Cookbook

This is a repository for *short and sweet* examples and links for useful pandas recipes. We encourage users to add to this documentation.

Adding interesting links and/or inline examples to this section is a great *First Pull Request*.

Simplified, condensed, new-user friendly, in-line examples have been inserted where possible to augment the Stack-Overflow and GitHub links. Many of the links contain expanded information, above what the in-line examples offer.

Pandas (pd) and Numpy (np) are the only two abbreviated imported modules. The rest are kept explicitly imported for newer users.

These examples are written for python 3.4. Minor tweaks might be necessary for earlier python versions.

Idioms

These are some neat pandas idioms

if-then/if-then-else on one column, and assignment to another one or more columns:

```
In [1]: df = pd.DataFrame(
   ...:     {'AAA' : [4,5,6,7], 'BBB' : [10,20,30,40],'CCC' : [100,50,-30,-50]}); df
   ...:
Out[1]:
   AAA  BBB  CCC
0    4   10  100
1    5   20   50
2    6   30  -30
3    7   40  -50
```

if-then...

An if-then on one column

```
In [2]: df.loc[df.AAA >= 5,'BBB'] = -1; df
```

```
Out[2]:
  AAA  BBB  CCC
0   4   10  100
1   5   -1   50
2   6   -1  -30
3   7   -1  -50
```

An if-then with assignment to 2 columns:

```
In [3]: df.loc[df.AAA >= 5,['BBB','CCC']] = 555; df
Out[3]:
  AAA  BBB  CCC
0   4   10  100
1   5  555  555
2   6  555  555
3   7  555  555
```

Add another line with different logic, to do the -else

```
In [4]: df.loc[df.AAA < 5,['BBB','CCC']] = 2000; df
Out[4]:
  AAA   BBB   CCC
0   4  2000  2000
1   5   555   555
2   6   555   555
3   7   555   555
```

Or use pandas where after you've set up a mask

```
In [5]: df_mask = pd.DataFrame({'AAA' : [True] * 4, 'BBB' : [False] * 4,'CCC' : [True,False

In [6]: df.where(df_mask,-1000)
Out[6]:
  AAA   BBB   CCC
0   4 -1000  2000
1   5 -1000 -1000
2   6 -1000   555
3   7 -1000 -1000
```

if-then-else using numpy's where()

```
In [7]: df = pd.DataFrame(
   ...:     {'AAA' : [4,5,6,7], 'BBB' : [10,20,30,40],'CCC' : [100,50,-30,-50]}); df
   ...:
Out[7]:
   AAA  BBB  CCC
0    4   10  100
1    5   20   50
2    6   30  -30
3    7   40  -50

In [8]: df['logic'] = np.where(df['AAA'] > 5,'high','low'); df
Out[8]:
   AAA  BBB  CCC logic
0    4   10  100   low
1    5   20   50   low
2    6   30  -30  high
3    7   40  -50  high
```

Splitting

Split a frame with a boolean criterion

```
In [9]: df = pd.DataFrame(
   ...:     {'AAA' : [4,5,6,7], 'BBB' : [10,20,30,40],'CCC' : [100,50,-30,-50]}); df
   ...:
Out[9]:
   AAA  BBB  CCC
0    4   10  100
1    5   20   50
2    6   30  -30
3    7   40  -50

In [10]: dflow = df[df.AAA <= 5]; dflow
Out[10]:
   AAA  BBB  CCC
0    4   10  100
1    5   20   50

In [11]: dfhigh = df[df.AAA > 5]; dfhigh
Out[11]:
   AAA  BBB  CCC
2    6   30  -30
```

```
3   7  40  -50
```

Building Criteria

Select with multi-column criteria

```
In [12]: df = pd.DataFrame(
   ....:     {'AAA' : [4,5,6,7], 'BBB' : [10,20,30,40],'CCC' : [100,50,-30,-50]}); df
   ....:
Out[12]:
   AAA  BBB  CCC
0   4   10  100
1   5   20   50
2   6   30  -30
3   7   40  -50
```

...and (without assignment returns a Series)

```
In [13]: newseries = df.loc[(df['BBB'] < 25) & (df['CCC'] >= -40), 'AAA']; newseries
Out[13]:
0   4
1   5
Name: AAA, dtype: int64
```

...or (without assignment returns a Series)

```
In [14]: newseries = df.loc[(df['BBB'] > 25) | (df['CCC'] >= -40), 'AAA']; newseries;
```

...or (with assignment modifies the DataFrame.)

```
In [15]: df.loc[(df['BBB'] > 25) | (df['CCC'] >= 75), 'AAA'] = 0.1; df
Out[15]:
   AAA  BBB  CCC
0  0.1   10  100
1  5.0   20   50
2  0.1   30  -30
3  0.1   40  -50
```

Select rows with data closest to certain value using argsort

```
In [16]: df = pd.DataFrame(
   ....:     {'AAA' : [4,5,6,7], 'BBB' : [10,20,30,40],'CCC' : [100,50,-30,-50]}); df
   ....:
Out[16]:
   AAA  BBB  CCC
0    4   10  100
1    5   20   50
2    6   30  -30
3    7   40  -50

In [17]: aValue = 43.0

In [18]: df.loc[(df.CCC-aValue).abs().argsort()]
Out[18]:
   AAA  BBB  CCC
1    5   20   50
0    4   10  100
2    6   30  -30
3    7   40  -50
```

Dynamically reduce a list of criteria using a binary operators

```
In [19]: df = pd.DataFrame(
   ....:     {'AAA' : [4,5,6,7], 'BBB' : [10,20,30,40],'CCC' : [100,50,-30,-50]}); df
   ....:
Out[19]:
   AAA  BBB  CCC
0    4   10  100
1    5   20   50
2    6   30  -30
3    7   40  -50

In [20]: Crit1 = df.AAA <= 5.5

In [21]: Crit2 = df.BBB == 10.0

In [22]: Crit3 = df.CCC > -40.0
```

One could hard code:

```
In [23]: AllCrit = Crit1 & Crit2 & Crit3
```

...Or it can be done with a list of dynamically built criteria

```
In [24]: CritList = [Crit1,Crit2,Crit3]

In [25]: AllCrit = functools.reduce(lambda x,y: x & y, CritList)

In [26]: df[AllCrit]
Out[26]:
  AAA  BBB  CCC
0   4   10  100
```

Selection

DataFrames

The indexing docs.

Using both row labels and value conditionals

```
In [27]: df = pd.DataFrame(
   ....:     {'AAA' : [4,5,6,7], 'BBB' : [10,20,30,40],'CCC' : [100,50,-30,-50]}); df
   ....:
Out[27]:
  AAA  BBB  CCC
0   4   10  100
1   5   20   50
2   6   30  -30
3   7   40  -50

In [28]: df[(df.AAA <= 6) & (df.index.isin([0,2,4]))]
Out[28]:
  AAA  BBB  CCC
0   4   10  100
2   6   30  -30
```

Use loc for label-oriented slicing and iloc positional slicing

```
In [29]: data = {'AAA' : [4,5,6,7], 'BBB' : [10,20,30,40],'CCC' : [100,50,-30,-50]}

In [30]: df = pd.DataFrame(data=data,index=['foo','bar','boo','kar']); df
Out[30]:
    AAA  BBB  CCC
foo   4   10  100
bar   5   20   50
boo   6   30  -30
kar   7   40  -50
```

There are 2 explicit slicing methods, with a third general case

1. Positional-oriented (Python slicing style : exclusive of end)
2. Label-oriented (Non-Python slicing style : inclusive of end)
3. General (Either slicing style : depends on if the slice contains labels or positions)

```
In [31]: df.loc['bar':'kar'] #Label
Out[31]:
    AAA  BBB  CCC
bar   5   20   50
boo   6   30  -30
kar   7   40  -50

# Generic
In [32]: df.iloc[0:3]
Out[32]:
    AAA  BBB  CCC
foo   4   10  100
bar   5   20   50
boo   6   30  -30

In [33]: df.loc['bar':'kar']
Out[33]:
    AAA  BBB  CCC
bar   5   20   50
boo   6   30  -30
kar   7   40  -50
```

Ambiguity arises when an index consists of integers with a non-zero start or non-unit increment.

```
In [34]: df2 = pd.DataFrame(data=data,index=[1,2,3,4]); #Note index starts at 1.
```

```
In [35]: df2.iloc[1:3] #Position-oriented
Out[35]:
  AAA  BBB  CCC
2   5   20   50
3   6   30  -30

In [36]: df2.loc[1:3] #Label-oriented
Out[36]:
  AAA  BBB  CCC
1   4   10  100
2   5   20   50
3   6   30  -30
```

Using inverse operator (~) to take the complement of a mask

```
In [37]: df = pd.DataFrame(
   ....:      {'AAA' : [4,5,6,7], 'BBB' : [10,20,30,40], 'CCC' : [100,50,-30,-50]}); df
   ....:
Out[37]:
  AAA  BBB  CCC
0   4   10  100
1   5   20   50
2   6   30  -30
3   7   40  -50

In [38]: df[~((df.AAA <= 6) & (df.index.isin([0,2,4])))]
Out[38]:
  AAA  BBB  CCC
1   5   20   50
3   7   40  -50
```

Panels

Extend a panel frame by transposing, adding a new dimension, and transposing back to the original dimensions

```
In [39]: rng = pd.date_range('1/1/2013',periods=100,freq='D')

In [40]: data = np.random.randn(100, 4)
```

```
In [41]: cols = ['A','B','C','D']

In [42]: df1, df2, df3 = pd.DataFrame(data, rng, cols), pd.DataFrame(data, rng, cols), p

In [43]: pf = pd.Panel({'df1':df1,'df2':df2,'df3':df3});pf
Out[43]:
<class 'pandas.core.panel.Panel'>
Dimensions: 3 (items) x 100 (major_axis) x 4 (minor_axis)
Items axis: df1 to df3
Major_axis axis: 2013-01-01 00:00:00 to 2013-04-10 00:00:00
Minor_axis axis: A to D

#Assignment using Transpose  (pandas < 0.15)
In [44]: pf = pf.transpose(2,0,1)

In [45]: pf['E'] = pd.DataFrame(data, rng, cols)

In [46]: pf = pf.transpose(1,2,0);pf
Out[46]:
<class 'pandas.core.panel.Panel'>
Dimensions: 3 (items) x 100 (major_axis) x 5 (minor_axis)
Items axis: df1 to df3
Major_axis axis: 2013-01-01 00:00:00 to 2013-04-10 00:00:00
Minor_axis axis: A to E

#Direct assignment (pandas > 0.15)
In [47]: pf.loc[:,:,'F'] = pd.DataFrame(data, rng, cols);pf
Out[47]:
<class 'pandas.core.panel.Panel'>
Dimensions: 3 (items) x 100 (major_axis) x 6 (minor_axis)
Items axis: df1 to df3
Major_axis axis: 2013-01-01 00:00:00 to 2013-04-10 00:00:00
Minor_axis axis: A to F
```

Mask a panel by using np.where and then reconstructing the panel with the new masked values

New Columns

Efficiently and dynamically creating new columns using applymap

```
In [48]: df = pd.DataFrame(
   ....:     {'AAA' : [1,2,1,3], 'BBB' : [1,1,2,2], 'CCC' : [2,1,3,1]}); df
   ....:
```

```
Out[48]:
  AAA  BBB  CCC
0   1    1    2
1   2    1    1
2   1    2    3
3   3    2    1

In [49]: source_cols = df.columns # or some subset would work too.

In [50]: new_cols = [str(x) + "_cat" for x in source_cols]

In [51]: categories = {1 : 'Alpha', 2 : 'Beta', 3 : 'Charlie' }

In [52]: df[new_cols] = df[source_cols].applymap(categories.get);df
Out[52]:
  AAA  BBB  CCC  AAA_cat BBB_cat  CCC_cat
0   1    1    2    Alpha   Alpha     Beta
1   2    1    1     Beta   Alpha    Alpha
2   1    2    3    Alpha    Beta  Charlie
3   3    2    1  Charlie    Beta    Alpha
```

Keep other columns when using min() with groupby

```
In [53]: df = pd.DataFrame(
   ....:     {'AAA' : [1,1,1,2,2,2,3,3], 'BBB' : [2,1,3,4,5,1,2,3]}); df
   ....:
Out[53]:
  AAA  BBB
0   1    2
1   1    1
2   1    3
3   2    4
4   2    5
5   2    1
6   3    2
7   3    3
```

Method 1 : idxmin() to get the index of the mins

```
In [54]: df.loc[df.groupby("AAA")["BBB"].idxmin()]
Out[54]:
  AAA  BBB
```

```
1   1   1
5   2   1
6   3   2
```

Method 2 : sort then take first of each

```
In [55]: df.sort_values(by="BBB").groupby("AAA", as_index=False).first()
Out[55]:
  AAA  BBB
0   1   1
1   2   1
2   3   2
```

Notice the same results, with the exception of the index.

MultiIndexing

The multindexing docs.

Creating a multi-index from a labeled frame

```
In [56]: df = pd.DataFrame({'row' : [0,1,2],
   ....:                    'One_X' : [1.1,1.1,1.1],
   ....:                    'One_Y' : [1.2,1.2,1.2],
   ....:                    'Two_X' : [1.11,1.11,1.11],
   ....:                    'Two_Y' : [1.22,1.22,1.22]}); df
   ....:
Out[56]:
  One_X  One_Y  Two_X  Two_Y  row
0   1.1   1.2   1.11   1.22    0
1   1.1   1.2   1.11   1.22    1
2   1.1   1.2   1.11   1.22    2

# As Labelled Index
In [57]: df = df.set_index('row');df
Out[57]:
    One_X  One_Y  Two_X  Two_Y
row
0     1.1   1.2   1.11   1.22
1     1.1   1.2   1.11   1.22
2     1.1   1.2   1.11   1.22
```

```
# With Hierarchical Columns
In [58]: df.columns = pd.MultiIndex.from_tuples([tuple(c.split('_')) for c in df.columns]
Out[58]:
    One       Two
     X   Y    X    Y
row
0   1.1  1.2  1.11  1.22
1   1.1  1.2  1.11  1.22
2   1.1  1.2  1.11  1.22

# Now stack & Reset
In [59]: df = df.stack(0).reset_index(1);df
Out[59]:
   level_1    X    Y
row
0      One  1.10  1.20
0      Two  1.11  1.22
1      One  1.10  1.20
1      Two  1.11  1.22
2      One  1.10  1.20
2      Two  1.11  1.22

# And fix the labels (Notice the label 'level_1' got added automatically)
In [60]: df.columns = ['Sample','All_X','All_Y'];df
Out[60]:
   Sample  All_X  All_Y
row
0     One   1.10   1.20
0     Two   1.11   1.22
1     One   1.10   1.20
1     Two   1.11   1.22
2     One   1.10   1.20
2     Two   1.11   1.22
```

Arithmetic

Performing arithmetic with a multi-index that needs broadcasting

```
In [61]: cols = pd.MultiIndex.from_tuples([ (x,y) for x in ['A','B','C'] for y in ['O','I']])

In [62]: df = pd.DataFrame(np.random.randn(2,6),index=['n','m'],columns=cols); df
Out[62]:
```

```
        A              B              C
        O       I      O       I      O       I
n  1.920906 -0.388231 -2.314394  0.665508  0.402562  0.399555
m -1.765956  0.850423  0.388054  0.992312  0.744086 -0.739776

In [63]: df = df.div(df['C'],level=1); df
Out[63]:
        A              B           C
        O       I      O       I   O   I
n  4.771702 -0.971660 -5.749162  1.665625  1.0  1.0
m -2.373321 -1.149568  0.521518 -1.341367  1.0  1.0
```

Slicing

Slicing a multi-index with xs

```
In [64]: coords = [('AA','one'),('AA','six'),('BB','one'),('BB','two'),('BB','six')]

In [65]: index = pd.MultiIndex.from_tuples(coords)

In [66]: df = pd.DataFrame([11,22,33,44,55],index,['MyData']); df
Out[66]:
       MyData
AA one     11
   six     22
BB one     33
   two     44
   six     55
```

To take the cross section of the 1st level and 1st axis the index:

```
In [67]: df.xs('BB',level=0,axis=0)  #Note : level and axis are optional, and default to ze
Out[67]:
     MyData
one      33
two      44
six      55
```

...and now the 2nd level of the 1st axis.

```
In [68]: df.xs('six',level=1,axis=0)
Out[68]:
   MyData
AA     22
BB     55
```

Slicing a multi-index with xs, method #2

```
In [69]: index = list(itertools.product(['Ada','Quinn','Violet'],['Comp','Math','Sci']))

In [70]: headr = list(itertools.product(['Exams','Labs'],['I','II']))

In [71]: indx = pd.MultiIndex.from_tuples(index,names=['Student','Course'])

In [72]: cols = pd.MultiIndex.from_tuples(headr) #Notice these are un-named

In [73]: data = [[70+x+y+(x*y)%3 for x in range(4)] for y in range(9)]

In [74]: df = pd.DataFrame(data,indx,cols); df
Out[74]:
            Exams     Labs
               I  II   I  II
Student Course
Ada     Comp     70  71   72  73
        Math     71  73   75  74
        Sci      72  75   75  75
Quinn   Comp     73  74   75  76
        Math     74  76   78  77
        Sci      75  78   78  78
Violet  Comp     76  77   78  79
        Math     77  79   81  80
        Sci      78  81   81  81

In [75]: All = slice(None)

In [76]: df.loc['Violet']
Out[76]:
      Exams     Labs
         I  II   I  II
Course
Comp     76  77   78  79
Math     77  79   81  80
Sci      78  81   81  81
```

```
In [77]: df.loc[(All,'Math'),All]
Out[77]:
          Exams    Labs
            I  II   I  II
Student Course
Ada     Math     71  73   75  74
Quinn   Math     74  76   78  77
Violet  Math     77  79   81  80

In [78]: df.loc[(slice('Ada','Quinn'),'Math'),All]
Out[78]:
          Exams    Labs
            I  II   I  II
Student Course
Ada     Math     71  73   75  74
Quinn   Math     74  76   78  77

In [79]: df.loc[(All,'Math'),('Exams')]
Out[79]:
            I  II
Student Course
Ada     Math   71  73
Quinn   Math   74  76
Violet  Math   77  79

In [80]: df.loc[(All,'Math'),(All,'II')]
Out[80]:
          Exams Labs
             II   II
Student Course
Ada     Math     73   74
Quinn   Math     76   77
Violet  Math     79   80
```

Setting portions of a multi-index with xs

Sorting

Sort by specific column or an ordered list of columns, with a multi-index

```
In [81]: df.sort_values(by=('Labs', 'II'), ascending=False)
Out[81]:
```

```
            Exams    Labs
              I  II   I  II
Student Course
Violet  Sci     78  81   81  81
        Math    77  79   81  80
        Comp    76  77   78  79
Quinn   Sci     75  78   78  78
        Math    74  76   78  77
        Comp    73  74   75  76
Ada     Sci     72  75   75  75
        Math    71  73   75  74
        Comp    70  71   72  73
```

Partial Selection, the need for sortedness;

Levels

Prepending a level to a multiindex

Flatten Hierarchical columns

panelnd

The panelnd docs.

Construct a 5D panelnd

Missing Data

The missing data docs.

Fill forward a reversed timeseries

```
In [82]: df = pd.DataFrame(np.random.randn(6,1), index=pd.date_range('2013-08-01',

In [83]: df.loc[df.index[3], 'A'] = np.nan

In [84]: df
Out[84]:
                   A
2013-08-01 -1.054874
```

```
2013-08-02 -0.179642
2013-08-05  0.639589
2013-08-06       NaN
2013-08-07  1.906684
2013-08-08  0.104050

In [85]: df.reindex(df.index[::-1]).ffill()
Out[85]:
                   A
2013-08-08  0.104050
2013-08-07  1.906684
2013-08-06  1.906684
2013-08-05  0.639589
2013-08-02 -0.179642
2013-08-01 -1.054874
```

cumsum reset at NaN values

Replace

Using replace with backrefs

Grouping

The grouping docs.

Basic grouping with apply

Unlike agg, apply's callable is passed a sub-DataFrame which gives you access to all the columns

```
In [86]: df = pd.DataFrame({'animal': 'cat dog cat fish dog cat cat'.split(),
   ....:                    'size': list('SSMMMLL'),
   ....:                    'weight': [8, 10, 11, 1, 20, 12, 12],
   ....:                    'adult' : [False] * 5 + [True] * 2}); df
   ....:
Out[86]:
  adult animal size  weight
0  False    cat    S       8
1  False    dog    S      10
2  False    cat    M      11
```

```
3  False   fish    M      1
4  False    dog    M     20
5   True    cat    L     12
6   True    cat    L     12

#List the size of the animals with the highest weight.
In [87]: df.groupby('animal').apply(lambda subf: subf['size'][subf['weight'].idxmax()])
Out[87]:
animal
cat     L
dog     M
fish    M
dtype: object
```

Using get_group

```
In [88]: gb = df.groupby(['animal'])

In [89]: gb.get_group('cat')
Out[89]:
  adult animal size  weight
0  False    cat    S      8
2  False    cat    M     11
5   True    cat    L     12
6   True    cat    L     12
```

Apply to different items in a group

```
In [90]: def GrowUp(x):
   ....:     avg_weight =  sum(x[x['size'] == 'S'].weight * 1.5)
   ....:     avg_weight += sum(x[x['size'] == 'M'].weight * 1.25)
   ....:     avg_weight += sum(x[x['size'] == 'L'].weight)
   ....:     avg_weight /= len(x)
   ....:     return pd.Series(['L',avg_weight,True], index=['size', 'weight', 'adult'])
   ....:

In [91]: expected_df = gb.apply(GrowUp)

In [92]: expected_df
Out[92]:
       size   weight  adult
animal
```

```
cat     L  12.4375   True
dog      L  20.0000   True
fish    L   1.2500   True
```

Expanding Apply

```
In [93]: S = pd.Series([i / 100.0 for i in range(1,11)])

In [94]: def CumRet(x,y):
   ....:     return x * (1 + y)
   ....:

In [95]: def Red(x):
   ....:     return functools.reduce(CumRet,x,1.0)
   ....:

In [96]: S.expanding().apply(Red)
Out[96]:
0    1.010000
1    1.030200
2    1.061106
3    1.103550
4    1.158728
5    1.228251
6    1.314229
7    1.419367
8    1.547110
9    1.701821
dtype: float64
```

Replacing some values with mean of the rest of a group

```
In [97]: df = pd.DataFrame({'A' : [1, 1, 2, 2], 'B' : [1, -1, 1, 2]})

In [98]: gb = df.groupby('A')

In [99]: def replace(g):
   ....:     mask = g < 0
   ....:     g.loc[mask] = g[~mask].mean()
   ....:     return g
   ....:
```

```
In [100]: gb.transform(replace)
Out[100]:
     B
0  1.0
1  1.0
2  1.0
3  2.0
```

Sort groups by aggregated data

```
In [101]: df = pd.DataFrame({'code': ['foo', 'bar', 'baz'] * 2,
   .....:                    'data': [0.16, -0.21, 0.33, 0.45, -0.59, 0.62],
   .....:                    'flag': [False, True] * 3})
   .....:

In [102]: code_groups = df.groupby('code')

In [103]: agg_n_sort_order = code_groups[['data']].transform(sum).sort_values(by='dat

In [104]: sorted_df = df.loc[agg_n_sort_order.index]

In [105]: sorted_df
Out[105]:
  code  data   flag
1  bar -0.21   True
4  bar -0.59  False
0  foo  0.16  False
3  foo  0.45   True
2  baz  0.33  False
5  baz  0.62   True
```

Create multiple aggregated columns

```
In [106]: rng = pd.date_range(start="2014-10-07",periods=10,freq='2min')

In [107]: ts = pd.Series(data = list(range(10)), index = rng)

In [108]: def MyCust(x):
   .....:     if len(x) > 2:
   .....:         return x[1] * 1.234
   .....:     return pd.NaT
   .....:
```

```
In [109]: mhc = {'Mean' : np.mean, 'Max' : np.max, 'Custom' : MyCust}

In [110]: ts.resample("5min").apply(mhc)
Out[110]:
Custom  2014-10-07 00:00:00    1.234
        2014-10-07 00:05:00      NaT
        2014-10-07 00:10:00    7.404
        2014-10-07 00:15:00      NaT
Max     2014-10-07 00:00:00        2
        2014-10-07 00:05:00        4
        2014-10-07 00:10:00        7
        2014-10-07 00:15:00        9
Mean    2014-10-07 00:00:00        1
        2014-10-07 00:05:00      3.5
        2014-10-07 00:10:00        6
        2014-10-07 00:15:00      8.5
dtype: object

In [111]: ts
Out[111]:
2014-10-07 00:00:00    0
2014-10-07 00:02:00    1
2014-10-07 00:04:00    2
2014-10-07 00:06:00    3
2014-10-07 00:08:00    4
2014-10-07 00:10:00    5
2014-10-07 00:12:00    6
2014-10-07 00:14:00    7
2014-10-07 00:16:00    8
2014-10-07 00:18:00    9
Freq: 2T, dtype: int64
```

Create a value counts column and reassign back to the DataFrame

```
In [112]: df = pd.DataFrame({'Color': 'Red Red Red Blue'.split(),
   .....:                    'Value': [100, 150, 50, 50]}); df
   .....:
Out[112]:
  Color  Value
0   Red    100
1   Red    150
2   Red     50
3  Blue     50
```

```
In [113]: df['Counts'] = df.groupby(['Color']).transform(len)

In [114]: df
Out[114]:
  Color  Value  Counts
0   Red    100       3
1   Red    150       3
2   Red     50       3
3  Blue     50       1
```

Shift groups of the values in a column based on the index

```
In [115]: df = pd.DataFrame(
   .....:    {u'line_race': [10, 10, 8, 10, 10, 8],
   .....:     u'beyer': [99, 102, 103, 103, 88, 100]},
   .....:     index=[u'Last Gunfighter', u'Last Gunfighter', u'Last Gunfighter',
   .....:            u'Paynter', u'Paynter', u'Paynter']); df
   .....:
Out[115]:
                beyer  line_race
Last Gunfighter    99         10
Last Gunfighter   102         10
Last Gunfighter   103          8
Paynter           103         10
Paynter            88         10
Paynter           100          8

In [116]: df['beyer_shifted'] = df.groupby(level=0)['beyer'].shift(1)

In [117]: df
Out[117]:
                beyer  line_race  beyer_shifted
Last Gunfighter    99         10            NaN
Last Gunfighter   102         10           99.0
Last Gunfighter   103          8          102.0
Paynter           103         10            NaN
Paynter            88         10          103.0
Paynter           100          8           88.0
```

Select row with maximum value from each group

```
In [118]: df = pd.DataFrame({'host':['other','other','that','this','this'],
```

```
   .....:                 'service':['mail','web','mail','mail','web'],
   .....:                 'no':[1, 2, 1, 2, 1]}).set_index(['host', 'service'])
   .....:

In [119]: mask = df.groupby(level=0).agg('idxmax')

In [120]: df_count = df.loc[mask['no']].reset_index()

In [121]: df_count
Out[121]:
   host service  no
0  other     web   2
1   that    mail   1
2   this    mail   2
```

Grouping like Python's itertools.groupby

```
In [122]: df = pd.DataFrame([0, 1, 0, 1, 1, 1, 0, 1, 1], columns=['A'])

In [123]: df.A.groupby((df.A != df.A.shift()).cumsum()).groups
Out[123]:
{1: Int64Index([0], dtype='int64'),
 2: Int64Index([1], dtype='int64'),
 3: Int64Index([2], dtype='int64'),
 4: Int64Index([3, 4, 5], dtype='int64'),
 5: Int64Index([6], dtype='int64'),
 6: Int64Index([7, 8], dtype='int64')}

In [124]: df.A.groupby((df.A != df.A.shift()).cumsum()).cumsum()
Out[124]:
0    0
1    1
2    0
3    1
4    2
5    3
6    0
7    1
8    2
Name: A, dtype: int64
```

Expanding Data

Alignment and to-date

Rolling Computation window based on values instead of counts

Rolling Mean by Time Interval

Splitting

Splitting a frame

Create a list of dataframes, split using a delineation based on logic included in rows.

```
In [125]: df = pd.DataFrame(data={'Case' : ['A','A','A','B','A','A','B','A','A'],
   .....:                         'Data' : np.random.randn(9)})
   .....:

In [126]: dfs = list(zip(*df.groupby((1*(df['Case']=='B')).cumsum().rolling(window=3,mi

In [127]: dfs[0]
Out[127]:
  Case      Data
0    A  0.174068
1    A -0.439461
2    A -0.741343
3    B -0.079673

In [128]: dfs[1]
Out[128]:
  Case      Data
4    A -0.922875
5    A  0.303638
6    B -0.917368

In [129]: dfs[2]
Out[129]:
  Case      Data
7    A -1.624062
8    A -0.758514
```

Pivot

The Pivot docs.

Partial sums and subtotals

```
In [130]: df = pd.DataFrame(data={'Province' : ['ON','QC','BC','AL','AL','MN','ON'],
   .....:                         'City' : ['Toronto','Montreal','Vancouver','Calgary','Edmonton','Wi
   .....:                         'Sales' : [13,6,16,8,4,3,1]})
   .....:

In [131]: table = pd.pivot_table(df,values=['Sales'],index=['Province'],columns=['City'],a

In [132]: table.stack('City')
Out[132]:
                    Sales
Province City
AL       All         12.0
         Calgary      8.0
         Edmonton     4.0
BC       All         16.0
         Vancouver   16.0
MN       All          3.0
         Winnipeg     3.0
...                   ...
All      Calgary      8.0
         Edmonton     4.0
         Montreal     6.0
         Toronto     13.0
         Vancouver   16.0
         Windsor      1.0
         Winnipeg     3.0

[20 rows x 1 columns]
```

Frequency table like plyr in R

```
In [133]: grades = [48,99,75,80,42,80,72,68,36,78]

In [134]: df = pd.DataFrame( {'ID': ["x%d" % r for r in range(10)],
   .....:                     'Gender' : ['F', 'M', 'F', 'M', 'F', 'M', 'F', 'M', 'M', 'M'],
   .....:                     'ExamYear': ['2007','2007','2007','2008','2008','2008','2008','2009','20
   .....:                     'Class': ['algebra', 'stats', 'bio', 'algebra', 'algebra', 'stats', 'stats', 'alge
   .....:                     'Participated': ['yes','yes','yes','yes','no','yes','yes','yes','yes','yes'],
   .....:                     'Passed': ['yes' if x > 50 else 'no' for x in grades],
   .....:                     'Employed': [True,True,True,False,False,False,False,True,True,False],
   .....:                     'Grade': grades})
```

```
   .....:
In [135]: df.groupby('ExamYear').agg({'Participated': lambda x: x.value_counts()['yes'],
   .....:                             'Passed': lambda x: sum(x == 'yes'),
   .....:                             'Employed' : lambda x : sum(x),
   .....:                             'Grade' : lambda x : sum(x) / len(x)})
   .....:
Out[135]:
          Participated  Passed  Employed     Grade
ExamYear
2007                 3       2         3  74.000000
2008                 3       3         0  68.500000
2009                 3       2         2  60.666667
```

Plot pandas DataFrame with year over year data

To create year and month crosstabulation:

```
In [136]: df = pd.DataFrame({'value': np.random.randn(36)},
   .....:                   index=pd.date_range('2011-01-01', freq='M', periods=36))
   .....:

In [137]: pd.pivot_table(df, index=df.index.month, columns=df.index.year,
   .....:                values='value', aggfunc='sum')
   .....:
Out[137]:
       2011      2012      2013
1  -0.560859  0.120930  0.516870
2  -0.589005 -0.210518  0.343125
3  -1.070678 -0.931184  2.137827
4  -1.681101  0.240647  0.452429
5   0.403776 -0.027462  0.483103
6   0.609862  0.033113  0.061495
7   0.387936 -0.658418  0.240767
8   1.815066  0.324102  0.782413
9   0.705200 -1.403048  0.628462
10 -0.668049 -0.581967 -0.880627
11  0.242501 -1.233862  0.777575
12  0.313421 -3.520876 -0.779367
```

Apply

Rolling Apply to Organize - Turning embedded lists into a multi-index frame

```
In [138]: df = pd.DataFrame(data={'A' : [[2,4,8,16],[100,200],[10,20,30]], 'B' : [['a','b','c'],

In [139]: def SeriesFromSubList(aList):
   .....:     return pd.Series(aList)
   .....:

In [140]: df_orgz = pd.concat(dict([ (ind,row.apply(SeriesFromSubList)) for ind,row in d
```

Rolling Apply with a DataFrame returning a Series

Rolling Apply to multiple columns where function calculates a Series before a Scalar from the Series is returned

```
In [141]: df = pd.DataFrame(data=np.random.randn(2000,2)/10000,
   .....:                   index=pd.date_range('2001-01-01',periods=2000),
   .....:                   columns=['A','B']); df
   .....:
Out[141]:
                   A         B
2001-01-01  0.000032 -0.000004
2001-01-02 -0.000001  0.000207
2001-01-03  0.000120 -0.000220
2001-01-04 -0.000083 -0.000165
2001-01-05 -0.000047  0.000156
2001-01-06  0.000027  0.000104
2001-01-07  0.000041 -0.000101
...              ...       ...
2006-06-17 -0.000034  0.000034
2006-06-18  0.000002  0.000166
2006-06-19  0.000023 -0.000081
2006-06-20 -0.000061  0.000012
2006-06-21 -0.000111  0.000027
2006-06-22 -0.000061 -0.000009
2006-06-23  0.000074 -0.000138

[2000 rows x 2 columns]

In [142]: def gm(aDF,Const):
   .....:     v = ((((aDF.A+aDF.B)+1).cumprod())-1)*Const
   .....:     return (aDF.index[0],v.iloc[-1])
   .....:

In [143]: S = pd.Series(dict([ gm(df.iloc[i:min(i+51,len(df)-1)],5) for i in range(len(df)-50
```

```
Out[143]:
2001-01-01   -0.001373
2001-01-02   -0.001705
2001-01-03   -0.002885
2001-01-04   -0.002987
2001-01-05   -0.002384
2001-01-06   -0.004700
2001-01-07   -0.005500
                ...
2006-04-28   -0.002682
2006-04-29   -0.002436
2006-04-30   -0.002602
2006-05-01   -0.001785
2006-05-02   -0.001799
2006-05-03   -0.000605
2006-05-04   -0.000541
Length: 1950, dtype: float64
```

Rolling apply with a DataFrame returning a Scalar

Rolling Apply to multiple columns where function returns a Scalar (Volume Weighted Average Price)

```
In [144]: rng = pd.date_range(start = '2014-01-01',periods = 100)

In [145]: df = pd.DataFrame({'Open' : np.random.randn(len(rng)),
   .....:                    'Close' : np.random.randn(len(rng)),
   .....:                    'Volume' : np.random.randint(100,2000,len(rng))}, index=rng); df
   .....:
Out[145]:
              Close      Open  Volume
2014-01-01 -0.653039  0.011174    1581
2014-01-02  1.314205  0.214258    1707
2014-01-03 -0.341915 -1.046922    1768
2014-01-04 -1.303586 -0.752902     836
2014-01-05  0.396288 -0.410793     694
2014-01-06 -0.548006  0.648401     796
2014-01-07  0.481380  0.737320     265
...              ...       ...     ...
2014-04-04 -2.548128  0.120378     564
2014-04-05  0.223346  0.231661    1908
2014-04-06  1.228841  0.952664    1090
2014-04-07  0.552784 -0.176090    1813
2014-04-08 -0.795389  1.781318    1103
```

```
2014-04-09 -0.018815 -0.753493    1456
2014-04-10  1.138197 -1.047997    1193

[100 rows x 3 columns]

In [146]: def vwap(bars): return ((bars.Close*bars.Volume).sum()/bars.Volume.sum())

In [147]: window = 5

In [148]: s = pd.concat([ (pd.Series(vwap(df.iloc[i:i+window]), index=[df.index[i+windo

In [149]: s.round(2)
Out[149]:
2014-01-06   -0.03
2014-01-07    0.07
2014-01-08   -0.40
2014-01-09   -0.81
2014-01-10   -0.63
2014-01-11   -0.86
2014-01-12   -0.36
             ...
2014-04-04   -1.27
2014-04-05   -1.36
2014-04-06   -0.73
2014-04-07    0.04
2014-04-08    0.21
2014-04-09    0.07
2014-04-10    0.25
Length: 95, dtype: float64
```

Timeseries

Between times

Using indexer between time

Constructing a datetime range that excludes weekends and includes only certain times

Vectorized Lookup

Aggregation and plotting time series

Turn a matrix with hours in columns and days in rows into a continuous row sequence in the form of a time series. How to rearrange a python pandas DataFrame?

Dealing with duplicates when reindexing a timeseries to a specified frequency

Calculate the first day of the month for each entry in a DatetimeIndex

```
In [150]: dates = pd.date_range('2000-01-01', periods=5)

In [151]: dates.to_period(freq='M').to_timestamp()
Out[151]:
DatetimeIndex(['2000-01-01', '2000-01-01', '2000-01-01', '2000-01-01',
               '2000-01-01'],
              dtype='datetime64[ns]', freq=None)
```

Resampling

The Resample docs.

TimeGrouping of values grouped across time

TimeGrouping #2

Using TimeGrouper and another grouping to create subgroups, then apply a custom function

Resampling with custom periods

Resample intraday frame without adding new days

Resample minute data

Resample with groupby

Merge

The Concat docs. The Join docs.

Append two dataframes with overlapping index (emulate R rbind)

```
In [152]: rng = pd.date_range('2000-01-01', periods=6)

In [153]: df1 = pd.DataFrame(np.random.randn(6, 3), index=rng, columns=['A', 'B', 'C']

In [154]: df2 = df1.copy()
```

ignore_index is needed in pandas < v0.13, and depending on df construction

```
In [155]: df = df1.append(df2,ignore_index=True); df
Out[155]:
          A         B         C
0  -0.480676 -1.305282 -0.212846
1   1.979901  0.363112 -0.275732
2  -1.433852  0.580237 -0.013672
3   1.776623 -0.803467  0.521517
4  -0.302508 -0.442948 -0.395768
5  -0.249024 -0.031510  2.413751
6  -0.480676 -1.305282 -0.212846
7   1.979901  0.363112 -0.275732
8  -1.433852  0.580237 -0.013672
9   1.776623 -0.803467  0.521517
10 -0.302508 -0.442948 -0.395768
11 -0.249024 -0.031510  2.413751
```

Self Join of a DataFrame

```
In [156]: df = pd.DataFrame(data={'Area' : ['A'] * 5 + ['C'] * 2,
   .....:                         'Bins' : [110] * 2 + [160] * 3 + [40] * 2,
   .....:                         'Test_0' : [0, 1, 0, 1, 2, 0, 1],
   .....:                         'Data' : np.random.randn(7)});df
   .....:
Out[156]:
  Area  Bins      Data  Test_0
0    A   110 -0.378914       0
1    A   110 -1.032527       1
2    A   160 -1.402816       0
3    A   160  0.715333       1
4    A   160 -0.091438       2
5    C    40  1.608418       0
6    C    40  0.753207       1

In [157]: df['Test_1'] = df['Test_0'] - 1

In [158]: pd.merge(df, df, left_on=['Bins', 'Area','Test_0'], right_on=['Bins', 'Area','Test_1
Out[158]:
  Area  Bins    Data_L  Test_0_L  Test_1_L    Data_R  Test_0_R  Test_1_R
0    A   110 -0.378914         0        -1 -1.032527         1         0
1    A   160 -1.402816         0        -1  0.715333         1         0
2    A   160  0.715333         1         0 -0.091438         2         1
```

```
3   C   40  1.608418       0      -1  0.753207       1       0
```

How to set the index and join

KDB like asof join

Join with a criteria based on the values

Using searchsorted to merge based on values inside a range

Plotting

The Plotting docs.

Make Matplotlib look like R

Setting x-axis major and minor labels

Plotting multiple charts in an ipython notebook

Creating a multi-line plot

Plotting a heatmap

Annotate a time-series plot

Annotate a time-series plot #2

Generate Embedded plots in excel files using Pandas, Vincent and xlsxwriter

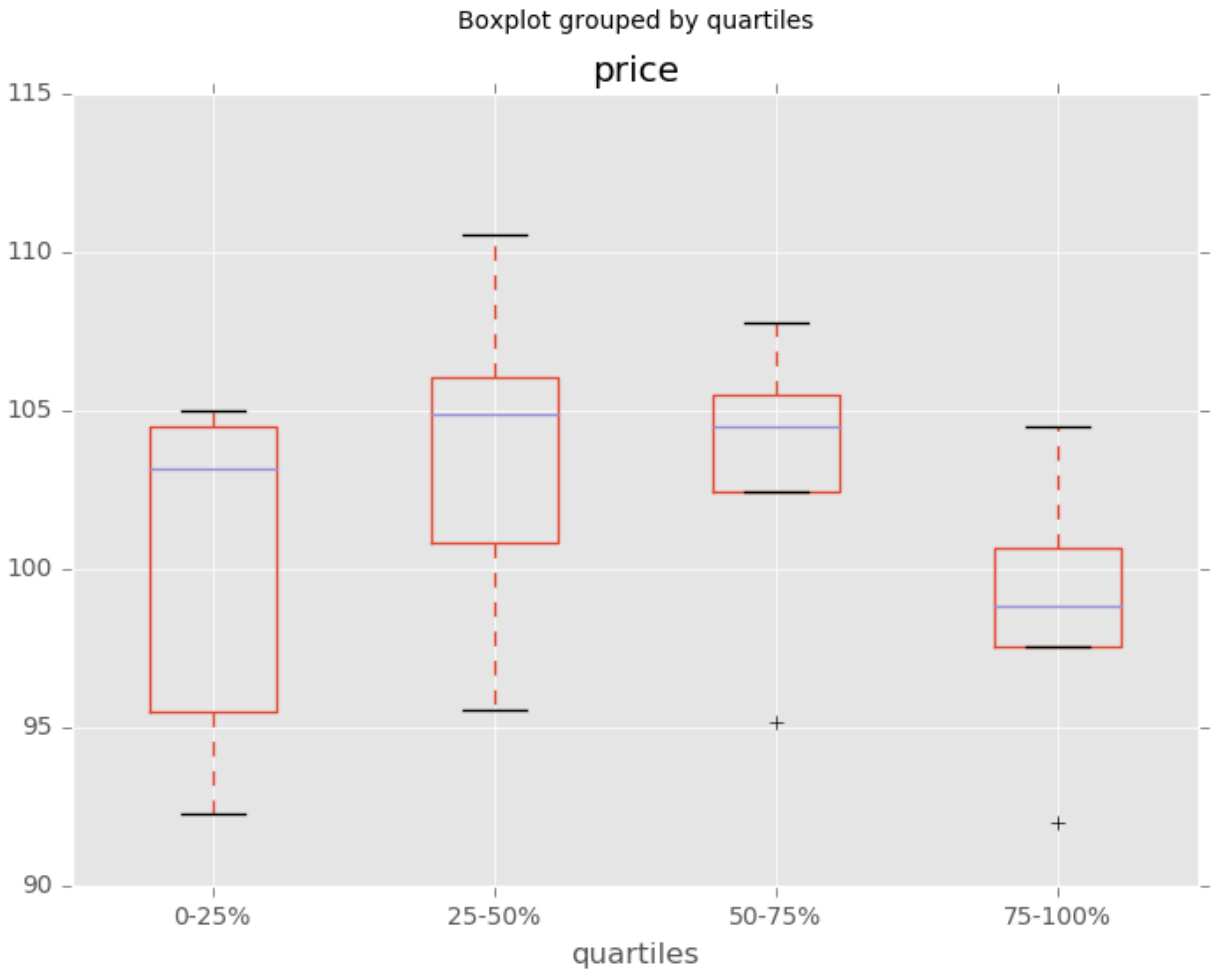
Boxplot for each quartile of a stratifying variable

```
In [159]: df = pd.DataFrame(
   .....:     {u'stratifying_var': np.random.uniform(0, 100, 20),
   .....:      u'price': np.random.normal(100, 5, 20)})
   .....:

In [160]: df[u'quartiles'] = pd.qcut(
   .....:     df[u'stratifying_var'],
   .....:     4,
   .....:     labels=[u'0-25%', u'25-50%', u'50-75%', u'75-100%'])
   .....:

In [161]: df.boxplot(column=u'price', by=u'quartiles')
```

Out[161]: <matplotlib.axes._subplots.AxesSubplot at 0x127e372b0>



Data In/Out

Performance comparison of SQL vs HDF5

CSV

The CSV docs

read_csv in action

appending to a csv

Reading a csv chunk-by-chunk

Reading only certain rows of a csv chunk-by-chunk

Reading the first few lines of a frame

Reading a file that is compressed but not by gzip/bz2 (the native compressed formats which read_csv understands). This example shows a WinZipped file, but is a general application of opening the file within a context manager and using that handle to read. See here

Inferring dtypes from a file

Dealing with bad lines

Dealing with bad lines II

Reading CSV with Unix timestamps and converting to local timezone

Write a multi-row index CSV without writing duplicates

Reading multiple files to create a single DataFrame

The best way to combine multiple files into a single DataFrame is to read the individual frames one by one, put all of the individual frames into a list, and then combine the frames in the list using pd.concat():

```
In [162]: for i in range(3):
   .....:     data = pd.DataFrame(np.random.randn(10, 4))
   .....:     data.to_csv('file_{}.csv'.format(i))
   .....:

In [163]: files = ['file_0.csv', 'file_1.csv', 'file_2.csv']

In [164]: result = pd.concat([pd.read_csv(f) for f in files], ignore_index=True)
```

You can use the same approach to read all files matching a pattern. Here is an example using glob:

```
In [165]: import glob

In [166]: files = glob.glob('file_*.csv')

In [167]: result = pd.concat([pd.read_csv(f) for f in files], ignore_index=True)
```

Finally, this strategy will work with the other pd.read_*(...) functions described in the io docs.

Parsing date components in multi-columns

Parsing date components in multi-columns is faster with a format

```
In [30]: i = pd.date_range('20000101',periods=10000)

In [31]: df = pd.DataFrame(dict(year = i.year, month = i.month, day = i.day))

In [32]: df.head()
Out[32]:
   day  month  year
0    1      1  2000
1    2      1  2000
2    3      1  2000
3    4      1  2000
4    5      1  2000

In [33]: %timeit pd.to_datetime(df.year*10000+df.month*100+df.day,format='%Y%m
100 loops, best of 3: 7.08 ms per loop

# simulate combinging into a string, then parsing
In [34]: ds = df.apply(lambda x: "%04d%02d%02d" % (x['year'],x['month'],x['day']),axis

In [35]: ds.head()
Out[35]:
0    20000101
1    20000102
2    20000103
3    20000104
4    20000105
dtype: object

In [36]: %timeit pd.to_datetime(ds)
1 loops, best of 3: 488 ms per loop
```

Skip row between header and data

```
In [168]: data = """;;;;
   .....: ;;;;
```

```
.....: ;;;;
.....: ;;;;
.....: ;;;;
.....: ;;;;
.....: ;;;;
.....: ;;;;
.....: ;;;;
.....: ;;;;
.....: date;Param1;Param2;Param4;Param5
.....:     ;m²;°C;m²;m
.....: ;;;;
.....: 01.01.1990 00:00;1;1;2;3
.....: 01.01.1990 01:00;5;3;4;5
.....: 01.01.1990 02:00;9;5;6;7
.....: 01.01.1990 03:00;13;7;8;9
.....: 01.01.1990 04:00;17;9;10;11
.....: 01.01.1990 05:00;21;11;12;13
.....: """
.....:
```

Option 1: pass rows explicitly to skiprows

```
In [169]: pd.read_csv(StringIO(data), sep=';', skiprows=[11,12],
   .....:         index_col=0, parse_dates=True, header=10)
   .....:
Out[169]:
                     Param1  Param2  Param4  Param5
date
1990-01-01 00:00:00       1       1       2       3
1990-01-01 01:00:00       5       3       4       5
1990-01-01 02:00:00       9       5       6       7
1990-01-01 03:00:00      13       7       8       9
1990-01-01 04:00:00      17       9      10      11
1990-01-01 05:00:00      21      11      12      13
```

Option 2: read column names and then data

```
In [170]: pd.read_csv(StringIO(data), sep=';', header=10, nrows=10).columns
Out[170]: Index(['date', 'Param1', 'Param2', 'Param4', 'Param5'], dtype='object')

In [171]: columns = pd.read_csv(StringIO(data), sep=';', header=10, nrows=10).columr
```

```
In [172]: pd.read_csv(StringIO(data), sep=';', index_col=0,
   .....:             header=12, parse_dates=True, names=columns)
   .....:
Out[172]:
                     Param1  Param2  Param4  Param5
date
1990-01-01 00:00:00       1       1       2       3
1990-01-01 01:00:00       5       3       4       5
1990-01-01 02:00:00       9       5       6       7
1990-01-01 03:00:00      13       7       8       9
1990-01-01 04:00:00      17       9      10      11
1990-01-01 05:00:00      21      11      12      13
```

SQL

The SQL docs

Reading from databases with SQL

Excel

The Excel docs

Reading from a filelike handle

Modifying formatting in XlsxWriter output

HTML

Reading HTML tables from a server that cannot handle the default request header

HDFStore

The HDFStores docs

Simple Queries with a Timestamp Index

Managing heterogeneous data using a linked multiple table hierarchy

Merging on-disk tables with millions of rows

Avoiding inconsistencies when writing to a store from multiple processes/threads

De-duplicating a large store by chunks, essentially a recursive reduction operation. Shows a function for taking in data from csv file and creating a store by chunks, with date parsing as well. See here

Creating a store chunk-by-chunk from a csv file

Appending to a store, while creating a unique index

Large Data work flows

Reading in a sequence of files, then providing a global unique index to a store while appending

Groupby on a HDFStore with low group density

Groupby on a HDFStore with high group density

Hierarchical queries on a HDFStore

Counting with a HDFStore

Troubleshoot HDFStore exceptions

Setting min_itemsize with strings

Using ptrepack to create a completely-sorted-index on a store

Storing Attributes to a group node

```
In [173]: df = pd.DataFrame(np.random.randn(8,3))

In [174]: store = pd.HDFStore('test.h5')

In [175]: store.put('df',df)

# you can store an arbitrary python object via pickle
In [176]: store.get_storer('df').attrs.my_attribute = dict(A = 10)

In [177]: store.get_storer('df').attrs.my_attribute
Out[177]: {'A': 10}
```

Binary Files

pandas readily accepts numpy record arrays, if you need to read in a binary file consisting of an

array of C structs. For example, given this C program in a file called main.c compiled with gcc main.c -std=gnu99 on a 64-bit machine,

```
#include <stdio.h>
#include <stdint.h>

typedef struct _Data
{
   int32_t count;
   double avg;
   float scale;
} Data;

int main(int argc, const char *argv[])
{
   size_t n = 10;
   Data d[n];

   for (int i = 0; i < n; ++i)
   {
      d[i].count = i;
      d[i].avg = i + 1.0;
      d[i].scale = (float) i + 2.0f;
   }

   FILE *file = fopen("binary.dat", "wb");
   fwrite(&d, sizeof(Data), n, file);
   fclose(file);

   return 0;
}
```

the following Python code will read the binary file 'binary.dat' into a pandas DataFrame, where each element of the struct corresponds to a column in the frame:

```
names = 'count', 'avg', 'scale'

# note that the offsets are larger than the size of the type because of
# struct padding
offsets = 0, 8, 16
formats = 'i4', 'f8', 'f4'
dt = np.dtype({'names': names, 'offsets': offsets, 'formats': formats},
```

```
            align=True)
df = pd.DataFrame(np.fromfile('binary.dat', dt))
```

Note: The offsets of the structure elements may be different depending on the architecture of the machine on which the file was created. Using a raw binary file format like this for general data storage is not recommended, as it is not cross platform. We recommended either HDF5 or msgpack, both of which are supported by pandas' IO facilities.

Computation

Numerical integration (sample-based) of a time series

Timedeltas

The Timedeltas docs.

Using timedeltas

```
In [178]: s  = pd.Series(pd.date_range('2012-1-1', periods=3, freq='D'))

In [179]: s - s.max()
Out[179]:
0   -2 days
1   -1 days
2    0 days
dtype: timedelta64[ns]

In [180]: s.max() - s
Out[180]:
0   2 days
1   1 days
2   0 days
dtype: timedelta64[ns]

In [181]: s - datetime.datetime(2011,1,1,3,5)
Out[181]:
0   364 days 20:55:00
1   365 days 20:55:00
2   366 days 20:55:00
dtype: timedelta64[ns]
```

```
In [182]: s + datetime.timedelta(minutes=5)
Out[182]:
0   2012-01-01 00:05:00
1   2012-01-02 00:05:00
2   2012-01-03 00:05:00
dtype: datetime64[ns]

In [183]: datetime.datetime(2011,1,1,3,5) - s
Out[183]:
0   -365 days +03:05:00
1   -366 days +03:05:00
2   -367 days +03:05:00
dtype: timedelta64[ns]

In [184]: datetime.timedelta(minutes=5) + s
Out[184]:
0   2012-01-01 00:05:00
1   2012-01-02 00:05:00
2   2012-01-03 00:05:00
dtype: datetime64[ns]
```

Adding and subtracting deltas and dates

```
In [185]: deltas = pd.Series([ datetime.timedelta(days=i) for i in range(3) ])

In [186]: df = pd.DataFrame(dict(A = s, B = deltas)); df
Out[186]:
         A      B
0 2012-01-01 0 days
1 2012-01-02 1 days
2 2012-01-03 2 days

In [187]: df['New Dates'] = df['A'] + df['B'];

In [188]: df['Delta'] = df['A'] - df['New Dates']; df
Out[188]:
         A      B  New Dates    Delta
0 2012-01-01 0 days 2012-01-01  0 days
1 2012-01-02 1 days 2012-01-03 -1 days
2 2012-01-03 2 days 2012-01-05 -2 days

In [189]: df.dtypes
Out[189]:
```

```
A             datetime64[ns]
B            timedelta64[ns]
New Dates     datetime64[ns]
Delta        timedelta64[ns]
dtype: object
```

Another example

Values can be set to NaT using np.nan, similar to datetime

```
In [190]: y = s - s.shift(); y
Out[190]:
0      NaT
1   1 days
2   1 days
dtype: timedelta64[ns]

In [191]: y[1] = np.nan; y
Out[191]:
0      NaT
1      NaT
2   1 days
dtype: timedelta64[ns]
```

Aliasing Axis Names

To globally provide aliases for axis names, one can define these 2 functions:

```
In [192]: def set_axis_alias(cls, axis, alias):
   .....:     if axis not in cls._AXIS_NUMBERS:
   .....:         raise Exception("invalid axis [%s] for alias [%s]" % (axis, alias))
   .....:     cls._AXIS_ALIASES[alias] = axis
   .....:
```

```
In [193]: def clear_axis_alias(cls, axis, alias):
   .....:     if axis not in cls._AXIS_NUMBERS:
   .....:         raise Exception("invalid axis [%s] for alias [%s]" % (axis, alias))
   .....:     cls._AXIS_ALIASES.pop(alias,None)
   .....:
```

```
In [194]: set_axis_alias(pd.DataFrame,'columns', 'myaxis2')

In [195]: df2 = pd.DataFrame(np.random.randn(3,2),columns=['c1','c2'],index=['i1','i2',

In [196]: df2.sum(axis='myaxis2')
Out[196]:
i1    0.745167
i2   -0.176251
i3    0.014354
dtype: float64

In [197]: clear_axis_alias(pd.DataFrame,'columns', 'myaxis2')
```

Creating Example Data

To create a dataframe from every combination of some given values, like R's expand.grid() function, we can create a dict where the keys are column names and the values are lists of the data values:

```
In [198]: def expand_grid(data_dict):
   .....:     rows = itertools.product(*data_dict.values())
   .....:     return pd.DataFrame.from_records(rows, columns=data_dict.keys())
   .....:

In [199]: df = expand_grid(
   .....:     {'height': [60, 70],
   .....:      'weight': [100, 140, 180],
   .....:      'sex': ['Male', 'Female']})
   .....:

In [200]: df
Out[200]:
   height  weight     sex
0      60     100    Male
1      60     100  Female
2      60     140    Male
3      60     140  Female
4      60     180    Male
5      60     180  Female
6      70     100    Male
7      70     100  Female
8      70     140    Male
```

```
9      70    140  Female
10     70    180    Male
11     70    180  Female
```