Collaborative Assignment 2

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## Background

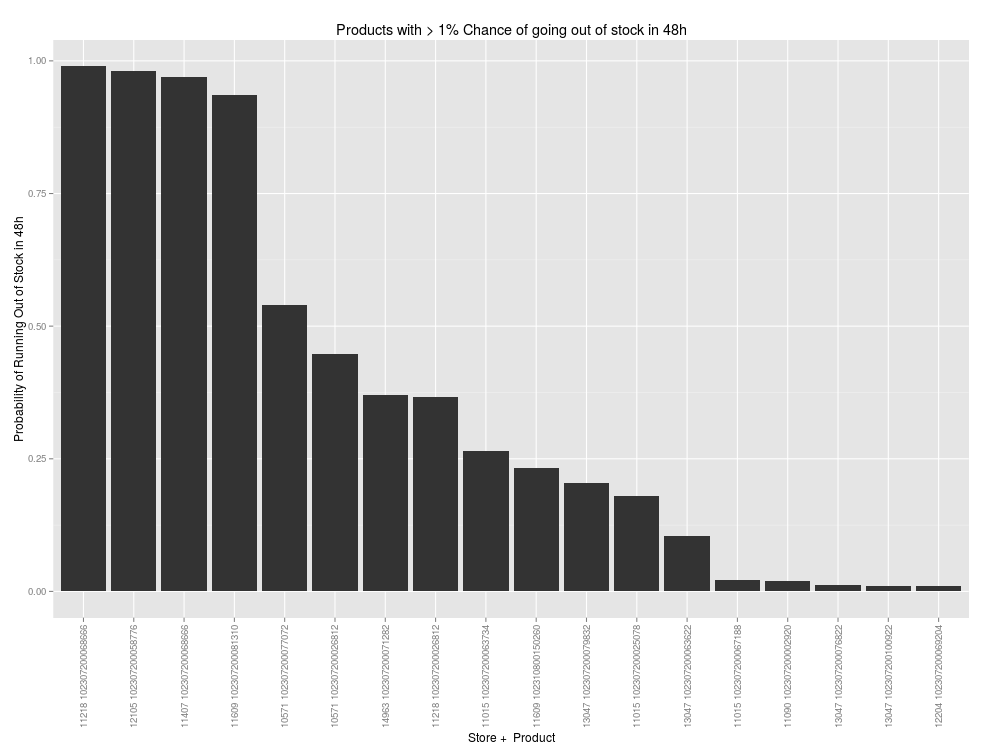
SPS retail manufacturing company is interested to find out whether stores are likely to run out of stock for any of its products in the next seven days. Client has two weeks of data for various stores and products available. Client would like a summary of products that will likely run out of stock the following week.

## Recommendation

Based on our analysis and assumptions, we recommend stocking up on the following products as soon as possible, as their probability of running out of stock in two days is at least 1%:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Store** | **Product** | **P1** | **P2** | **P3** | **P4** | **P5** | **P6** | **P7** |
| 11218 | 102307200068666 | 0.9007 | 0.9903 | 0.9995 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |
| 12105 | 102307200058776 | 0.8566 | 0.9808 | 0.9971 | 0.9995 | 0.9997 | 1.0000 | 1.0000 |
| 11407 | 102307200068666 | 0.8259 | 0.9693 | 0.9948 | 0.9994 | 1.0000 | 1.0000 | 1.0000 |
| 11609 | 102307200081310 | 0.7505 | 0.9351 | 0.9831 | 0.9955 | 0.9990 | 0.9997 | 1.0000 |
| 10571 | 102307200077072 | 0.3238 | 0.5397 | 0.6847 | 0.7895 | 0.8566 | 0.9016 | 0.9367 |
| 14963 | 102307200071282 | 0.2113 | 0.3710 | 0.5012 | 0.6050 | 0.6821 | 0.7529 | 0.8070 |
| 10571 | 102307200026812 | 0.1774 | 0.4484 | 0.6677 | 0.8112 | 0.8968 | 0.9440 | 0.9703 |
| 11218 | 102307200026812 | 0.0935 | 0.3660 | 0.6318 | 0.8061 | 0.9054 | 0.9535 | 0.9783 |
| 11609 | 102310800150260 | 0.0811 | 0.2323 | 0.4008 | 0.5456 | 0.6663 | 0.7595 | 0.8297 |
| 11015 | 102307200025078 | 0.0577 | 0.1798 | 0.3217 | 0.4506 | 0.5744 | 0.6734 | 0.7522 |
| 13047 | 102307200079832 | 0.0289 | 0.2046 | 0.4614 | 0.6771 | 0.8260 | 0.9119 | 0.9591 |
| 11015 | 102307200063734 | 0.0222 | 0.2647 | 0.6188 | 0.8560 | 0.9553 | 0.9870 | 0.9968 |
| 13047 | 102307200063622 | 0.0095 | 0.1041 | 0.3119 | 0.5463 | 0.7398 | 0.8599 | 0.9349 |
| 13047 | 102307200100922 | 0.0034 | 0.0111 | 0.0243 | 0.0403 | 0.0592 | 0.0789 | 0.1040 |
| 12204 | 102307200069204 | 0.0025 | 0.0108 | 0.0242 | 0.0414 | 0.0603 | 0.0813 | 0.1054 |

Here is a visual representation of the above at-risk products:



For a full listing of results, check out the “Full Results” section.

## Data Assumptions

* Demand for each product follows a Poisson distribution.
* A product spends a day in transit from distribution center to store. When a product is shipped from distribution center, it will be available the next day in store.
* Daily product demand is calculated as previous day’s stock reduced by current day’s stock plus any products received in transit: .
  + Transit that takes longer than a day is verified by = and

## Data Discrepancy

* For some stores, product quantity in stock was negative. These stores were excluded from this analysis.
* For some stores, calculated daily demand was negative. A common cause was a sudden jump in stock quantity. This may have resulted from returns or some other reason. These stores will be excluded from this analysis until the cause can be clarified and accounted for. See Data Recommendations section as well.

## Analysis

After preliminary data management process and removing data discrepancies, the resulting dataset includes product quantity in stock and transit for 216 distinct store and product combinations. Check Code Snippet #1 in the appendix.

For each store and product combination, the mean daily demand was calculated using data from the previous two weeks. Individual mean values served as lambda values for Poisson distribution used to simulate demand for the following 7 days. Check Code Snippet #2 in the appendix.

Weekly demand was simulated for N = 10000 iterations. Using these results, we calculated the out of stock probability as the proportion of simulations that end up with 0 products left in stock per day. Check Code Snippet #3 in the appendix as well as the full final result in the “Full Results” section.

We also look at the assumption of two-day transit for items being delivered to the store. The percentage of shipments that took one day is about 75%; shipments taking two days account for 19%. Therefore, the percentage of shipments that are at most two day is about 94%. It seems that the transit time is more likely to take one day. The assumption could be updated to say “that shipments take at most two days”. It can also be updated to say “The time a shipment is in transit is expected to be one day”. Check Code Snippet #4 in the appendix.

## Data Recommendations

Based on using this data, here are some suggestions for the future:

* Determining demand based on the InStock data, as well as InTransit and AtCenter, is unreliable and difficult. This data should instead be gathered from sales records for that day, which would be much more accurate.
* Reasoning for negative stock should be recorded as this may be a result of back orders, clerical error, or other cause. Likewise, the reason for negative demand is unclear and may be a result of same day deliveries (not captured as Transit or AtCenter), product returns, or other. For this analysis, products with either negative stock or demand were excluded but perhaps not appropriately if further information were available.

## Appendix

* Snippet #1: Code to Load Data, Filter Negative InStock Rows: Lines 7 – 22
* Snippet #2: Code to Calculate demand, remove any negative demand: Lines 23 – 54
* Snippet #3: Simulate demand and find probabilities of running out of stock: Lines 79 - 121
* Snippet #4: Calculating transit time distribution: Lines 127 - end

## R Code

Link to the final source code can be found here: <https://github.com/jquacinella/IS606_Collab_2/blob/master/606group2.R>

## Full Results

Here is the full result of store and product combinations and their daily probability of running out, sorted by the probability of running out in one day (descending):

StoreProduct P1 P2 P3 P4 P5 P6 P7

11218 102307200068666 0.9007 0.9903 0.9995 1.0000 1.0000 1.0000 1.0000

12105 102307200058776 0.8566 0.9808 0.9971 0.9995 0.9997 1.0000 1.0000

11407 102307200068666 0.8259 0.9693 0.9948 0.9994 1.0000 1.0000 1.0000

11609 102307200081310 0.7505 0.9351 0.9831 0.9955 0.9990 0.9997 1.0000

10571 102307200077072 0.3238 0.5397 0.6847 0.7895 0.8566 0.9016 0.9367

14963 102307200071282 0.2113 0.3710 0.5012 0.6050 0.6821 0.7529 0.8070

10571 102307200026812 0.1774 0.4484 0.6677 0.8112 0.8968 0.9440 0.9703

11218 102307200026812 0.0935 0.3660 0.6318 0.8061 0.9054 0.9535 0.9783

11609 102310800150260 0.0811 0.2323 0.4008 0.5456 0.6663 0.7595 0.8297

11015 102307200025078 0.0577 0.1798 0.3217 0.4506 0.5744 0.6734 0.7522

13047 102307200079832 0.0289 0.2046 0.4614 0.6771 0.8260 0.9119 0.9591

11015 102307200063734 0.0222 0.2647 0.6188 0.8560 0.9553 0.9870 0.9968

13047 102307200063622 0.0095 0.1041 0.3119 0.5463 0.7398 0.8599 0.9349

13047 102307200100922 0.0034 0.0111 0.0243 0.0403 0.0592 0.0789 0.1040

13047 102307200076822 0.0026 0.0130 0.0334 0.0697 0.1110 0.1596 0.2156

12204 102307200069204 0.0025 0.0108 0.0242 0.0414 0.0603 0.0813 0.1054

11090 102307200002920 0.0009 0.0196 0.0896 0.2008 0.3470 0.4932 0.6287

11015 102307200067188 0.0008 0.0211 0.0853 0.2018 0.3474 0.4928 0.6263

11090 102307200067986 0.0004 0.0030 0.0123 0.0349 0.0783 0.1396 0.2158

14963 102307200082318 0.0004 0.0037 0.0152 0.0390 0.0823 0.1468 0.2268

10571 102307200081308 0.0003 0.0026 0.0144 0.0383 0.0837 0.1484 0.2233

11167 102307200077066 0.0003 0.0048 0.0235 0.0660 0.1390 0.2301 0.3290

11218 102307200079832 0.0002 0.0031 0.0243 0.0802 0.1788 0.3134 0.4587

11132 102307200051728 0.0001 0.0042 0.0347 0.1395 0.3103 0.5146 0.6919

11218 102307200064440 0.0001 0.0003 0.0026 0.0090 0.0216 0.0395 0.0696

11575 102307200067182 0.0001 0.0049 0.0336 0.1210 0.2722 0.4565 0.6259

11609 102307200063624 0.0001 0.0069 0.0466 0.1269 0.2482 0.3985 0.5439

12236 102307200039258 0.0001 0.0041 0.0232 0.0666 0.1379 0.2354 0.3521

10571 102307200002148 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

10571 102307200031898 0.0000 0.0000 0.0027 0.0152 0.0445 0.0997 0.1800

10571 102307200051672 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

10571 102307200063606 0.0000 0.0000 0.0004 0.0013 0.0105 0.0405 0.0973

10571 102307200065038 0.0000 0.0000 0.0009 0.0033 0.0064 0.0136 0.0230

10571 102307200071952 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0001

10571 102307200072006 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

10571 102307200072010 0.0000 0.0000 0.0000 0.0000 0.0001 0.0007 0.0026

10571 102307200072028 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

10571 102307200074292 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

10571 102307200078432 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

10571 102307200078722 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

11015 102307200002148 0.0000 0.0000 0.0000 0.0000 0.0006 0.0008 0.0019

11015 102307200020716 0.0000 0.0000 0.0000 0.0000 0.0000 0.0002 0.0002

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11015 102307200067986 0.0000 0.0000 0.0000 0.0000 0.0000 0.0002 0.0002

11015 102307200068660 0.0000 0.0000 0.0000 0.0000 0.0005 0.0036 0.0109

11015 102307200068664 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

11015 102307200071940 0.0000 0.0000 0.0000 0.0002 0.0007 0.0029 0.0070

11015 102307200074612 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

11015 102307200074746 0.0000 0.0000 0.0015 0.1913 0.8154 0.9931 1.0000

11015 102307200080838 0.0000 0.0000 0.0003 0.0011 0.0025 0.0040 0.0069

11015 102307200081034 0.0000 0.0000 0.0000 0.0000 0.0000 0.0002 0.0006

11015 102307200082700 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

11015 102421077713040 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

11090 102307200030136 0.0000 0.0003 0.0020 0.0053 0.0142 0.0291 0.0518

11090 102307200057650 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

11090 102307200066162 0.0000 0.0004 0.0033 0.0129 0.0331 0.0630 0.1077

11090 102307200071282 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

11090 102307200074780 0.0000 0.0095 0.3042 0.7981 0.9798 0.9991 1.0000

11090 102307200134660 0.0000 0.0000 0.0002 0.0007 0.0012 0.0027 0.0055

11090 102310800150286 0.0000 0.0003 0.0015 0.0034 0.0077 0.0157 0.0249

11132 102307200026782 0.0000 0.0001 0.0003 0.0018 0.0051 0.0123 0.0227

11132 102307200037952 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

11132 102307200057480 0.0000 0.0000 0.0000 0.0000 0.0000 0.0002 0.0006

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11132 102307200074806 0.0000 0.0000 0.0018 0.0246 0.1104 0.2756 0.4927

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11167 102307200030648 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

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11218 102307200038604 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

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11873 102307200071288 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0001

11873 102307200074748 0.0000 0.0009 0.0070 0.0208 0.0477 0.0880 0.1386

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11873 102310800072818 0.0000 0.0001 0.0030 0.0158 0.0520 0.1267 0.2310

11873 102421077712960 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12020 102307200024706 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

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12020 102307200030136 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12020 102307200030648 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0001

12020 102307200039258 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12020 102307200065038 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12020 102307200074288 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12020 102307200074806 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12020 102307200077062 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12020 102307200082318 0.0000 0.0010 0.0056 0.0190 0.0442 0.0793 0.1334

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12105 102307200065792 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12105 102307200071282 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12105 102307200071948 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0003

12105 102307200074748 0.0000 0.0000 0.0000 0.0003 0.0018 0.0110 0.0297

12105 102307200074766 0.0000 0.0000 0.0000 0.0000 0.0000 0.0008 0.0063

12105 102307200074802 0.0000 0.0000 0.0000 0.0000 0.0000 0.0002 0.0015

12105 102307200077068 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12105 102307200081548 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12204 102307200038096 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0002

12204 102307200038366 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12204 102307200067990 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12204 102307200071948 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12204 102307200072030 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12236 102307200006028 0.0000 0.0002 0.0062 0.0390 0.1300 0.2738 0.4513

12236 102307200025714 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12236 102307200036690 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12236 102307200037810 0.0000 0.0000 0.0005 0.0014 0.0037 0.0099 0.0213

12236 102307200037964 0.0000 0.0000 0.0000 0.0000 0.0000 0.0001 0.0020

12236 102307200072014 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12236 102307200073852 0.0000 0.0000 0.0000 0.0038 0.0873 0.3890 0.7560

12236 102307200078722 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12236 102307200079622 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

12236 103788201631842 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

13047 102307200002190 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

13047 102307200006008 0.0000 0.0000 0.0000 0.0002 0.0004 0.0010 0.0027

13047 102307200028388 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

13047 102307200057650 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0003

13047 102307200067188 0.0000 0.0000 0.0000 0.0001 0.0005 0.0006 0.0018

13047 102307200067988 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

13047 102307200072008 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

13047 102307200074850 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

13047 102307200081312 0.0000 0.0006 0.0029 0.0080 0.0206 0.0408 0.0687

13047 102307200144888 0.0000 0.0000 0.0003 0.0026 0.0122 0.0386 0.0994

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14963 102307200023948 0.0000 0.0000 0.0007 0.0051 0.0177 0.0454 0.0980

14963 102307200025554 0.0000 0.0004 0.0011 0.0027 0.0072 0.0137 0.0245

14963 102307200067182 0.0000 0.0000 0.0000 0.0000 0.0000 0.0001 0.0004

14963 102307200074290 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000

14963 102307200081312 0.0000 0.0002 0.0006 0.0028 0.0060 0.0136 0.0226