial.a
stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_cvodes.a
stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_idas.a
stan/lib/stan_math/lib/sundials_6.0.0/lib/libsundials_kinsol.a
stan/lib/stan_math/lib/tbb/tbb.dll -o
C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_10.exe
rm -f C:/Users/norbe/Desktop/DATAAN~1/LAB2~1/code_10.o

INFO:cmdstanpy:Chain [1] start processing
INFO:cmdstanpy:Chain [2] start processing
INFO:cmdstanpy:Chain [3] start processing
INFO:cmdstanpy:Chain [4] start processing
```

```
INFO:cmdstanpy:Chain [2] done processing
INFO:cmdstanpy:Chain [1] done processing
INFO:cmdstanpy:Chain [3] done processing
INFO:cmdstanpy:Chain [4] done processing
```

[ ]:
```
df = mean_of_y.draws_pd()
```

[ ]:
```
df.hist()
plt.show()
```