Homework10

April 12, 2023

1 Homework 10

[1]:
```
\l ../columbiaHdb/
```

[2]:
```
\c 50 200
```

[3]:
```
dt: 2019.01.03
```

1.1 Exercise 1 Simulating an AB-Test

1.1.1 1. For each correlation, create a synthetic alpha.

[4]:
```
u12: {[n] -6f+sum n cut (12*n)?1f}
```

Write a function to create synthetic alpha and I use the method in the last homework here.

[5]:
```
synalpha: {[tbl]

    tbl: update lambda: 8 * (vol * sqrt 6 * 60 * 6.5) % adv,
                rtn: ((last mid) % mid) - 1,
                b: 0.3 * sqrt (1 - 0.3 * 0.3) by id from tbl;

    crossTbl: tbl cross ([]rho: 0, .05, .3; strat: 0, 1, 2);

    crossTbl: update W: vol * (sums(u12[count time])) by id, strat from␣
↪crossTbl;

    crossTbl: update a: rho * b % sqrt (1 - rho * rho) by id, strat from␣
↪crossTbl;

    crossTbl: update alpha: (a * (rtn - last rtn)) + (W - last W) * b by id,␣
↪strat from crossTbl;

    crossTbl}
```

Get the data on 2019.01.03.

[6]:
```
tbl: select from bin10 where date = dt
```

[7]:
```
tbl: update reverse fills reverse date,
                 reverse fills reverse mid,
                 reverse fills reverse spread,
                 reverse fills reverse vol,
                 reverse fills reverse adv
                 by id from tbl;
```

Check whether the function works.

[8]:
```
tbl1: synalpha[tbl]
```

[9]:
```
`date`time`id`mid`vol`adv`lambda`rtn`strat`rho`alpha#/:tbl1
```

[9]:
```
date       time     id mid      vol         adv          lambda       rtn
strat rho  alpha
-------------------------------------------------------------------------------
-------------------------
2019.01.03 09:30:00 0  91.715   0.000446367 1.122415e+08 1.538993e-09
-0.02958659 0     0    -0.002310466
2019.01.03 09:30:00 0  91.715   0.000446367 1.122415e+08 1.538993e-09
-0.02958659 1     0.05 0.007971313
2019.01.03 09:30:00 0  91.715   0.000446367 1.122415e+08 1.538993e-09
-0.02958659 2     0.3  -0.00303044
2019.01.03 09:30:10 0  91.72671 0.000446367 1.122415e+08 1.538993e-09
-0.02971043 0     0    -0.002296605
2019.01.03 09:30:10 0  91.72671 0.000446367 1.122415e+08 1.538993e-09
-0.02971043 1     0.05 0.008013164
2019.01.03 09:30:10 0  91.72671 0.000446367 1.122415e+08 1.538993e-09
-0.02971043 2     0.3  -0.003224674
2019.01.03 09:30:20 0  91.58853 0.000446367 1.122415e+08 1.538993e-09
-0.02824664 0     0    -0.002552029
2019.01.03 09:30:20 0  91.58853 0.000446367 1.122415e+08 1.538993e-09
-0.02824664 1     0.05 0.008143221
2019.01.03 09:30:20 0  91.58853 0.000446367 1.122415e+08 1.538993e-09
-0.02824664 2     0.3  -0.00312549
2019.01.03 09:30:30 0  91.65646 0.000446367 1.122415e+08 1.538993e-09
-0.02896681 0     0    -0.00235423
2019.01.03 09:30:30 0  91.65646 0.000446367 1.122415e+08 1.538993e-09
-0.02896681 1     0.05 0.007954908
2019.01.03 09:30:30 0  91.65646 0.000446367 1.122415e+08 1.538993e-09
-0.02896681 2     0.3  -0.003135533
2019.01.03 09:30:40 0  91.60259 0.000446367 1.122415e+08 1.538993e-09
-0.02839575 0     0    -0.002192224
2019.01.03 09:30:40 0  91.60259 0.000446367 1.122415e+08 1.538993e-09
-0.02839575 1     0.05 0.007881796
2019.01.03 09:30:40 0  91.60259 0.000446367 1.122415e+08 1.538993e-09
-0.02839575 2     0.3  -0.003123565
2019.01.03 09:30:50 0  91.58385 0.000446367 1.122415e+08 1.538993e-09
```

```
-0.02819692 0     0    -0.002035673
2019.01.03 09:30:50 0  91.58385 0.000446367 1.122415e+08 1.538993e-09
-0.02819692 1     0.05 0.007982854
2019.01.03 09:30:50 0  91.58385 0.000446367 1.122415e+08 1.538993e-09
-0.02819692 2     0.3  -0.003086863
2019.01.03 09:31:00 0  91.56276 0.000446367 1.122415e+08 1.538993e-09
-0.02797313 0     0    -0.002017081
2019.01.03 09:31:00 0  91.56276 0.000446367 1.122415e+08 1.538993e-09
-0.02797313 1     0.05 0.007832867
2019.01.03 09:31:00 0  91.56276 0.000446367 1.122415e+08 1.538993e-09
-0.02797313 2     0.3  -0.002958428
2019.01.03 09:31:10 0  91.59088 0.000446367 1.122415e+08 1.538993e-09
-0.02827149 0     0    -0.002076641
2019.01.03 09:31:10 0  91.59088 0.000446367 1.122415e+08 1.538993e-09
-0.02827149 1     0.05 0.007950151
2019.01.03 09:31:10 0  91.59088 0.000446367 1.122415e+08 1.538993e-09
-0.02827149 2     0.3  -0.002980728
2019.01.03 09:31:20 0  91.59322 0.000446367 1.122415e+08 1.538993e-09
-0.02829635 0     0    -0.002156335
2019.01.03 09:31:20 0  91.59322 0.000446367 1.122415e+08 1.538993e-09
-0.02829635 1     0.05 0.008020756
2019.01.03 09:31:20 0  91.59322 0.000446367 1.122415e+08 1.538993e-09
-0.02829635 2     0.3  -0.00301043
2019.01.03 09:31:30 0  91.60727 0.000446367 1.122415e+08 1.538993e-09
-0.02844544 0     0    -0.002119105
2019.01.03 09:31:30 0  91.60727 0.000446367 1.122415e+08 1.538993e-09
-0.02844544 1     0.05 0.007793857
2019.01.03 09:31:30 0  91.60727 0.000446367 1.122415e+08 1.538993e-09
-0.02844544 2     0.3  -0.003046778
2019.01.03 09:31:40 0  91.5487  0.000446367 1.122415e+08 1.538993e-09
-0.02782386 0     0    -0.002174843
2019.01.03 09:31:40 0  91.5487  0.000446367 1.122415e+08 1.538993e-09
-0.02782386 1     0.05 0.007819078
2019.01.03 09:31:40 0  91.5487  0.000446367 1.122415e+08 1.538993e-09
-0.02782386 2     0.3  -0.002946783
2019.01.03 09:31:50 0  91.56745 0.000446367 1.122415e+08 1.538993e-09
-0.02802287 0     0    -0.002289976
2019.01.03 09:31:50 0  91.56745 0.000446367 1.122415e+08 1.538993e-09
-0.02802287 1     0.05 0.007774184
2019.01.03 09:31:50 0  91.56745 0.000446367 1.122415e+08 1.538993e-09
-0.02802287 2     0.3  -0.003070472
2019.01.03 09:32:00 0  91.82033 0.000446367 1.122415e+08 1.538993e-09
-0.03069975 0     0    -0.002187449
2019.01.03 09:32:00 0  91.82033 0.000446367 1.122415e+08 1.538993e-09
-0.03069975 1     0.05 0.00771336
2019.01.03 09:32:00 0  91.82033 0.000446367 1.122415e+08 1.538993e-09
-0.03069975 2     0.3  -0.003303479
```

```
2019.01.03 09:32:10 0  91.84138 0.000446367 1.122415e+08 1.538993e-09 -0.030922
0     0    -0.002336914
2019.01.03 09:32:10 0  91.84138 0.000446367 1.122415e+08 1.538993e-09 -0.030922
1     0.05 0.007873737
2019.01.03 09:32:10 0  91.84138 0.000446367 1.122415e+08 1.538993e-09 -0.030922
2     0.3  -0.003167176
2019.01.03 09:32:20 0  92.02614 0.000446367 1.122415e+08 1.538993e-09
-0.03286751 0     0    -0.002268692
2019.01.03 09:32:20 0  92.02614 0.000446367 1.122415e+08 1.538993e-09
-0.03286751 1     0.05 0.007753655
2019.01.03 09:32:20 0  92.02614 0.000446367 1.122415e+08 1.538993e-09
-0.03286751 2     0.3  -0.003092887
..
```

1.1.2 2. For each synthetic alpha, backtest the optimal trading strategy.

We will use the impact model

$$dI_t = -\beta I_t dt + 8\frac{\sigma}{\text{adv}} dQ_t$$

with $\log(2)/\beta = 60$ minutes to get the optimal trading strategy and the impact.

[10]:
```
beta: (log 2) % 60
```

[11]:
```
createtrade:{[tbl]
    tbl: update dalpha: 0 ^ ((alpha - xprev[60; alpha]) % 10) by id, strat from␣
↪tbl;
    tbl: update I: (last alpha) ^ next prev 0.5 * (alpha - dalpha % beta) by␣
↪id, strat from tbl;
    tbl: update I_: 0 ^ xprev[1; I] * exp neg beta % 6 by id, strat from tbl;
    tbl: update deltaQ: (I - I_) % lambda by id, strat from tbl;
    tbl}
```

Check whether the function works.

[12]:
```
tbl2: createtrade[tbl1]
```

[13]:
```
`date`time`id`strat`rho`alpha`dalpha`I`I_`deltaQ#/:tbl2
```

[13]:
```
date       time     id strat rho  alpha        dalpha I            I_
deltaQ
-------------------------------------------------------------------------------
---------
2019.01.03 09:30:00 0  0     0    -0.002310466 0      -0.001155233 0
-750642.4
2019.01.03 09:30:00 0  1     0.05 0.007971313  0      0.003985656  0
2589783
2019.01.03 09:30:00 0  2     0.3  -0.00303044  0      -0.00151522  0
```

```
-984553.2
2019.01.03 09:30:10 0  0     0    -0.002296605 0      -0.001148302 -0.001153011
3059.528
2019.01.03 09:30:10 0  1     0.05 0.008013164  0      0.004006582  0.00397799
18578.62
2019.01.03 09:30:10 0  2     0.3  -0.003224674 0      -0.001612337 -0.001512305
-64998.09
2019.01.03 09:30:20 0  0     0    -0.002552029 0      -0.001276014 -0.001146094
-84419.41
2019.01.03 09:30:20 0  1     0.05 0.008143221  0      0.00407161   0.003998875
47261.62
2019.01.03 09:30:20 0  2     0.3  -0.00312549  0      -0.001562745 -0.001609236
30208.41
2019.01.03 09:30:30 0  0     0    -0.00235423  0      -0.001177115 -0.00127356
62667.7
2019.01.03 09:30:30 0  1     0.05 0.007954908  0      0.003977454  0.004063778
-56091.51
2019.01.03 09:30:30 0  2     0.3  -0.003135533 0      -0.001567767 -0.001559739
-5216.016
2019.01.03 09:30:40 0  0     0    -0.002192224 0      -0.001096112 -0.001174851
51162.55
2019.01.03 09:30:40 0  1     0.05 0.007881796  0      0.003940898  0.003969803
-18781.96
2019.01.03 09:30:40 0  2     0.3  -0.003123565 0      -0.001561782 -0.001564751
1928.767
2019.01.03 09:30:50 0  0     0    -0.002035673 0      -0.001017837 -0.001094003
49491.28
2019.01.03 09:30:50 0  1     0.05 0.007982854  0      0.003991427  0.003933317
37758.27
2019.01.03 09:30:50 0  2     0.3  -0.003086863 0      -0.001543431 -0.001558778
9972.122
2019.01.03 09:31:00 0  0     0    -0.002017081 0      -0.001008541 -0.001015879
4768.226
2019.01.03 09:31:00 0  1     0.05 0.007832867  0      0.003916433  0.003983749
-43740.21
2019.01.03 09:31:00 0  2     0.3  -0.002958428 0      -0.001479214 -0.001540462
39797.62
2019.01.03 09:31:10 0  0     0    -0.002076641 0      -0.00103832  -0.001006601
-20610.73
2019.01.03 09:31:10 0  1     0.05 0.007950151  0      0.003975076  0.0039089
42999.33
2019.01.03 09:31:10 0  2     0.3  -0.002980728 0      -0.001490364 -0.001476369
-9093.736
2019.01.03 09:31:20 0  0     0    -0.002156335 0      -0.001078168 -0.001036323
-27189.6
2019.01.03 09:31:20 0  1     0.05 0.008020756  0      0.004010378  0.003967429
27907.04
```

```
2019.01.03 09:31:20 0  2     0.3  -0.00301043  0      -0.001505215 -0.001487497
-11512.48
2019.01.03 09:31:30 0  0     0    -0.002119105 0      -0.001059552 -0.001076094
10748.22
2019.01.03 09:31:30 0  1     0.05 0.007793857  0      0.003896928  0.004002664
-68704.32
2019.01.03 09:31:30 0  2     0.3  -0.003046778 0      -0.001523389 -0.001502319
-13690.53
2019.01.03 09:31:40 0  0     0    -0.002174843 0      -0.001087422 -0.001057514
-19433.19
2019.01.03 09:31:40 0  1     0.05 0.007819078  0      0.003909539  0.003889432
13064.86
2019.01.03 09:31:40 0  2     0.3  -0.002946783 0      -0.001473392 -0.001520459
30583.08
2019.01.03 09:31:50 0  0     0    -0.002289976 0      -0.001144988 -0.00108533
-38764.41
2019.01.03 09:31:50 0  1     0.05 0.007774184  0      0.003887092  0.003902019
-9699.187
2019.01.03 09:31:50 0  2     0.3  -0.003070472 0      -0.001535236 -0.001470557
-42026.41
2019.01.03 09:32:00 0  0     0    -0.002187449 0      -0.001093725 -0.001142786
31878.71
2019.01.03 09:32:00 0  1     0.05 0.00771336   0      0.00385668   0.003879615
-14902.47
2019.01.03 09:32:00 0  2     0.3  -0.003303479 0      -0.00165174  -0.001532283
-77620.28
2019.01.03 09:32:10 0  0     0    -0.002336914 0      -0.001168457 -0.001091621
-49926.3
2019.01.03 09:32:10 0  1     0.05 0.007873737  0      0.003936868  0.003849262
56924.78
2019.01.03 09:32:10 0  2     0.3  -0.003167176 0      -0.001583588 -0.001648563
42218.94
2019.01.03 09:32:20 0  0     0    -0.002268692 0      -0.001134346 -0.001166209
20703.97
2019.01.03 09:32:20 0  1     0.05 0.007753655  0      0.003876828  0.003929296
-34092.42
2019.01.03 09:32:20 0  2     0.3  -0.003092887 0      -0.001546443 -0.001580542
22156.38
..
```

1.1.3 3. Implement an ab Test that randomly assigns each (stock, day) pair to one of two strategies.

Simulate an A-B testing engine.

[14]:
```
abTest:{[tbl; strat1; strat2; prob1]
    n: count distinct tbl`id;
    seqs: 0N?n;
    tbl: update seq: seqs[id] from tbl;
    tbl: update indicator: (seq + 1) <= (floor 0.5+prob1*n) by id from tbl;
    tbl: update abstrat: (indicator * strat1) + (1 - indicator) * strat2 by id␣
 ↪from tbl;

    tbl1: select from tbl where abstrat=strat;
    tbl1: delete W, indicator, abstrat, a, b, seq from tbl1;

    tbl1: update dalpha: 0 ^ ((alpha - xprev[60; alpha]) % 10) by id from tbl1;
    tbl1: update I: (last alpha) ^ next prev 0.5 * (alpha - dalpha % beta) by␣
 ↪id from tbl1;
    tbl1: update I_: 0 ^ xprev[1; I] * exp neg beta % 6 by id from tbl1;
    tbl1: update deltaQ: (I - I_) % lambda by id, strat from tbl1;

    tbl1}
```

Check whether the function works.

[15]:
```
tbl3: abTest[tbl1; 1; 0; 0.6]
```

[16]:
```
`time xasc `date`time`id`strat`rho`alpha`dalpha`I`I_`deltaQ#/:tbl3
```

[16]:
```
date       time     id strat rho  alpha         dalpha I             I_ deltaQ
-------------------------------------------------------------------------------
-----
2019.01.03 09:30:00 0  1     0.05 0.007971313   0      0.003985656   0  2589783
2019.01.03 09:30:00 1  1     0.05 0.003156933   0      0.001578467   0  410695.5
2019.01.03 09:30:00 2  1     0.05 0.003944261   0      0.00197213    0  146398.5
2019.01.03 09:30:00 3  1     0.05 0.001514924   0      0.0007574621  0  50024.73
2019.01.03 09:30:00 4  0     0    0.005760423   0      0.002880212   0  410224.6
2019.01.03 09:30:00 5  0     0    -0.003169687  0      -0.001584844  0
-62869.58
2019.01.03 09:30:00 6  0     0    -0.002218607  0      -0.001109304  0
-107985.3
2019.01.03 09:30:00 7  0     0    0.008937761   0      0.00446888    0  271311.4
2019.01.03 09:30:00 8  0     0    -0.009877799  0      -0.004938899  0
-588093.8
2019.01.03 09:30:00 9  1     0.05 0.00341617    0      0.001708085   0  123263.8
2019.01.03 09:30:00 10 1     0.05 -0.002470171  0      -0.001235086  0
-385163.2
2019.01.03 09:30:00 11 1     0.05 -0.002022312  0      -0.001011156  0
-392689.2
2019.01.03 09:30:00 12 1     0.05 0.008465974   0      0.004232987   0  856058
2019.01.03 09:30:00 13 1     0.05 -0.00717051   0      -0.003585255  0
-298476.5
```

```
2019.01.03 09:30:00 14 0     0    -0.008044147  0      -0.004022073  0
-2.009145e+07
2019.01.03 09:30:00 15 1     0.05 0.002376593   0      0.001188297   0  602403.5
2019.01.03 09:30:00 16 0     0    -0.001828655  0      -0.0009143277 0
-491917.3
2019.01.03 09:30:00 17 1     0.05 0.01406207    0      0.007031033   0  241730.7
2019.01.03 09:30:00 18 1     0.05 0.01319551    0      0.006597754   0  230698
2019.01.03 09:30:00 19 1     0.05 -0.01094538   0      -0.005472692  0  -3724994
2019.01.03 09:30:00 20 1     0.05 -0.003570431  0      -0.001785215  0
-521756.7
2019.01.03 09:30:00 21 1     0.05 0.005228351   0      0.002614175   0  1780193
2019.01.03 09:30:00 22 1     0.05 0.004897739   0      0.002448869   0  247286.3
2019.01.03 09:30:00 23 1     0.05 7.724724e-05  0      3.862362e-05  0  2559.644
2019.01.03 09:30:00 24 1     0.05 -0.008764127  0      -0.004382064  0
-482363.6
2019.01.03 09:30:00 25 0     0    -0.009228581  0      -0.00461429   0  -661597
2019.01.03 09:30:00 26 1     0.05 -0.005246063  0      -0.002623031  0
-269093.8
2019.01.03 09:30:00 27 1     0.05 -0.01293472   0      -0.006467359  0
-382338.5
2019.01.03 09:30:00 28 1     0.05 -0.01020242   0      -0.005101208  0
-434824.2
2019.01.03 09:30:00 29 1     0.05 0.001034721   0      0.0005173605  0  141041.8
2019.01.03 09:30:00 30 1     0.05 0.004753746   0      0.002376873   0  477248.5
2019.01.03 09:30:00 31 0     0    -0.01074999   0      -0.005374997  0
-641812.4
2019.01.03 09:30:00 32 1     0.05 -0.0005363261 0      -0.000268163  0
-98087.58
2019.01.03 09:30:00 33 1     0.05 -0.001211555  0      -0.0006057776 0
-43990.09
2019.01.03 09:30:00 34 1     0.05 0.001296799   0      0.0006483994  0  96750.92
2019.01.03 09:30:00 35 0     0    -0.0006727231 0      -0.0003363615 0
-111597.3
2019.01.03 09:30:00 36 1     0.05 -0.004431268  0      -0.002215634  0
-485438.6
2019.01.03 09:30:00 37 0     0    -0.003084012  0      -0.001542006  0
-129355.2
2019.01.03 09:30:00 38 1     0.05 -0.0111088    0      -0.0055544    0  -1451018
2019.01.03 09:30:00 39 1     0.05 0.002633934   0      0.001316967   0  123439.3
2019.01.03 09:30:00 40 1     0.05 0.003489071   0      0.001744535   0  13742.57
2019.01.03 09:30:00 41 1     0.05 -0.007463262  0      -0.003731631  0
-174734.7
2019.01.03 09:30:00 42 0     0    0.004797632   0      0.002398816   0  66885.91
2019.01.03 09:30:00 43 0     0    -0.00698573   0      -0.003492865  0
-336743.3
2019.01.03 09:30:00 44 1     0.05 0.004319166   0      0.002159583   0  294742.4
..
```

Count the number of different strategies. $(501 * 0.6 = 300.6)$

[17]:
```
select count distinct id by strat from tbl3
```

[17]:
```
strat| id
-----| ---
0    | 200
1    | 301
```

Get all the dates. I delete the file on 2019.01.09, so there are only 249 days and I don't need to consider that day.

[18]:
```
dt_list: ([] date: "D"$ system "ls ../columbiaHdb/")
count dt_list
```

[18]:
```
249
```

Write an ab Test function for all the stocks in one day.

[19]:
```
abTestday:{[dt; strat1; strat2; prob1]
    tbl: select from bin10 where date = dt;
    tbl: update reverse fills reverse date,
                reverse fills reverse mid,
                reverse fills reverse spread,
                reverse fills reverse vol,
                reverse fills reverse adv
                by id from tbl;

    tbl1: synalpha[tbl];

    tbl2: abTest[tbl1; strat1; strat2; prob1];

    tbl2}
```

Check whether the function works.

[20]:
```
abTestday[dt; 1; 2; 0.5]
```

[20]:
```
date       time     id trade     mid      spread       vol         adv
lambda       rtn         rho  strat alpha        dalpha I             I_
deltaQ
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------
2019.01.03 09:30:00 0  454071.8  91.715   0.001148717  0.000446367 1.122415e+08
```

```
1.538993e-09 -0.02958659 0.05 1     -0.001369694 0      -0.000684847  0
-444996.9
2019.01.03 09:30:10 0  -171833.3 91.72671 0.001072136  0.000446367 1.122415e+08
1.538993e-09 -0.02971043 0.05 1     -0.00141201  0      -0.0007060048
-0.0006835296 -14603.84
2019.01.03 09:30:20 0  -301.2193 91.58853 7.658112e-05 0.000446367 1.122415e+08
1.538993e-09 -0.02824664 0.05 1     -0.001523138 0      -0.0007615689
-0.0007046468 -36986.59
2019.01.03 09:30:30 0  -78884.65 91.65646 0.000612649  0.000446367 1.122415e+08
1.538993e-09 -0.02896681 0.05 1     -0.001670854 0      -0.000835427
-0.000760104  -48943.08
2019.01.03 09:30:40 0  -24705.54 91.60259 0.0008423923 0.000446367 1.122415e+08
1.538993e-09 -0.02839575 0.05 1     -0.001864687 0      -0.0009323435
-0.00083382   -64018.18
2019.01.03 09:30:50 0  -92166.19 91.58385 0.0005871219 0.000446367 1.122415e+08
1.538993e-09 -0.02819692 0.05 1     -0.001937439 0      -0.0009687193
-0.0009305501 -24801.44
2019.01.03 09:31:00 0  -22823.01 91.56276 0.000663703  0.000446367 1.122415e+08
1.538993e-09 -0.02797313 0.05 1     -0.001754734 0      -0.0008773672
-0.0009668559 58147.62
2019.01.03 09:31:10 0  -4940.182 91.59088 0.0005615949 0.000446367 1.122415e+08
1.538993e-09 -0.02827149 0.05 1     -0.001668693 0      -0.0008343465
-0.0008756795 26857.21
2019.01.03 09:31:20 0  -41691.88 91.59322 0.0005360678 0.000446367 1.122415e+08
1.538993e-09 -0.02829635 0.05 1     -0.001737157 0      -0.0008685784
-0.0008327416 -23285.94
2019.01.03 09:31:30 0  -539826.4 91.60727 0.0007402842 0.000446367 1.122415e+08
1.538993e-09 -0.02844544 0.05 1     -0.001742279 0      -0.0008711397
-0.0008669077 -2749.893
2019.01.03 09:31:40 0  -53883.89 91.5487  0.0004594867 0.000446367 1.122415e+08
1.538993e-09 -0.02782386 0.05 1     -0.001542437 0      -0.0007712183
-0.0008694641 63837.71
2019.01.03 09:31:50 0  316896.2  91.56745 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.02802287 0.05 1     -0.001705819 0      -0.0008529093
-0.0007697348 -54044.77
2019.01.03 09:32:00 0  8767.784  91.82033 0.0004594867 0.000446367 1.122415e+08
1.538993e-09 -0.03069975 0.05 1     -0.001989366 0      -0.0009946829
-0.0008512687 -93187.05
2019.01.03 09:32:10 0  132407.8  91.84138 0.000638176  0.000446367 1.122415e+08
1.538993e-09 -0.030922   0.05 1     -0.001913042 0      -0.000956521
-0.0009927695 23553.43
2019.01.03 09:32:20 0  -52051.64 92.02614 0.0005615949 0.000446367 1.122415e+08
1.538993e-09 -0.03286751 0.05 1     -0.001914223 0      -0.0009571115
-0.0009546811 -1579.24
2019.01.03 09:32:30 0  441082.8  92.01445 0.0004339597 0.000446367 1.122415e+08
1.538993e-09 -0.03274466 0.05 1     -0.001963288 0      -0.000981644
-0.0009552705 -17136.9
```

```
2019.01.03 09:32:40 0  -182.6154 92.23874 0.000638176  0.000446367 1.122415e+08
1.538993e-09 -0.03509664 0.05 1     -0.002033033 0      -0.001016517
-0.0009797558 -23886.27
2019.01.03 09:32:50 0  4196.414  92.18269 0.0002807974 0.000446367 1.122415e+08
1.538993e-09 -0.03450997 0.05 1     -0.002173561 0      -0.00108678
-0.001014561  -46926.2
2019.01.03 09:33:00 0  112899.5  92.36479 0.0007402842 0.000446367 1.122415e+08
1.538993e-09 -0.03641345 0.05 1     -0.002282854 0      -0.001141427
-0.00108469   -36866.43
2019.01.03 09:33:10 0  -51038.96 92.27376 0.000612649  0.000446367 1.122415e+08
1.538993e-09 -0.03546287 0.05 1     -0.002151343 0      -0.001075671
-0.001139231  41299.7
2019.01.03 09:33:20 0  -20440.02 92.19904 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.03468117 0.05 1     -0.001927403 0      -0.0009637013
-0.001073602  71411
2019.01.03 09:33:30 0  -121802   92.20604 0.0003318515 0.000446367 1.122415e+08
1.538993e-09 -0.03475452 0.05 1     -0.002014805 0      -0.001007403
-0.0009618476 -29600.47
2019.01.03 09:33:40 0  24287.28  92.07989 0.0005360678 0.000446367 1.122415e+08
1.538993e-09 -0.03343212 0.05 1     -0.002040679 0      -0.00102034
-0.001005465  -9665.426
2019.01.03 09:33:50 0  -14046.25 92.17101 0.0004084326 0.000446367 1.122415e+08
1.538993e-09 -0.03438764 0.05 1     -0.001731801 0      -0.0008659005
-0.001018377  99075.58
2019.01.03 09:34:00 0  -12283.33 92.17334 0.0004850138 0.000446367 1.122415e+08
1.538993e-09 -0.03441211 0.05 1     -0.001939312 0      -0.0009696558
-0.0008642349 -68499.97
2019.01.03 09:34:10 0  -106524.7 92.16634 0.0003573786 0.000446367 1.122415e+08
1.538993e-09 -0.03433869 0.05 1     -0.001983544 0      -0.0009917719
-0.0009677906 -15582.47
2019.01.03 09:34:20 0  0         92.04016 0.000663703  0.000446367 1.122415e+08
1.538993e-09 -0.03301488 0.05 1     -0.002165433 0      -0.001082716
-0.0009898642 -60333.14
2019.01.03 09:34:30 0  -229900.1 92.00276 0.0002552704 0.000446367 1.122415e+08
1.538993e-09 -0.03262178 0.05 1     -0.001990219 0      -0.0009951093
-0.001080634  55571.74
2019.01.03 09:34:40 0  18159.89  91.88817 0.0003318515 0.000446367 1.122415e+08
1.538993e-09 -0.03141545 0.05 1     -0.001828555 0      -0.0009142777
-0.0009931951 51278.66
2019.01.03 09:34:50 0  25469.17  91.85074 0.0005360678 0.000446367 1.122415e+08
1.538993e-09 -0.03102074 0.05 1     -0.001832482 0      -0.0009162412
-0.000912519  -2418.586
2019.01.03 09:35:00 0  -18781.33 91.94197 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.03198214 0.05 1     -0.001780941 0      -0.0008904704
-0.0009144788 15600.03
2019.01.03 09:35:10 0  3026.875  91.89285 0.0005871219 0.000446367 1.122415e+08
1.538993e-09 -0.03146476 0.05 1     -0.00197058  0      -0.0009852899
```

```
-0.0008887575 -62724.41
2019.01.03 09:35:20 0  -21253.42 91.90689 0.0005360678 0.000446367 1.122415e+08
1.538993e-09 -0.03161265 0.05 1     -0.001868565 0      -0.0009342825
-0.0009833947 31911.9
2019.01.03 09:35:30 0  -37882.34 91.86946 0.0007402842 0.000446367 1.122415e+08
1.538993e-09 -0.03121814 0.05 1     -0.001898134 0      -0.0009490672
-0.0009324854 -10774.48
2019.01.03 09:35:40 0  0         91.82033 0.0007147571 0.000446367 1.122415e+08
1.538993e-09 -0.03069975 0.05 1     -0.001801584 0      -0.0009007918
-0.0009472416 30181.95
2019.01.03 09:35:50 0  38337.81  91.82267 0.000638176  0.000446367 1.122415e+08
1.538993e-09 -0.03072445 0.05 1     -0.001765134 0      -0.0008825668
-0.0008990591 10716.3
2019.01.03 09:36:00 0  -261640.9 91.83437 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.03084793 0.05 1     -0.001796185 0      -0.0008980923
-0.0008808691 -11191.17
2019.01.03 09:36:10 0  -358734   91.70095 0.0004850138 0.000446367 1.122415e+08
1.538993e-09 -0.02943793 0.05 1     -0.001875664 0      -0.000937832
-0.0008963647 -26944.45
2019.01.03 09:36:20 0  -24277.96 91.74309 0.0004339597 0.000446367 1.122415e+08
1.538993e-09 -0.02988374 0.05 1     -0.002033578 0      -0.001016789
-0.0009360281 -52476.37
2019.01.03 09:36:30 0  -7837.575 91.63538 0.0007913382 0.000446367 1.122415e+08
1.538993e-09 -0.02874345 0.05 1     -0.0020401   0      -0.00102005
-0.001014833  -3389.814
2019.01.03 09:36:40 0  -68098.53 91.60962 0.0005105408 0.000446367 1.122415e+08
1.538993e-09 -0.02847028 0.05 1     -0.001911452 0      -0.0009557262
-0.001018088  40521.01
2019.01.03 09:36:50 0  -187543.1 91.56979 0.0003318515 0.000446367 1.122415e+08
1.538993e-09 -0.02804774 0.05 1     -0.001643087 0      -0.0008215436
-0.0009538878 85994.03
2019.01.03 09:37:00 0  -445392.8 91.45495 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.02682728 0.05 1     -0.001604548 0      -0.0008022742
-0.0008199633 11493.96
2019.01.03 09:37:10 0  24626.54  91.25089 0.0004850138 0.000446367 1.122415e+08
1.538993e-09 -0.02465101 0.05 1     -0.001825543 0      -0.0009127717
-0.000800731  -72801.34
2019.01.03 09:37:20 0  -8152.001 91.27436 0.0004339597 0.000446367 1.122415e+08
1.538993e-09 -0.02490177 0.05 1     -0.001820615 0      -0.0009103073
-0.000911016  460.4915
..
```

Implement an ab Test that randomly assigns each (stock, day) pair to one of two strategies.

[21]:
```
/dt_short: dt_list[til 5]
/tbl4: `date`time`id xasc raze abTestday[; 1; 2; 0.5] peach dt_short `date
```

```
tbl4: `date`time`id xasc raze abTestday[; 1; 2; 0.5] peach dt_list `date
```

[22]:
```
`id`date`time`mid`strat`deltaQ#/:tbl4
```

[22]:
```
id date       time     mid     strat deltaQ
-----------------------------------------------
0  2019.01.02 09:30:00 92.145  2     29823.31
1  2019.01.02 09:30:00 279.87  1     -48454.57
2  2019.01.02 09:30:00 56.27   1     130225.4
3  2019.01.02 09:30:00 51.185  1     214912.9
4  2019.01.02 09:30:00 43.995  1     -609975.2
5  2019.01.02 09:30:00 167.595 1     -131188
6  2019.01.02 09:30:00 29.27   2     211295.3
7  2019.01.02 09:30:00 99.575  2     361179.7
8  2019.01.02 09:30:00 107.64  2     -402305.3
9  2019.01.02 09:30:00 110.195 1     -448657.3
10 2019.01.02 09:30:00 187.07  1     -679738.3
11 2019.01.02 09:30:00 125.44  1     -18939.2
12 2019.01.02 09:30:00 188.58  2     -501998.4
13 2019.01.02 09:30:00 19.995  1     112290.8
14 2019.01.02 09:30:00 28.255  1     -25189.73
15 2019.01.02 09:30:00 79.875  1     -146845.7
16 2019.01.02 09:30:00 55.89   2     193928.1
17 2019.01.02 09:30:00 25.4    2     326868.7
18 2019.01.02 09:30:00 96.69   2     138681.1
19 2019.01.02 09:30:00 32.4    1     -120985.5
20 2019.01.02 09:30:00 148.275 2     -198391.2
21 2019.01.02 09:30:00 14.45   1     -19448.09
22 2019.01.02 09:30:00 110.575 1     -206796.7
23 2019.01.02 09:30:00 18.21   2     10338.63
24 2019.01.02 09:30:00 49.895  1     70749.64
25 2019.01.02 09:30:00 73.4    2     -310580.9
26 2019.01.02 09:30:00 33.135  2     70971.65
27 2019.01.02 09:30:00 33.58   1     -126946.1
28 2019.01.02 09:30:00 60.34   1     129942.3
29 2019.01.02 09:30:00 63.32   1     1321305
30 2019.01.02 09:30:00 69.875  2     -42755.43
31 2019.01.02 09:30:00 833.185 1     986559.5
32 2019.01.02 09:30:00 94.545  2     111012.5
33 2019.01.02 09:30:00 42.9    1     10987.87
34 2019.01.02 09:30:00 166.54  2     -899695.2
35 2019.01.02 09:30:00 18.14   1     295076.3
36 2019.01.02 09:30:00 90.985  1     933087
37 2019.01.02 09:30:00 65.035  1     851631.7
38 2019.01.02 09:30:00 57.98   2     -118140.3
39 2019.01.02 09:30:00 70.565  1     -232728.3
40 2019.01.02 09:30:00 95.485  2     -35993.08
```

```
41 2019.01.02 09:30:00 82.275  2     400556.3
42 2019.01.02 09:30:00 24.065  2     -265863
43 2019.01.02 09:30:00 128.385 1     -246312.9
44 2019.01.02 09:30:00 200.73  2     865538.5
..
```

1.1.4 4. For each day, bucket all stocks into three equal-size groups: low, medium, and high volatility. Implement an abTest that randomizes within each volatility bucket.

Write a function to implement the stratified randomization.

[23]:
```
abTestbucket:{[tbl; strat1; strat2; prob1]
    tbl: update buck: 3 xrank vol from tbl;
    tbl: update n: count distinct id by buck from tbl;
    seqs: 0N?(count distinct tbl`id);
    tbl: update seq: seqs[id] by buck from tbl;
    tbl: update seq: n xrank seq by buck from tbl;
    tbl: update indicator: (seq + 1) <= (floor 0.5+n*prob1) by buck from tbl;
    tbl: update abstrat: (indicator * strat1) + (1 - indicator) * strat2 by␣
 ↪buck from tbl;

    tbl1: select from tbl where abstrat=strat;
    tbl1: delete W, indicator, abstrat, seq, a, b, n from tbl1;

    tbl1: update dalpha: 0 ^ ((alpha - xprev[60; alpha]) % 10) by id from tbl1;
    tbl1: update I: (last alpha) ^ next prev 0.5 * (alpha - dalpha % beta) by␣
 ↪id from tbl1;
    tbl1: update I_: 0 ^ xprev[1; I] * exp neg beta % 6 by id from tbl1;
    tbl1: update deltaQ: (I - I_) % lambda by id, strat from tbl1;

    tbl1}
```

Check whether the function works.

[24]:
```
tbl5: abTestbucket[tbl1; 1; 2; 0.5]
```

[25]:
```
tbl5
```

[25]:
```
date       time     id trade     mid      spread       vol         adv
lambda       rtn         rho  strat alpha       buck dalpha I           I_
deltaQ
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
-------------
2019.01.03 09:30:00 0  454071.8  91.715   0.001148717  0.000446367 1.122415e+08
1.538993e-09 -0.02958659 0.05 1     0.007971313 0    0      0.003985656 0
```

```
2589783
2019.01.03 09:30:10 0  -171833.3 91.72671 0.001072136  0.000446367 1.122415e+08
1.538993e-09 -0.02971043 0.05 1     0.008013164 0    0      0.004006582
0.00397799  18578.62
2019.01.03 09:30:20 0  -301.2193 91.58853 7.658112e-05 0.000446367 1.122415e+08
1.538993e-09 -0.02824664 0.05 1     0.008143221 0    0      0.00407161
0.003998875 47261.62
2019.01.03 09:30:30 0  -78884.65 91.65646 0.000612649  0.000446367 1.122415e+08
1.538993e-09 -0.02896681 0.05 1     0.007954908 0    0      0.003977454
0.004063778 -56091.51
2019.01.03 09:30:40 0  -24705.54 91.60259 0.0008423923 0.000446367 1.122415e+08
1.538993e-09 -0.02839575 0.05 1     0.007881796 0    0      0.003940898
0.003969803 -18781.96
2019.01.03 09:30:50 0  -92166.19 91.58385 0.0005871219 0.000446367 1.122415e+08
1.538993e-09 -0.02819692 0.05 1     0.007982854 0    0      0.003991427
0.003933317 37758.27
2019.01.03 09:31:00 0  -22823.01 91.56276 0.000663703  0.000446367 1.122415e+08
1.538993e-09 -0.02797313 0.05 1     0.007832867 0    0      0.003916433
0.003983749 -43740.21
2019.01.03 09:31:10 0  -4940.182 91.59088 0.0005615949 0.000446367 1.122415e+08
1.538993e-09 -0.02827149 0.05 1     0.007950151 0    0      0.003975076
0.0039089   42999.33
2019.01.03 09:31:20 0  -41691.88 91.59322 0.0005360678 0.000446367 1.122415e+08
1.538993e-09 -0.02829635 0.05 1     0.008020756 0    0      0.004010378
0.003967429 27907.04
2019.01.03 09:31:30 0  -539826.4 91.60727 0.0007402842 0.000446367 1.122415e+08
1.538993e-09 -0.02844544 0.05 1     0.007793857 0    0      0.003896928
0.004002664 -68704.32
2019.01.03 09:31:40 0  -53883.89 91.5487  0.0004594867 0.000446367 1.122415e+08
1.538993e-09 -0.02782386 0.05 1     0.007819078 0    0      0.003909539
0.003889432 13064.86
2019.01.03 09:31:50 0  316896.2  91.56745 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.02802287 0.05 1     0.007774184 0    0      0.003887092
0.003902019 -9699.187
2019.01.03 09:32:00 0  8767.784  91.82033 0.0004594867 0.000446367 1.122415e+08
1.538993e-09 -0.03069975 0.05 1     0.00771336  0    0      0.00385668
0.003879615 -14902.47
2019.01.03 09:32:10 0  132407.8  91.84138 0.000638176  0.000446367 1.122415e+08
1.538993e-09 -0.030922   0.05 1     0.007873737 0    0      0.003936868
0.003849262 56924.78
2019.01.03 09:32:20 0  -52051.64 92.02614 0.0005615949 0.000446367 1.122415e+08
1.538993e-09 -0.03286751 0.05 1     0.007753655 0    0      0.003876828
0.003929296 -34092.42
2019.01.03 09:32:30 0  441082.8  92.01445 0.0004339597 0.000446367 1.122415e+08
1.538993e-09 -0.03274466 0.05 1     0.007666623 0    0      0.003833311
0.00386937  -23430.29
2019.01.03 09:32:40 0  -182.6154 92.23874 0.000638176  0.000446367 1.122415e+08
```

```
1.538993e-09 -0.03509664 0.05 1     0.00736701  0    0      0.003683505
0.003825938 -92549.28
2019.01.03 09:32:50 0  4196.414  92.18269 0.0002807974 0.000446367 1.122415e+08
1.538993e-09 -0.03450997 0.05 1     0.007260086 0    0      0.003630043
0.00367642  -30134.31
2019.01.03 09:33:00 0  112899.5  92.36479 0.0007402842 0.000446367 1.122415e+08
1.538993e-09 -0.03641345 0.05 1     0.007308504 0    0      0.003654252
0.003623061 20267.25
2019.01.03 09:33:10 0  -51038.96 92.27376 0.000612649  0.000446367 1.122415e+08
1.538993e-09 -0.03546287 0.05 1     0.007323909 0    0      0.003661955
0.003647223 9572.5
2019.01.03 09:33:20 0  -20440.02 92.19904 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.03468117 0.05 1     0.007269667 0    0      0.003634833
0.003654911 -13045.74
2019.01.03 09:33:30 0  -121802   92.20604 0.0003318515 0.000446367 1.122415e+08
1.538993e-09 -0.03475452 0.05 1     0.007376114 0    0      0.003688057
0.003627842 39126.63
2019.01.03 09:33:40 0  24287.28  92.07989 0.0005360678 0.000446367 1.122415e+08
1.538993e-09 -0.03343212 0.05 1     0.007204718 0    0      0.003602359
0.003680963 -51074.85
2019.01.03 09:33:50 0  -14046.25 92.17101 0.0004084326 0.000446367 1.122415e+08
1.538993e-09 -0.03438764 0.05 1     0.007217249 0    0      0.003608624
0.00359543  8573.463
2019.01.03 09:34:00 0  -12283.33 92.17334 0.0004850138 0.000446367 1.122415e+08
1.538993e-09 -0.03441211 0.05 1     0.007203841 0    0      0.003601921
0.003601683 154.4191
2019.01.03 09:34:10 0  -106524.7 92.16634 0.0003573786 0.000446367 1.122415e+08
1.538993e-09 -0.03433869 0.05 1     0.007229841 0    0      0.00361492
0.003594992 12948.99
2019.01.03 09:34:20 0  0         92.04016 0.000663703  0.000446367 1.122415e+08
1.538993e-09 -0.03301488 0.05 1     0.00717857  0    0      0.003589285
0.003607967 -12139.21
2019.01.03 09:34:30 0  -229900.1 92.00276 0.0002552704 0.000446367 1.122415e+08
1.538993e-09 -0.03262178 0.05 1     0.007144394 0    0      0.003572197
0.003582381 -6616.872
2019.01.03 09:34:40 0  18159.89  91.88817 0.0003318515 0.000446367 1.122415e+08
1.538993e-09 -0.03141545 0.05 1     0.007237717 0    0      0.003618858
0.003565326 34784.14
2019.01.03 09:34:50 0  25469.17  91.85074 0.0005360678 0.000446367 1.122415e+08
1.538993e-09 -0.03102074 0.05 1     0.007245165 0    0      0.003622583
0.003611897 6943.031
2019.01.03 09:35:00 0  -18781.33 91.94197 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.03198214 0.05 1     0.007287341 0    0      0.003643671
0.003615614 18230.17
2019.01.03 09:35:10 0  3026.875  91.89285 0.0005871219 0.000446367 1.122415e+08
1.538993e-09 -0.03146476 0.05 1     0.007422079 0    0      0.00371104
0.003636662 48328.97
```

```
2019.01.03 09:35:20 0  -21253.42 91.90689 0.0005360678 0.000446367 1.122415e+08
1.538993e-09 -0.03161265 0.05 1     0.007471187 0    0      0.003735593
0.003703901 20592.84
2019.01.03 09:35:30 0  -37882.34 91.86946 0.0007402842 0.000446367 1.122415e+08
1.538993e-09 -0.03121814 0.05 1     0.00742616  0    0      0.00371308
0.003728408 -9959.524
2019.01.03 09:35:40 0  0         91.82033 0.0007147571 0.000446367 1.122415e+08
1.538993e-09 -0.03069975 0.05 1     0.007489985 0    0      0.003744993
0.003705938 25376.78
2019.01.03 09:35:50 0  38337.81  91.82267 0.000638176  0.000446367 1.122415e+08
1.538993e-09 -0.03072445 0.05 1     0.0074989   0    0      0.00374945
0.003737789 7577.257
2019.01.03 09:36:00 0  -261640.9 91.83437 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.03084793 0.05 1     0.007568015 0    0      0.003784008
0.003742238 27140.92
2019.01.03 09:36:10 0  -358734   91.70095 0.0004850138 0.000446367 1.122415e+08
1.538993e-09 -0.02943793 0.05 1     0.007666962 0    0      0.003833481
0.003776729 36875.99
2019.01.03 09:36:20 0  -24277.96 91.74309 0.0004339597 0.000446367 1.122415e+08
1.538993e-09 -0.02988374 0.05 1     0.007849207 0    0      0.003924604
0.003826107 64000.83
2019.01.03 09:36:30 0  -7837.575 91.63538 0.0007913382 0.000446367 1.122415e+08
1.538993e-09 -0.02874345 0.05 1     0.00785272  0    0      0.00392636
0.003917054 6046.628
2019.01.03 09:36:40 0  -68098.53 91.60962 0.0005105408 0.000446367 1.122415e+08
1.538993e-09 -0.02847028 0.05 1     0.007734093 0    0      0.003867047
0.003918808 -33633.01
2019.01.03 09:36:50 0  -187543.1 91.56979 0.0003318515 0.000446367 1.122415e+08
1.538993e-09 -0.02804774 0.05 1     0.007608313 0    0      0.003804157
0.003859608 -36031.05
2019.01.03 09:37:00 0  -445392.8 91.45495 0.0003063245 0.000446367 1.122415e+08
1.538993e-09 -0.02682728 0.05 1     0.00775003  0    0      0.003875015
0.003796839 50796.64
2019.01.03 09:37:10 0  24626.54  91.25089 0.0004850138 0.000446367 1.122415e+08
1.538993e-09 -0.02465101 0.05 1     0.00758574  0    0      0.00379287
0.003867561 -48532.52
2019.01.03 09:37:20 0  -8152.001 91.27436 0.0004339597 0.000446367 1.122415e+08
1.538993e-09 -0.02490177 0.05 1     0.007670343 0    0      0.003835171
0.003785574 32227.16
..
```

Check whether the randomization in each bucket is balanced. $(501/3 * 0.5 = 83.5)$

[26]:
```
select count distinct id by buck, strat from tbl5
```

[26]:
```
buck strat| id
----------| --
0    1    | 84
0    2    | 83
1    1    | 84
1    2    | 83
2    1    | 84
2    2    | 83
```

1.2 Exercise 2 Analyzing an AB-Test

1.2.1 1. Simulate an AB-test with prob1 at 80%. What is the average daily P&L of this randomized strategy? What is the average daily P&L for each strategy?

Write a function to calculate the P&L for each strategy and stock in one day.

[27]:
```
PaLcalc:{[dt; strat1; strat2; prob1]
    tbl: abTestday[dt; strat1; strat2; prob1];

    tbl: update palpha: deltaQ * rtn,
             TC: deltaQ * 0.5 * (I + I_) by id from tbl;
    tbl: update PaL: palpha - TC by id from tbl;
    tbl: update prob1: prob1 from tbl;

    tbl1: select PaL: sum PaL,
                 vol: last vol,
                 adv: last adv by date, id, strat, prob1 from tbl;
    tbl1}
```

Simulate an AB-test with prob1 at 80%.

[28]:
```
strat1: 1
strat2: 0
prob1: 0.8
```

Check whether the function works.

[29]:
```
tbl6: PaLcalc[dt; strat1; strat2; prob1]
```

[30]:
```
tbl6
```

[30]:
```
date       id strat prob1| PaL       vol          adv
-------------------------| ----------------------------------
2019.01.03 0  0     0.8  | 88103.1   0.000446367  1.122415e+08
2019.01.03 1  1     0.8  | -54587.62 0.000358252  3.607207e+07
2019.01.03 2  1     0.8  | -5041.71  0.0004827488 1.38682e+07
2019.01.03 3  1     0.8  | -6065.987 0.0004667023 1.192783e+07
2019.01.03 4  1     0.8  | -28831.09 0.0003663134 2.019054e+07
```

```
2019.01.03 5  1     0.8  | -16428.53 0.000516633  7931115
2019.01.03 6  1     0.8  | -16236.86 0.0004753984 1.790894e+07
2019.01.03 7  1     0.8  | -122.6485 0.0004223277 9922401
2019.01.03 8  0     0.8  | -26729.57 0.0007492939 3.452761e+07
2019.01.03 9  1     0.8  | -45271.43 0.0006668529 1.862319e+07
2019.01.03 10 1     0.8  | -182725.4 0.0007148106 8.626539e+07
2019.01.03 11 1     0.8  | 8652.427  0.0003864019 5.807214e+07
2019.01.03 12 1     0.8  | -33682.63 0.0003828439 2.996236e+07
2019.01.03 13 0     0.8  | -46385.76 0.0004774389 1.538175e+07
2019.01.03 14 1     0.8  | 61619.18  0.0005112646 9.883369e+08
2019.01.03 15 1     0.8  | 20754.5   0.000372391  7.305665e+07
2019.01.03 16 0     0.8  | 167614.7  0.0009286111 1.933401e+08
2019.01.03 17 1     0.8  | 5150.628  0.0006442204 8571269
2019.01.03 18 0     0.8  | -19939.19 0.0006423178 8691514
2019.01.03 19 1     0.8  | 42082.05  0.0004340049 1.143187e+08
2019.01.03 20 1     0.8  | -29877.19 0.0004842376 5.476887e+07
2019.01.03 21 1     0.8  | -27392.2  0.0003934688 1.036909e+08
2019.01.03 22 1     0.8  | -7113.915 0.0003475031 1.357973e+07
2019.01.03 23 1     0.8  | 2998.035  0.0006300022 1.615722e+07
2019.01.03 24 0     0.8  | 1474.554  0.0004235462 1.804241e+07
2019.01.03 25 1     0.8  | -16496.29 0.0004774169 2.649014e+07
2019.01.03 26 1     0.8  | -11401.47 0.0003429665 1.361601e+07
2019.01.03 27 1     0.8  | 8364.534  0.0006841965 1.565308e+07
2019.01.03 28 1     0.8  | -5853.825 0.0005421428 1.788349e+07
2019.01.03 29 1     0.8  | -7356.535 0.000553965  5.844333e+07
2019.01.03 30 1     0.8  | -8957.307 0.0004884136 3.795109e+07
2019.01.03 31 1     0.8  | -9403.368 0.0004894108 2.261525e+07
2019.01.03 32 1     0.8  | -32942.6  0.0003286248 4.651718e+07
2019.01.03 33 1     0.8  | -6071.266 0.0004340077 1.219655e+07
2019.01.03 34 1     0.8  | -38614.91 0.0004228632 2.441801e+07
2019.01.03 35 1     0.8  | 31752.25  0.0004287401 5.504771e+07
2019.01.03 36 1     0.8  | -27299.76 0.0005528349 4.687374e+07
2019.01.03 37 0     0.8  | -24909.37 0.0005698626 1.849975e+07
2019.01.03 38 0     0.8  | -12267.07 0.0004820823 4.873656e+07
2019.01.03 39 1     0.8  | -29847.16 0.00040451   1.467255e+07
2019.01.03 40 1     0.8  | -913.2765 0.0004607547 1404610
2019.01.03 41 0     0.8  | 2450.125  0.0005473872 9919119
2019.01.03 42 0     0.8  | -6478.84  0.0006445486 6954907
2019.01.03 43 1     0.8  | -2798.345 0.000435497  1.624801e+07
2019.01.03 44 1     0.8  | -66754.98 0.0004997701 2.639617e+07
..
```

Compute the average daily P&L of this randomized strategy.

[31]:
```
select avg PaL from tbl6
```

[31]:
```
PaL
---------
-26072.36
```

Compute the the average daily P&L for each strategy.

[32]:
```
select avg PaL by strat from tbl6
```

[32]:
```
strat| PaL
-----| ---------
0    | -46579.06
1    | -20958.47
```

Run this function on all stocks for every day.

[33]:
```
tbl7: `date`id`strat`prob1 xasc raze PaLcalc[; strat1; strat2; prob1] peach␣
↪dt_list `date
```

Show the results.

[34]:
```
`id`date`strat`prob1 xasc tbl7
```

[34]:
```
date       id strat prob1| PaL       vol          adv
-------------------------| ----------------------------------
2019.01.02 0  1     0.8  | 234.4555  0.0004776026 1.161895e+07
2019.01.03 0  1     0.8  | 24283.7   0.000446367  1.122415e+08
2019.01.04 0  1     0.8  | -14910.89 0.0003734812 4.616465e+07
2019.01.07 0  1     0.8  | -16710.27 0.0006555364 2.792096e+07
2019.01.08 0  1     0.8  | -23064.29 0.0006025296 3.37982e+07
2019.01.10 0  1     0.8  | 2193.719  0.0002003507 2.825232e+07
2019.01.11 0  1     0.8  | -3629.312 0.0003653003 9741619
2019.01.14 0  1     0.8  | -6058.28  0.0001948262 1.286862e+07
2019.01.15 0  1     0.8  | 1179.211  0.0004426495 6261346
2019.01.16 0  1     0.8  | -10064.12 0.0002774355 1.32556e+07
2019.01.17 0  0     0.8  | -25897.58 0.0004034561 1.134706e+07
2019.01.18 0  1     0.8  | -2198.16  0.0003945121 1.584851e+07
2019.01.22 0  0     0.8  | -40138.07 0.0003692038 6.411582e+07
2019.01.23 0  1     0.8  | -5551.41  0.0003637114 1.924005e+07
2019.01.24 0  1     0.8  | -4912.37  0.0005039294 2.032542e+07
2019.01.25 0  1     0.8  | -32.44709 0.0002006835 1.932214e+07
2019.01.28 0  1     0.8  | 1185.103  0.000308841  1.166641e+07
2019.01.29 0  0     0.8  | -10957.14 0.0003591947 1.71625e+07
2019.01.30 0  0     0.8  | -49527.05 0.0002280322 6.614907e+07
2019.01.31 0  1     0.8  | 13046.27  0.0003905473 1.258223e+07
2019.02.01 0  1     0.8  | 21158.61  0.0003026355 2.611727e+07
2019.02.04 0  1     0.8  | -4678.842 0.0001864867 2.50885e+07
2019.02.05 0  1     0.8  | -24332.74 0.000259934  4.736976e+07
```

```
2019.02.06 0  0     0.8  | 1694.014  0.0002231478 9983923
2019.02.07 0  1     0.8  | 129481    0.0003301745 8.108885e+07
2019.02.08 0  1     0.8  | -11448.87 0.000243224  1.547711e+07
2019.02.11 0  0     0.8  | -9316.56  0.00026465   1.31969e+07
2019.02.12 0  1     0.8  | -115.1761 0.0001929842 1.136227e+07
2019.02.13 0  0     0.8  | -12242.07 0.0002116595 2.135984e+07
2019.02.14 0  1     0.8  | -12618.39 0.0004256269 2.124528e+07
2019.02.15 0  1     0.8  | -5080.295 0.0002149229 1.113491e+07
2019.02.19 0  1     0.8  | -3508.628 0.0001281745 2.455316e+07
2019.02.20 0  1     0.8  | -1949.005 0.0001573028 1.657878e+07
2019.02.21 0  0     0.8  | -2096.352 0.0002743772 8725839
2019.02.22 0  1     0.8  | -2476.747 0.0002141157 2.138548e+07
2019.02.25 0  1     0.8  | -6005.458 0.0001351715 1.649324e+07
2019.02.26 0  0     0.8  | -19144.82 0.0002389228 3.683921e+07
2019.02.27 0  1     0.8  | -6093.064 0.0002412728 1.160727e+07
2019.02.28 0  1     0.8  | 7285.52   0.000242914  1.747858e+07
2019.03.01 0  1     0.8  | -2392.475 0.0004923238 1.430192e+07
2019.03.04 0  1     0.8  | -164.3265 0.0002415074 4249470
2019.03.05 0  1     0.8  | -6208.699 0.0005211686 8146522
2019.03.06 0  1     0.8  | -447.5509 0.0002148852 5922378
2019.03.07 0  1     0.8  | -4199.817 0.0002239874 1.012283e+07
2019.03.08 0  0     0.8  | -8224.946 0.0002442807 3.421358e+07
..
```

Compute the average daily P&L of this randomized strategy.

[35]:
```
select avg PaL from tbl7
```

[35]:
```
PaL
--------
-10460.2
```

Compute the the average daily P&L for each strategy.

[36]:
```
select avg PaL by strat from tbl7
```

[36]:
```
strat| PaL
-----| ---------
0    | -11026.1
1    | -10318.69
```

1.2.2 2. For every day, compute the daily t-stat (mean/sdev) of each strategy's P&L across all stocks.

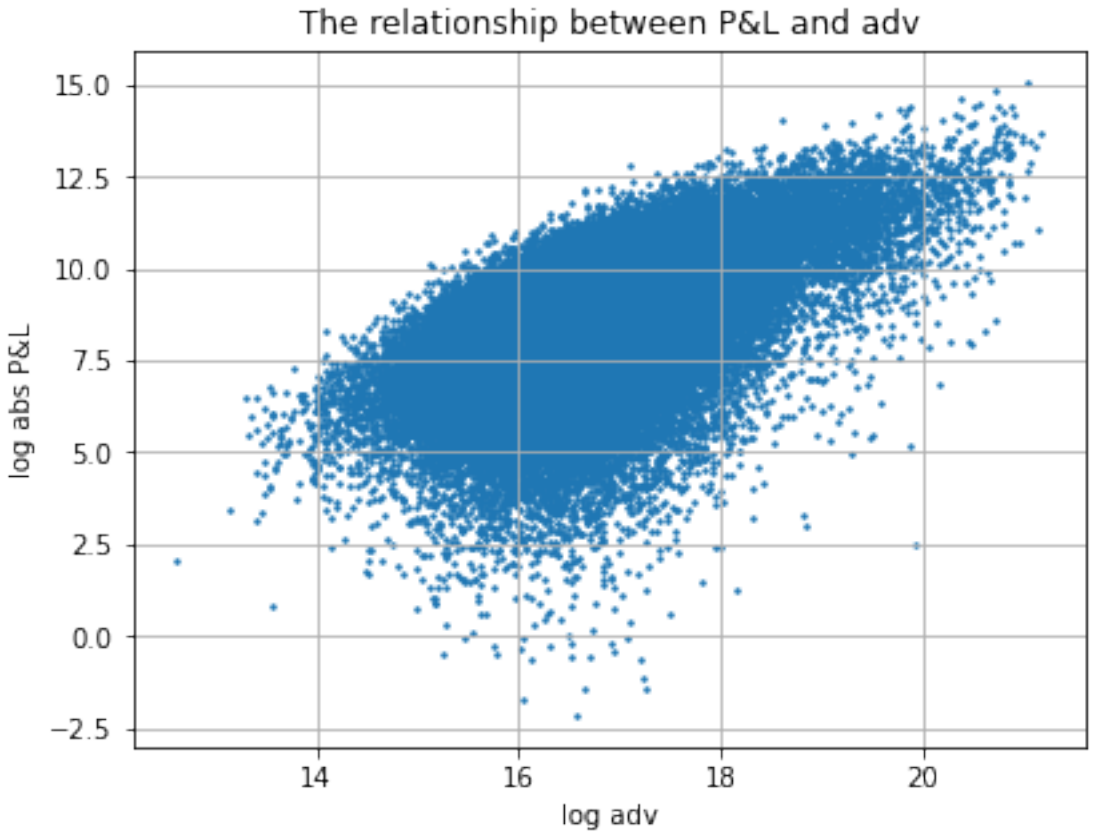
[37]:
```
tbl8: 0!tbl7
```

We need to find some suitably normalized units. In order to do this, I try to use some scatter plots between P&L and other features to understand which one is good.

[38]:
```
\l ../importmatplotlib.q

plt:.matplotlib.pyplot[]
plt.

plt.scatter[log tbl8`adv; log abs tbl8 `PaL; s:2];
plt.xlabel"log adv";
plt.ylabel"log abs P&L";
plt.title"The relationship between P&L and adv";
plt.grid 1b;
plt.show[];
```



Based on the previous plot, we find that there exists a power law relationship between P&L and adv, so I would like to use adv to do normalization.

[39]:
```
tbl8: update norm_PaL: PaL % adv from tbl8
```

[40]:
```
tbl8
```

[40]:

date	id	strat	prob1	PaL	vol	adv	norm_PaL
2019.01.02	0	1	0.8	234.4555	0.0004776026	1.161895e+07	2.017872e-05
2019.01.02	1	0	0.8	-10000.85	0.0004289543	4.081003e+07	-0.0002450586
2019.01.02	2	1	0.8	-3329	0.0004655141	1.052341e+07	-0.0003163424
2019.01.02	3	0	0.8	-3170.095	0.0005068115	6987232	-0.0004536983
2019.01.02	4	1	0.8	-4620.629	0.0003931664	1.907262e+07	-0.000242265
2019.01.02	5	1	0.8	-17930.69	0.0004659031	2.222419e+07	-0.0008068096
2019.01.02	6	0	0.8	-41567.81	0.0003448442	1.009195e+07	-0.004118906
2019.01.02	7	1	0.8	-12580.37	0.0007937001	2.039854e+07	-0.0006167292
2019.01.02	8	0	0.8	-7472.944	0.0004189908	2.821476e+07	-0.0002648594
2019.01.02	9	1	0.8	-18476.23	0.0005368464	1.895952e+07	-0.0009745091
2019.01.02	10	1	0.8	-32485.97	0.0002936445	5.362121e+07	-0.0006058418
2019.01.02	11	0	0.8	-20304.68	0.0005445913	1.371147e+07	-0.001480854
2019.01.02	12	1	0.8	91796.27	0.0004928323	4.953557e+07	0.001853138
2019.01.02	13	1	0.8	10166.07	0.0004186735	1.092683e+07	0.0009303763
2019.01.02	14	0	0.8	-6317.678	0.000342972	1.145875e+07	-0.0005513408
2019.01.02	15	1	0.8	-3369.42	0.0003834546	2.327105e+07	-0.0001447902
2019.01.02	16	1	0.8	6453.934	0.0003747228	1.236677e+07	0.0005218773
2019.01.02	17	1	0.8	11194.5	0.0004778426	1.599064e+07	0.0007000658
2019.01.02	18	1	0.8	-30070.52	0.0006521663	7045968	-0.004267763
2019.01.02	19	1	0.8	-34021.67	0.0009456223	9231475	-0.003685399
2019.01.02	20	1	0.8	-20064.99	0.0006752427	1.589806e+07	-0.001262103
2019.01.02	21	1	0.8	-10745.33	0.0004560371	6176131	-0.001739815
2019.01.02	22	1	0.8	-34120.7	0.0003638657	2.387497e+07	-0.001429141
2019.01.02	23	1	0.8	-13883.45	0.000587086	1.505667e+07	-0.0009220797
2019.01.02	24	1	0.8	-51790.65	0.0003823996	2.74124e+07	-0.001889315
2019.01.02	25	1	0.8	291.9013	0.0004814114	9743904	2.995733e-05
2019.01.02	26	1	0.8	-1190.886	0.0004513634	1.197435e+07	-9.945304e-05
2019.01.02	27	1	0.8	-5074.005	0.0004495159	8665796	-0.000585521
2019.01.02	28	1	0.8	-32592.28	0.0005898566	1.431196e+07	-0.002277276
2019.01.02	29	1	0.8	11.44568	0.0004995882	6.449573e+07	1.774642e-07
2019.01.02	30	0	0.8	-33950.86	0.000452326	8555770	-0.003968183
2019.01.02	31	1	0.8	-84244.08	0.000633535	3.708067e+07	-0.002271914
2019.01.02	32	1	0.8	-9054.343	0.0005513465	8523391	-0.001062294
2019.01.02	33	1	0.8	-20354.75	0.0005069254	1.481507e+07	-0.001373922
2019.01.02	34	0	0.8	-21349.96	0.0005094877	2.629457e+07	-0.0008119533
2019.01.02	35	1	0.8	10374.33	0.0005509134	1.425214e+07	0.0007279134
2019.01.02	36	1	0.8	-7905.271	0.0003135381	5.577244e+07	-0.0001417415
2019.01.02	37	1	0.8	-1767.726	0.0003975732	2.805252e+07	-6.301487e-05
2019.01.02	38	1	0.8	-6684.955	0.0005353687	1.255333e+07	-0.0005325245
2019.01.02	39	1	0.8	-16347.1	0.0004394434	4.104227e+07	-0.0003982993
2019.01.02	40	1	0.8	-3842.056	0.0006714575	7441732	-0.0005162851

```
2019.01.02 41 0     0.8   -22922.64 0.0003883097 1.215736e+07 -0.001885494
2019.01.02 42 0     0.8   79672.54  0.00041801   1.34563e+08  0.0005920837
2019.01.02 43 1     0.8   12461.05  0.0003074411 5.173965e+07 0.0002408415
2019.01.02 44 1     0.8   10720.91  0.0005207574 2.218375e+07 0.0004832776
..
```

Compute the daily t-stat (mean/sdev) of each strategy's P&L across all stocks.

[41]:
```
tbl9: select tstat: (avg norm_PaL) % (sdev norm_PaL) by date, strat, prob1 from␣
 ↪tbl8
```

[42]:
```
tbl9
```

[42]:
```
date       strat prob1| tstat
----------------------| ----------
2019.01.02 0     0.8  | -0.5920137
2019.01.02 1     0.8  | -0.5071748
2019.01.03 0     0.8  | -0.5618384
2019.01.03 1     0.8  | -0.5186362
2019.01.04 0     0.8  | -0.6731932
2019.01.04 1     0.8  | -0.6316654
2019.01.07 0     0.8  | -0.7442622
2019.01.07 1     0.8  | -0.6736096
2019.01.08 0     0.8  | -0.5970091
2019.01.08 1     0.8  | -0.6390992
2019.01.10 0     0.8  | -0.6251246
2019.01.10 1     0.8  | -0.5558702
2019.01.11 0     0.8  | -0.767822
2019.01.11 1     0.8  | -0.7289149
2019.01.14 0     0.8  | -0.566518
2019.01.14 1     0.8  | -0.6901025
2019.01.15 0     0.8  | -0.6919755
2019.01.15 1     0.8  | -0.667607
2019.01.16 0     0.8  | -0.6065022
2019.01.16 1     0.8  | -0.6654103
2019.01.17 0     0.8  | -0.5902623
2019.01.17 1     0.8  | -0.5125032
2019.01.18 0     0.8  | -0.7132148
2019.01.18 1     0.8  | -0.7180403
2019.01.22 0     0.8  | -0.6432544
2019.01.22 1     0.8  | -0.6953514
2019.01.23 0     0.8  | -0.7576816
2019.01.23 1     0.8  | -0.6637121
2019.01.24 0     0.8  | -0.5901536
2019.01.24 1     0.8  | -0.6906583
2019.01.25 0     0.8  | -0.5895151
2019.01.25 1     0.8  | -0.677487
```

```
2019.01.28 0     0.8  | -0.543942
2019.01.28 1     0.8  | -0.5959197
2019.01.29 0     0.8  | -0.6199022
2019.01.29 1     0.8  | -0.578271
2019.01.30 0     0.8  | -0.6203878
2019.01.30 1     0.8  | -0.4124749
2019.01.31 0     0.8  | -0.4729666
2019.01.31 1     0.8  | -0.3956205
2019.02.01 0     0.8  | -0.4602769
2019.02.01 1     0.8  | -0.6053296
2019.02.04 0     0.8  | -0.6455254
2019.02.04 1     0.8  | -0.432646
2019.02.05 0     0.8  | -0.6668544
..
```

1.2.3 3. For every month, compute the t-stat (mean/sdev) of each strategy's P&L across all (stock,days).

Compute the t-stat (mean/sdev) of each strategy's P&L across all (stock, days).

[43]:
```
tbl10: select tstat: (avg norm_PaL) % (sdev norm_PaL) by date.month, strat,␣
↪prob1 from tbl8
```

[44]:
```
tbl10
```

[44]:
```
month   strat prob1| tstat
-------------------| ----------
2019.01 0     0.8  | -0.6049641
2019.01 1     0.8  | -0.577258
2019.02 0     0.8  | -0.6248924
2019.02 1     0.8  | -0.5813537
2019.03 0     0.8  | -0.5644177
2019.03 1     0.8  | -0.5376424
2019.04 0     0.8  | -0.602292
2019.04 1     0.8  | -0.5478949
2019.05 0     0.8  | -0.5716337
2019.05 1     0.8  | -0.5144237
2019.06 0     0.8  | -0.589981
2019.06 1     0.8  | -0.5364863
2019.07 0     0.8  | -0.5459655
2019.07 1     0.8  | -0.5040475
2019.08 0     0.8  | -0.494953
2019.08 1     0.8  | -0.4993057
2019.09 0     0.8  | -0.583313
2019.09 1     0.8  | -0.5476141
2019.10 0     0.8  | -0.5715352
2019.10 1     0.8  | -0.5682119
```

```
2019.11 0     0.8  | -0.6335849
2019.11 1     0.8  | -0.5721445
2019.12 0     0.8  | -0.6366654
2019.12 1     0.8  | -0.5506822
```

1.2.4 4. Repeat Questions 1-3 for prob1 = 0.1,0.2,...,0.9.

Generate the prob list.

[45]:
```
prob_list: (1 + til 9) % 10
prob_list
```

[45]:
```
0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9
```

Repeat question 1 First, we need to write a function to calculate the P&L for each stock and day given a specific probability.

[46]:
```
PaLcalcprob:{[strat1; strat2; prob1]
    `date`id`strat`prob1 xasc raze PaLcalc[; strat1; strat2; prob1] peach␣
 ↪dt_list `date}
```

[47]:
```
tbl11: `date`id`strat`prob1 xasc raze PaLcalcprob[strat1; strat2;] peach␣
 ↪prob_list
```

[48]:
```
tbl11
```

[48]:
```
date       id strat prob1| PaL       vol          adv
-------------------------| ----------------------------------
2019.01.02 0  0     0.1  | -11475.81 0.0004776026 1.161895e+07
2019.01.02 0  0     0.2  | -1222.901 0.0004776026 1.161895e+07
2019.01.02 0  0     0.3  | -6665.199 0.0004776026 1.161895e+07
2019.01.02 0  0     0.4  | -14510.62 0.0004776026 1.161895e+07
2019.01.02 0  0     0.6  | 169.2224  0.0004776026 1.161895e+07
2019.01.02 0  0     0.7  | -16287.51 0.0004776026 1.161895e+07
2019.01.02 0  1     0.5  | -19338.33 0.0004776026 1.161895e+07
2019.01.02 0  1     0.8  | -6684.26  0.0004776026 1.161895e+07
2019.01.02 0  1     0.9  | -3847.125 0.0004776026 1.161895e+07
2019.01.02 1  0     0.1  | -39762.22 0.0004289543 4.081003e+07
2019.01.02 1  0     0.2  | -6406.699 0.0004289543 4.081003e+07
2019.01.02 1  0     0.3  | -8438.14  0.0004289543 4.081003e+07
2019.01.02 1  0     0.5  | -32921.33 0.0004289543 4.081003e+07
2019.01.02 1  0     0.6  | 21957.2   0.0004289543 4.081003e+07
2019.01.02 1  1     0.4  | -19510.66 0.0004289543 4.081003e+07
2019.01.02 1  1     0.7  | -8715.515 0.0004289543 4.081003e+07
2019.01.02 1  1     0.8  | -49612.89 0.0004289543 4.081003e+07
2019.01.02 1  1     0.9  | -2658.061 0.0004289543 4.081003e+07
```

```
2019.01.02 2  0     0.1  | 15.01538  0.0004655141 1.052341e+07
2019.01.02 2  0     0.2  | -8860.978 0.0004655141 1.052341e+07
2019.01.02 2  0     0.4  | -6344.454 0.0004655141 1.052341e+07
2019.01.02 2  0     0.6  | -10501.27 0.0004655141 1.052341e+07
2019.01.02 2  1     0.3  | -16726.6  0.0004655141 1.052341e+07
2019.01.02 2  1     0.5  | -14698.04 0.0004655141 1.052341e+07
2019.01.02 2  1     0.7  | -3767.384 0.0004655141 1.052341e+07
2019.01.02 2  1     0.8  | -14707.76 0.0004655141 1.052341e+07
2019.01.02 2  1     0.9  | -7534.994 0.0004655141 1.052341e+07
2019.01.02 3  0     0.1  | -7776.593 0.0005068115 6987232
2019.01.02 3  0     0.3  | -6855.751 0.0005068115 6987232
2019.01.02 3  0     0.4  | -10989.76 0.0005068115 6987232
2019.01.02 3  1     0.2  | -1535.883 0.0005068115 6987232
2019.01.02 3  1     0.5  | -7997.147 0.0005068115 6987232
2019.01.02 3  1     0.6  | -1667.775 0.0005068115 6987232
2019.01.02 3  1     0.7  | -4702.61  0.0005068115 6987232
2019.01.02 3  1     0.8  | -185.9899 0.0005068115 6987232
2019.01.02 3  1     0.9  | -5264.384 0.0005068115 6987232
2019.01.02 4  0     0.1  | -19397.4  0.0003931664 1.907262e+07
2019.01.02 4  0     0.4  | -13092.17 0.0003931664 1.907262e+07
2019.01.02 4  0     0.6  | -536.1819 0.0003931664 1.907262e+07
2019.01.02 4  0     0.7  | -17049.84 0.0003931664 1.907262e+07
2019.01.02 4  0     0.8  | -10607.41 0.0003931664 1.907262e+07
2019.01.02 4  1     0.2  | -18862.39 0.0003931664 1.907262e+07
2019.01.02 4  1     0.3  | -17165.5  0.0003931664 1.907262e+07
2019.01.02 4  1     0.5  | -8899.61  0.0003931664 1.907262e+07
2019.01.02 4  1     0.9  | -12486.26 0.0003931664 1.907262e+07
..
```

[49]:
```
tbl12: 0!tbl11
```

Compute the average daily P&L of randomized strategies for different probabilities.

[50]:
```
select avg PaL by prob1 from tbl12
```

[50]:
```
prob1| PaL
-----| ---------
0.1  | -10810.22
0.2  | -10747.16
0.3  | -10802.13
0.4  | -10533.67
0.5  | -10756.43
0.6  | -10686.5
0.7  | -10605.26
0.8  | -10496.24
0.9  | -10390.75
```

Compute the average daily P&L for each strategies for different probabilities.

[51]:
```
select avg PaL by strat, prob1 from tbl12
```

[51]:
```
strat prob1| PaL
-----------| ---------
0     0.1  | -10891.69
0     0.2  | -10847.24
0     0.3  | -11207.57
0     0.4  | -10597.35
0     0.5  | -10844.65
0     0.6  | -11242.96
0     0.7  | -10636.19
0     0.8  | -10715.53
0     0.9  | -10615.65
1     0.1  | -10076.16
1     0.2  | -10346.92
1     0.3  | -9856.227
1     0.4  | -10438.17
1     0.5  | -10668.33
1     0.6  | -10315.44
1     0.7  | -10592
1     0.8  | -10441.4
1     0.9  | -10365.79
```

From the previous table, it is obvious that there is a trade-off between P&L and uncertainty trade-off across A-B allocations. In other words, we need to pay more to get a better understand of the difference between two strategies.

Repeat question2 First, normalize the P&L.

[52]:
```
tbl12: update norm_PaL: PaL % adv from tbl12
```

Compute the daily t-stat (mean/sdev) of each strategy's P&L across all stocks for different probabilities.

[53]:
```
tbl13: select tstat: (avg norm_PaL) % (sdev norm_PaL) by date, strat, prob1␣
↪from tbl12
```

[54]:
```
tbl13
```

[54]:
```
date       strat prob1| tstat
----------------------| ----------
2019.01.02 0     0.1  | -0.6400416
2019.01.02 0     0.2  | -0.6381416
2019.01.02 0     0.3  | -0.7219497
2019.01.02 0     0.4  | -0.5969954
2019.01.02 0     0.5  | -0.6793502
```

```
2019.01.02 0     0.6  | -0.6059852
2019.01.02 0     0.7  | -0.5557579
2019.01.02 0     0.8  | -0.5909487
2019.01.02 0     0.9  | -0.6601294
2019.01.02 1     0.1  | -0.8280533
2019.01.02 1     0.2  | -0.589222
2019.01.02 1     0.3  | -0.463426
2019.01.02 1     0.4  | -0.4854779
2019.01.02 1     0.5  | -0.6217554
2019.01.02 1     0.6  | -0.5414928
2019.01.02 1     0.7  | -0.5814816
2019.01.02 1     0.8  | -0.5261402
2019.01.02 1     0.9  | -0.533474
2019.01.03 0     0.1  | -0.6345727
2019.01.03 0     0.2  | -0.5838619
2019.01.03 0     0.3  | -0.6381266
2019.01.03 0     0.4  | -0.5522611
2019.01.03 0     0.5  | -0.5621262
2019.01.03 0     0.6  | -0.5988506
2019.01.03 0     0.7  | -0.7017218
2019.01.03 0     0.8  | -0.4785438
2019.01.03 0     0.9  | -0.7719161
2019.01.03 1     0.1  | -0.7530135
2019.01.03 1     0.2  | -0.6978921
2019.01.03 1     0.3  | -0.614078
2019.01.03 1     0.4  | -0.6552524
2019.01.03 1     0.5  | -0.6524432
2019.01.03 1     0.6  | -0.5418031
2019.01.03 1     0.7  | -0.5491593
2019.01.03 1     0.8  | -0.6602552
2019.01.03 1     0.9  | -0.5335851
2019.01.04 0     0.1  | -0.5439521
2019.01.04 0     0.2  | -0.5406533
2019.01.04 0     0.3  | -0.6337535
2019.01.04 0     0.4  | -0.5088412
2019.01.04 0     0.5  | -0.5769809
2019.01.04 0     0.6  | -0.7082523
2019.01.04 0     0.7  | -0.570093
2019.01.04 0     0.8  | -0.680912
2019.01.04 0     0.9  | -0.6095621
..
```

Repeat question3 Compute the t-stat (mean/sdev) of each strategy's P&L across all (stock, days) for different probabilities.

[55]:
```
tbl14: select tstat: (avg norm_PaL) % (sdev norm_PaL) by date.month, strat,␣
↪prob1 from tbl12
```

[56]:
```
tbl14
```

[56]:
```
month   strat prob1| tstat
-----------------| ----------
2019.01 0     0.1  | -0.6141037
2019.01 0     0.2  | -0.5807033
2019.01 0     0.3  | -0.6264962
2019.01 0     0.4  | -0.6065307
2019.01 0     0.5  | -0.5940078
2019.01 0     0.6  | -0.6168794
2019.01 0     0.7  | -0.6421601
2019.01 0     0.8  | -0.6024044
2019.01 0     0.9  | -0.6706231
2019.01 1     0.1  | -0.6102387
2019.01 1     0.2  | -0.638001
2019.01 1     0.3  | -0.5815803
2019.01 1     0.4  | -0.6102685
2019.01 1     0.5  | -0.6241412
2019.01 1     0.6  | -0.6025455
2019.01 1     0.7  | -0.5775482
2019.01 1     0.8  | -0.5971612
2019.01 1     0.9  | -0.5828537
2019.02 0     0.1  | -0.6085034
2019.02 0     0.2  | -0.6149274
2019.02 0     0.3  | -0.6050895
2019.02 0     0.4  | -0.548277
2019.02 0     0.5  | -0.6016825
2019.02 0     0.6  | -0.597833
2019.02 0     0.7  | -0.6203094
2019.02 0     0.8  | -0.6031953
2019.02 0     0.9  | -0.6598823
2019.02 1     0.1  | -0.6367188
2019.02 1     0.2  | -0.496489
2019.02 1     0.3  | -0.5601655
2019.02 1     0.4  | -0.5708116
2019.02 1     0.5  | -0.6113385
2019.02 1     0.6  | -0.5792012
2019.02 1     0.7  | -0.5702525
2019.02 1     0.8  | -0.5752875
2019.02 1     0.9  | -0.5723636
2019.03 0     0.1  | -0.5791693
2019.03 0     0.2  | -0.5708278
2019.03 0     0.3  | -0.5897061
2019.03 0     0.4  | -0.5340019
```

```
2019.03 0     0.5  | -0.5844549
2019.03 0     0.6  | -0.6018674
2019.03 0     0.7  | -0.5851493
2019.03 0     0.8  | -0.5983374
2019.03 0     0.9  | -0.5450142
..
```

1.2.5 5. Repeat Questions 1-4 for every strategy pair. Comment on the amount of A-B testing needed based on an alpha's strength and the trader's waiting time.

This scenario is strat1 follows the ρ_2 alpha signal and strat2 does not trade.

[57]:
```
strat1: 2
strat2: 0
```

[58]:
```
tbl15: `date`id`strat`prob1 xasc raze PaLcalcprob[strat1; strat2;] peach␣
 ↪prob_list
```

[59]:
```
tbl15
```

[59]:
```
date       id strat prob1| PaL       vol          adv
-------------------------| ----------------------------------
2019.01.02 0  0     0.2  | -9497.991 0.0004776026 1.161895e+07
2019.01.02 0  0     0.4  | -16331.05 0.0004776026 1.161895e+07
2019.01.02 0  0     0.5  | -6093.432 0.0004776026 1.161895e+07
2019.01.02 0  0     0.6  | -18064.12 0.0004776026 1.161895e+07
2019.01.02 0  2     0.1  | -9442.309 0.0004776026 1.161895e+07
2019.01.02 0  2     0.3  | -4771.894 0.0004776026 1.161895e+07
2019.01.02 0  2     0.7  | 1429.436  0.0004776026 1.161895e+07
2019.01.02 0  2     0.8  | -14205.48 0.0004776026 1.161895e+07
2019.01.02 0  2     0.9  | -10600.93 0.0004776026 1.161895e+07
2019.01.02 1  0     0.1  | -23041.57 0.0004289543 4.081003e+07
2019.01.02 1  0     0.2  | -58208.01 0.0004289543 4.081003e+07
2019.01.02 1  0     0.4  | -5073.932 0.0004289543 4.081003e+07
2019.01.02 1  0     0.5  | -8566.259 0.0004289543 4.081003e+07
2019.01.02 1  0     0.7  | -13675.61 0.0004289543 4.081003e+07
2019.01.02 1  2     0.3  | -25839.22 0.0004289543 4.081003e+07
2019.01.02 1  2     0.6  | -25613.22 0.0004289543 4.081003e+07
2019.01.02 1  2     0.8  | -13140.98 0.0004289543 4.081003e+07
2019.01.02 1  2     0.9  | -25631.75 0.0004289543 4.081003e+07
2019.01.02 2  0     0.1  | -1812.416 0.0004655141 1.052341e+07
2019.01.02 2  0     0.2  | -10246.27 0.0004655141 1.052341e+07
2019.01.02 2  0     0.5  | -2632.506 0.0004655141 1.052341e+07
2019.01.02 2  2     0.3  | -7629.429 0.0004655141 1.052341e+07
2019.01.02 2  2     0.4  | 2979.83   0.0004655141 1.052341e+07
2019.01.02 2  2     0.6  | -7606.685 0.0004655141 1.052341e+07
2019.01.02 2  2     0.7  | -6837.902 0.0004655141 1.052341e+07
```

```
2019.01.02 2  2     0.8  | -6311.413 0.0004655141 1.052341e+07
2019.01.02 2  2     0.9  | 1179.581  0.0004655141 1.052341e+07
2019.01.02 3  0     0.1  | -18260.83 0.0005068115 6987232
2019.01.02 3  0     0.2  | -1229.942 0.0005068115 6987232
2019.01.02 3  0     0.3  | -2931.334 0.0005068115 6987232
2019.01.02 3  0     0.4  | 2309.14   0.0005068115 6987232
2019.01.02 3  0     0.5  | -20601.09 0.0005068115 6987232
2019.01.02 3  0     0.6  | 3267.795  0.0005068115 6987232
2019.01.02 3  0     0.7  | -2826.098 0.0005068115 6987232
2019.01.02 3  2     0.8  | -2875.269 0.0005068115 6987232
2019.01.02 3  2     0.9  | -18162.44 0.0005068115 6987232
2019.01.02 4  0     0.1  | -4084.675 0.0003931664 1.907262e+07
2019.01.02 4  0     0.2  | -23486.49 0.0003931664 1.907262e+07
2019.01.02 4  0     0.6  | -12780.37 0.0003931664 1.907262e+07
2019.01.02 4  2     0.3  | -3145.149 0.0003931664 1.907262e+07
2019.01.02 4  2     0.4  | -21739.72 0.0003931664 1.907262e+07
2019.01.02 4  2     0.5  | -24696.06 0.0003931664 1.907262e+07
2019.01.02 4  2     0.7  | -2911.462 0.0003931664 1.907262e+07
2019.01.02 4  2     0.8  | -18027.1  0.0003931664 1.907262e+07
2019.01.02 4  2     0.9  | -4918.887 0.0003931664 1.907262e+07
..
```

[60]:
```
tbl16: 0!tbl15
```

Compute the average daily P&L of randomized strategies for different probabilities.

[61]:
```
select avg PaL by prob1 from tbl16
```

[61]:
```
prob1| PaL
-----| ---------
0.1  | -10482.47
0.2  | -10169.9
0.3  | -10002.81
0.4  | -9606.062
0.5  | -9311.511
0.6  | -9208.628
0.7  | -8822.697
0.8  | -8503.346
0.9  | -8184.926
```

Compute the average daily P&L for each strategies for different probabilities.

[62]:
```
select avg PaL by strat, prob1 from tbl16
```

[62]:
```
strat prob1| PaL
-----------| ---------
```

```
0     0.1  | -10764.4
0     0.2  | -10748.65
0     0.3  | -10993.09
0     0.4  | -10880.85
0     0.5  | -10651.72
0     0.6  | -10969.17
0     0.7  | -11077.22
0     0.8  | -10611.69
0     0.9  | -11362.66
2     0.1  | -7942.059
2     0.2  | -7855.433
2     0.3  | -7692.449
2     0.4  | -7694.274
2     0.5  | -7973.207
2     0.6  | -8034.689
2     0.7  | -7856.382
2     0.8  | -7976.137
2     0.9  | -7832.295
```

Normalize P&L.

[63]:
```
tbl16: update norm_PaL: PaL % adv from tbl16
```

Compute the daily t-stat (mean/sdev) of each strategy's P&L across all stocks for different probabilities.

[64]:
```
select tstat: (avg norm_PaL) % (sdev norm_PaL) by date, strat, prob1 from tbl16
```

[64]:
```
date       strat prob1| tstat
----------------------| ----------
2019.01.02 0     0.1  | -0.6147677
2019.01.02 0     0.2  | -0.6523812
2019.01.02 0     0.3  | -0.5643407
2019.01.02 0     0.4  | -0.5882835
2019.01.02 0     0.5  | -0.597587
2019.01.02 0     0.6  | -0.7225948
2019.01.02 0     0.7  | -0.631868
2019.01.02 0     0.8  | -0.6090861
2019.01.02 0     0.9  | -0.4342122
2019.01.02 2     0.1  | -0.3945615
2019.01.02 2     0.2  | -0.3540183
2019.01.02 2     0.3  | -0.3500048
2019.01.02 2     0.4  | -0.4131702
2019.01.02 2     0.5  | -0.4910068
2019.01.02 2     0.6  | -0.4013399
2019.01.02 2     0.7  | -0.443944
2019.01.02 2     0.8  | -0.3867238
```

```
2019.01.02 2     0.9  | -0.5305396
2019.01.03 0     0.1  | -0.5917071
2019.01.03 0     0.2  | -0.7049498
2019.01.03 0     0.3  | -0.5782391
2019.01.03 0     0.4  | -0.6706955
2019.01.03 0     0.5  | -0.5915724
2019.01.03 0     0.6  | -0.6065077
2019.01.03 0     0.7  | -0.6873409
2019.01.03 0     0.8  | -0.5971306
2019.01.03 0     0.9  | -0.6165776
2019.01.03 2     0.1  | -0.6903603
2019.01.03 2     0.2  | -0.5354441
2019.01.03 2     0.3  | -0.6477765
2019.01.03 2     0.4  | -0.4851113
2019.01.03 2     0.5  | -0.5426214
2019.01.03 2     0.6  | -0.5716509
2019.01.03 2     0.7  | -0.6292966
2019.01.03 2     0.8  | -0.5653662
2019.01.03 2     0.9  | -0.4953553
2019.01.04 0     0.1  | -0.603792
2019.01.04 0     0.2  | -0.5171978
2019.01.04 0     0.3  | -0.5831731
2019.01.04 0     0.4  | -0.5992666
2019.01.04 0     0.5  | -0.6366883
2019.01.04 0     0.6  | -0.6839105
2019.01.04 0     0.7  | -0.6889733
2019.01.04 0     0.8  | -0.5747156
2019.01.04 0     0.9  | -0.6122315
..
```

Compute the t-stat (mean/sdev) of each strategy's P&L across all (stock, days) for different probabilities.

[65]:
```
select tstat: (avg norm_PaL) % (sdev norm_PaL) by date.month, strat, prob1 from␣
 ↪tbl16
```

[65]:
```
month   strat prob1| tstat
-------------------| ----------
2019.01 0     0.1  | -0.5859134
2019.01 0     0.2  | -0.5996984
2019.01 0     0.3  | -0.6270811
2019.01 0     0.4  | -0.6184797
2019.01 0     0.5  | -0.598966
2019.01 0     0.6  | -0.628067
2019.01 0     0.7  | -0.637853
2019.01 0     0.8  | -0.6016745
2019.01 0     0.9  | -0.6325047
```

```
2019.01 2     0.1  | -0.5072341
2019.01 2     0.2  | -0.5258881
2019.01 2     0.3  | -0.553598
2019.01 2     0.4  | -0.4600281
2019.01 2     0.5  | -0.5334656
2019.01 2     0.6  | -0.5153421
2019.01 2     0.7  | -0.5182826
2019.01 2     0.8  | -0.5160768
2019.01 2     0.9  | -0.516929
2019.02 0     0.1  | -0.5901041
2019.02 0     0.2  | -0.6029969
2019.02 0     0.3  | -0.6011092
2019.02 0     0.4  | -0.5770402
2019.02 0     0.5  | -0.5918283
2019.02 0     0.6  | -0.6170187
2019.02 0     0.7  | -0.6364158
2019.02 0     0.8  | -0.5506304
2019.02 0     0.9  | -0.6651779
2019.02 2     0.1  | -0.5183816
2019.02 2     0.2  | -0.485689
2019.02 2     0.3  | -0.4780717
2019.02 2     0.4  | -0.4667049
2019.02 2     0.5  | -0.4376216
2019.02 2     0.6  | -0.4742507
2019.02 2     0.7  | -0.477777
2019.02 2     0.8  | -0.4914517
2019.02 2     0.9  | -0.462539
2019.03 0     0.1  | -0.5597417
2019.03 0     0.2  | -0.5574554
2019.03 0     0.3  | -0.5779457
2019.03 0     0.4  | -0.5621122
2019.03 0     0.5  | -0.5833959
2019.03 0     0.6  | -0.5911106
2019.03 0     0.7  | -0.5710055
2019.03 0     0.8  | -0.5490151
2019.03 0     0.9  | -0.6182458
..
```

This scenario is strat1 follows the ρ_1 alpha signal and strat2 follows the ρ_2 alpha signal.

[66]:
```
strat1: 1
strat2: 2
```

[67]:
```
tbl17: `date`id`strat`prob1 xasc raze PaLcalcprob[strat1; strat2;] peach␣
 ↪prob_list
```

[68]:
```
tbl17
```

[68]:

date	id	strat	prob1	PaL	vol	adv
2019.01.02	0	1	0.3	-12186.82	0.0004776026	1.161895e+07
2019.01.02	0	1	0.6	-8463.46	0.0004776026	1.161895e+07
2019.01.02	0	1	0.7	-7697.683	0.0004776026	1.161895e+07
2019.01.02	0	1	0.8	-4730.391	0.0004776026	1.161895e+07
2019.01.02	0	1	0.9	1461.579	0.0004776026	1.161895e+07
2019.01.02	0	2	0.1	-1477.103	0.0004776026	1.161895e+07
2019.01.02	0	2	0.2	-8397.54	0.0004776026	1.161895e+07
2019.01.02	0	2	0.4	-10967.57	0.0004776026	1.161895e+07
2019.01.02	0	2	0.5	-9862.647	0.0004776026	1.161895e+07
2019.01.02	1	1	0.2	-26638.12	0.0004289543	4.081003e+07
2019.01.02	1	1	0.3	-27143.58	0.0004289543	4.081003e+07
2019.01.02	1	1	0.5	-24807.35	0.0004289543	4.081003e+07
2019.01.02	1	1	0.7	-55481.48	0.0004289543	4.081003e+07
2019.01.02	1	1	0.9	-90790.42	0.0004289543	4.081003e+07
2019.01.02	1	2	0.1	-5257.948	0.0004289543	4.081003e+07
2019.01.02	1	2	0.4	-52691.81	0.0004289543	4.081003e+07
2019.01.02	1	2	0.6	-9697.591	0.0004289543	4.081003e+07
2019.01.02	1	2	0.8	-69662.19	0.0004289543	4.081003e+07
2019.01.02	2	1	0.3	7186.235	0.0004655141	1.052341e+07
2019.01.02	2	1	0.7	-5065.114	0.0004655141	1.052341e+07
2019.01.02	2	1	0.8	-9812.493	0.0004655141	1.052341e+07
2019.01.02	2	1	0.9	-6703.791	0.0004655141	1.052341e+07
2019.01.02	2	2	0.1	-7150.989	0.0004655141	1.052341e+07
2019.01.02	2	2	0.2	-1432.922	0.0004655141	1.052341e+07
2019.01.02	2	2	0.4	5448.851	0.0004655141	1.052341e+07
2019.01.02	2	2	0.5	-10008.56	0.0004655141	1.052341e+07
2019.01.02	2	2	0.6	12725.31	0.0004655141	1.052341e+07
2019.01.02	3	1	0.1	-9118.794	0.0005068115	6987232
2019.01.02	3	1	0.4	-639.7484	0.0005068115	6987232
2019.01.02	3	1	0.7	-2166.058	0.0005068115	6987232
2019.01.02	3	1	0.8	-16483	0.0005068115	6987232
2019.01.02	3	1	0.9	-14781.05	0.0005068115	6987232
2019.01.02	3	2	0.2	-13737.57	0.0005068115	6987232
2019.01.02	3	2	0.3	869.6803	0.0005068115	6987232
2019.01.02	3	2	0.5	-6241.152	0.0005068115	6987232
2019.01.02	3	2	0.6	-3330.05	0.0005068115	6987232
2019.01.02	4	1	0.1	-11649.54	0.0003931664	1.907262e+07
2019.01.02	4	1	0.5	-14454.45	0.0003931664	1.907262e+07
2019.01.02	4	1	0.6	-5522.665	0.0003931664	1.907262e+07
2019.01.02	4	1	0.7	-14083.85	0.0003931664	1.907262e+07
2019.01.02	4	2	0.2	-7133.617	0.0003931664	1.907262e+07
2019.01.02	4	2	0.3	2100.758	0.0003931664	1.907262e+07
2019.01.02	4	2	0.4	3676.535	0.0003931664	1.907262e+07
2019.01.02	4	2	0.8	-12834.53	0.0003931664	1.907262e+07
2019.01.02	4	2	0.9	-6802.551	0.0003931664	1.907262e+07

..

[69]:
```
tbl18: 0!tbl17
```

Compute the average daily P&L of randomized strategies for different probabilities.

[70]:
```
select avg PaL by prob1 from tbl18
```

[70]:
```
prob1| PaL
-----| ---------
0.1  | -8191.806
0.2  | -8430.946
0.3  | -8712.834
0.4  | -8881.573
0.5  | -9113.344
0.6  | -9361.96
0.7  | -9736.228
0.8  | -9976.229
0.9  | -10282.99
```

Compute the average daily P&L for each strategies for different probabilities.

[71]:
```
select avg PaL by strat, prob1 from tbl18
```

[71]:
```
strat prob1| PaL
-----------| ---------
1     0.1  | -10374.87
1     0.2  | -10435.77
1     0.3  | -10239.73
1     0.4  | -10489.08
1     0.5  | -10241.77
1     0.6  | -10201.55
1     0.7  | -10588.67
1     0.8  | -10404.65
1     0.9  | -10572.6
2     0.1  | -7949.532
2     0.2  | -7929.624
2     0.3  | -8058.363
2     0.4  | -7809.679
2     0.5  | -7983.311
2     0.6  | -8102.84
2     0.7  | -7747.378
2     0.8  | -8262.965
2     0.9  | -7673.12
```

Normalize P&L.

[72]:
```
tbl18: update norm_PaL: PaL % adv from tbl18
```

Compute the daily t-stat (mean/sdev) of each strategy's P&L across all stocks for different probabilities.

[73]:
```
select tstat: (avg norm_PaL) % (sdev norm_PaL) by date, strat, prob1 from tbl18
```

[73]:

date	strat	prob1	tstat
2019.01.02	1	0.1	-0.7095423
2019.01.02	1	0.2	-0.6514291
2019.01.02	1	0.3	-0.4856018
2019.01.02	1	0.4	-0.5133155
2019.01.02	1	0.5	-0.5696158
2019.01.02	1	0.6	-0.5204644
2019.01.02	1	0.7	-0.5633631
2019.01.02	1	0.8	-0.6633451
2019.01.02	1	0.9	-0.6006956
2019.01.02	2	0.1	-0.4446923
2019.01.02	2	0.2	-0.4745992
2019.01.02	2	0.3	-0.5034083
2019.01.02	2	0.4	-0.407319
2019.01.02	2	0.5	-0.4165594
2019.01.02	2	0.6	-0.354369
2019.01.02	2	0.7	-0.4414928
2019.01.02	2	0.8	-0.7421608
2019.01.02	2	0.9	-0.2729681
2019.01.03	1	0.1	-0.7017412
2019.01.03	1	0.2	-0.6436996
2019.01.03	1	0.3	-0.7731613
2019.01.03	1	0.4	-0.5465922
2019.01.03	1	0.5	-0.5590623
2019.01.03	1	0.6	-0.649788
2019.01.03	1	0.7	-0.6437841
2019.01.03	1	0.8	-0.6045001
2019.01.03	1	0.9	-0.610173
2019.01.03	2	0.1	-0.5534337
2019.01.03	2	0.2	-0.5912838
2019.01.03	2	0.3	-0.5346446
2019.01.03	2	0.4	-0.5666877
2019.01.03	2	0.5	-0.5473863
2019.01.03	2	0.6	-0.6373784
2019.01.03	2	0.7	-0.5159313
2019.01.03	2	0.8	-0.6130931
2019.01.03	2	0.9	-0.3830813
2019.01.04	1	0.1	-0.3065276
2019.01.04	1	0.2	-0.5403348
2019.01.04	1	0.3	-0.6754307

```
2019.01.04 1     0.4  | -0.5528484
2019.01.04 1     0.5  | -0.5622415
2019.01.04 1     0.6  | -0.5236789
2019.01.04 1     0.7  | -0.5861377
2019.01.04 1     0.8  | -0.4794231
2019.01.04 1     0.9  | -0.5780627
..
```

Compute the t-stat (mean/sdev) of each strategy's P&L across all (stock, days) for different probabilities.

[74]:
```
select tstat: (avg norm_PaL) % (sdev norm_PaL) by date.month, strat, prob1 from␣
↪tbl18
```

[74]:
```
month   strat prob1| tstat
-------------------| ----------
2019.01 1     0.1  | -0.5946879
2019.01 1     0.2  | -0.6141946
2019.01 1     0.3  | -0.6277323
2019.01 1     0.4  | -0.59373
2019.01 1     0.5  | -0.5968321
2019.01 1     0.6  | -0.6095024
2019.01 1     0.7  | -0.6086038
2019.01 1     0.8  | -0.6033343
2019.01 1     0.9  | -0.606746
2019.01 2     0.1  | -0.5157519
2019.01 2     0.2  | -0.5332482
2019.01 2     0.3  | -0.5344774
2019.01 2     0.4  | -0.5024997
2019.01 2     0.5  | -0.5069393
2019.01 2     0.6  | -0.5169131
2019.01 2     0.7  | -0.5468923
2019.01 2     0.8  | -0.5974663
2019.01 2     0.9  | -0.5079425
2019.02 1     0.1  | -0.5489733
2019.02 1     0.2  | -0.5669973
2019.02 1     0.3  | -0.6020029
2019.02 1     0.4  | -0.5754923
2019.02 1     0.5  | -0.5909739
2019.02 1     0.6  | -0.598995
2019.02 1     0.7  | -0.583556
2019.02 1     0.8  | -0.5739094
2019.02 1     0.9  | -0.5793133
2019.02 2     0.1  | -0.4601397
2019.02 2     0.2  | -0.4971616
2019.02 2     0.3  | -0.486486
2019.02 2     0.4  | -0.4802209
```

```
2019.02 2     0.5  | -0.4661813
2019.02 2     0.6  | -0.5144656
2019.02 2     0.7  | -0.5252097
2019.02 2     0.8  | -0.4777162
2019.02 2     0.9  | -0.497662
2019.03 1     0.1  | -0.5649989
2019.03 1     0.2  | -0.5564252
2019.03 1     0.3  | -0.5336704
2019.03 1     0.4  | -0.5706506
2019.03 1     0.5  | -0.5410951
2019.03 1     0.6  | -0.5425729
2019.03 1     0.7  | -0.5333615
2019.03 1     0.8  | -0.5350828
2019.03 1     0.9  | -0.5392401
..
```

From the previous test, we find that compared to strategy which follows the ρ_1 alpha signal, the strategy which follows the ρ_2 alpha signal will have approximately 6 times larger t-stat.

Suppose we want to test whether the strategy could make money, we could do the following hypothesis testing:

$H_0 : P\&L = 0$ and $H_1 : P\&L > 0$.

Suppose we have n samples then we can reject H_0 when t-stat $> \frac{1.96}{\sqrt{n}}$ with 95% confidence.

Hence, when we have larger alpha strength, we don't need many samples and trader's waiting time will be small.

[ ]: