

In addition to being a more efficient computation, compared to the masking expression this is much easier to read and understand. Note that the `query()` method also accepts the `@` flag to mark local variables:

```
In[25]: Cmean = df['C'].mean()
        result1 = df[(df.A < Cmean) & (df.B < Cmean)]
        result2 = df.query('A < @Cmean and B < @Cmean')
        np.allclose(result1, result2)
```

```
Out[25]: True
```

Performance: When to Use These Functions

When considering whether to use these functions, there are two considerations: *computation time* and *memory use*. Memory use is the most predictable aspect. As already mentioned, every compound expression involving NumPy arrays or Pandas DataFrames will result in implicit creation of temporary arrays: For example, this:

```
In[26]: x = df[(df.A < 0.5) & (df.B < 0.5)]
```

is roughly equivalent to this:

```
In[27]: tmp1 = df.A < 0.5
        tmp2 = df.B < 0.5
        tmp3 = tmp1 & tmp2
        x = df[tmp3]
```

If the size of the temporary DataFrames is significant compared to your available system memory (typically several gigabytes), then it's a good idea to use an `eval()` or `query()` expression. You can check the approximate size of your array in bytes using this:

```
In[28]: df.values.nbytes
```

```
Out[28]: 32000
```

On the performance side, `eval()` can be faster even when you are not maxing out your system memory. The issue is how your temporary DataFrames compare to the size of the L1 or L2 CPU cache on your system (typically a few megabytes in 2016); if they are much bigger, then `eval()` can avoid some potentially slow movement of values between the different memory caches. In practice, I find that the difference in computation time between the traditional methods and the `eval/query` method is usually not significant—if anything, the traditional method is faster for smaller arrays! The benefit of `eval/query` is mainly in the saved memory, and the sometimes cleaner syntax they offer.

We've covered most of the details of `eval()` and `query()` here; for more information on these, you can refer to the Pandas documentation. In particular, different parsers and engines can be specified for running these queries; for details on this, see the discussion within the [“Enhancing Performance” section](#).

Further Resources

In this chapter, we've covered many of the basics of using Pandas effectively for data analysis. Still, much has been omitted from our discussion. To learn more about Pandas, I recommend the following resources:

Pandas online documentation

This is the go-to source for complete documentation of the package. While the examples in the documentation tend to be small generated datasets, the description of the options is complete and generally very useful for understanding the use of various functions.

Python for Data Analysis

Written by Wes McKinney (the original creator of Pandas), this book contains much more detail on the package than we had room for in this chapter. In particular, he takes a deep dive into tools for time series, which were his bread and butter as a financial consultant. The book also has many entertaining examples of applying Pandas to gain insight from real-world datasets. Keep in mind, though, that the book is now several years old, and the Pandas package has quite a few new features that this book does not cover (but be on the lookout for a new edition in 2017).

Pandas on Stack Overflow

Pandas has so many users that any question you have has likely been asked and answered on Stack Overflow. Using Pandas is a case where some Google-Fu is your best friend. Simply go to your favorite search engine and type in the question, problem, or error you're coming across—more than likely you'll find your answer on a Stack Overflow page.

Pandas on PyVideo

From PyCon to SciPy to PyData, many conferences have featured tutorials from Pandas developers and power users. The PyCon tutorials in particular tend to be given by very well-vetted presenters.

My hope is that, by using these resources, combined with the walk-through given in this chapter, you'll be poised to use Pandas to tackle any data analysis problem you come across!