

Cycle Detection

As we now have the cyclical data set prepared, the next step is to discover the individual cycles that are active. Subsequently, the engine needs to perform a spectral analysis and then isolate those cycles that are repetitive and have the largest amplitudes. For that, we need to decide on a cycle detection algorithm that suits our goal. Most cycle researchers are familiar with the fast Fourier transform (FFT) and many "FFT-based engines" are available to detect one or more cycles in data sets. What many do not know, however, is that there is a special subset: the Goertzel algorithm [\[1\]](#) [\[2\]](#).

Originally, the algorithm was used to detect "dominant" tone frequencies used in landline phones for DTMF signaling, which was originally developed in 1958, long before the period of smartphones. Have you ever thought about how the telephone exchange knows what button has been pressed? The answer is the Goertzel algorithm. Today, the Goertzel algorithm is used extensively in communications for tone detection and is built into hardware as integrated circuits to detect tones of a button pushed in near-real-time.

Additionally, and even more important, the Goertzel algorithm was originally designed to detect cycles in data sets that have similar characteristics to contemporary financial series data. The problem a long time ago was that a special tone needed to be detected in a very short amount of available data and with considerable noise. This is similar to the problem of determining dominant cycles in financial data sets observed today.

Therefore, instead of using standard Fourier or wavelet transforms, why not use a well-established variant of the discrete Fourier transform (DFT): the Goertzel algorithm? As our requirements for cycle detection in financial markets are similar to the ones Goertzel was addressing in the case of old phone lines?

Our research shows that the Goertzel algorithm delivers reliable results in decoding dominant cycles out of detrended financial data sets, outperforming other methods such as wavelets or MESA.

For sure, you need to apply the Goertzel DFT (GDFT) in a special way, as you need to apply a GDFT test on all possible wavelengths and use different methods to obtain the current phase and amplitude. That is, for covering a full cycle length spectrum, the Goertzel algorithm has a higher complexity than FFT algorithms. Nevertheless, using the Goertzel algorithm to obtain the dominant cycle length out of short and noisy data, along with standard versions to obtain the related current phase and amplitude for the detected cycle length, helps generate all dynamic cycle data for the active cycle at the last point of our data set under consideration. As we are not interested in the "averaged" cycle length for longer data sets, we want the cycle length and phase that are active on the last bar of the chart. Therefore, this combination of the Goertzel algorithm as the core, with additional analysis to obtain the current phase of the cycle at the end of the data set, is used.

Finally, this approach is supported by a study conducted by Dennis Meyers (2003) on the Goertzel method: [3]

“ With very noisy data where the noise strength is greater than the signal strength, [...], only the Goertzel Algorithm can successfully identify the frequencies present.

In addition, we can see an increasing amount of noise coming into play for financial markets. Some examples of this are high-frequency trading, pure algo-based trading engines, or alternative news. So, in our real-life environments, we will not see a "clean" financial data set as it is diluted by noise that hides the real underlying cycles. The Meyers study shows that the GDFT even outperforms the proposed method "MESA" used by John F. Ehlers in most of his cycle research.

Therefore, our cycle scanner framework applies the GDFT to the detrended data set to cover all possible cycle lengths. Once the most active cycle is detected based on the full spectrum GDFT analysis, we use an additional run to check for the least current phase status on the last bar of our data set with a shorter subset of the original full data set, as we are interested in the status of the detected cycle length at the point of the analysis, or the last bar available.

References:

[1] Goertzel: <https://www.mstarlabs.com/dsp/goertzel/goertzel.html>

[2] Goertzel: <https://courses.cs.washington.edu/courses/cse466/12au/calendar/Goertzel-EETimes.pdf>

[3] Source: <http://meyersanalytics.com/publications2/MesaVsGDFT.pdf>

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