Time-series Capsule Specification

Purpose

This capsule provides a starting point for applications that need to handle time-series data. It will significantly increase the functionality of some other capsules. This Capsule may leverage the Multi-Dimensional Indexing and/or Array of Arrays Capsules.

Background

“A time series is a sequence of data points, measured typically at successive times, spaced at (often uniform) time intervals. Time series analysis comprises methods that attempt to understand such time series, often either to understand the underlying context of the data points (Where did they come from? What generated them?), or to make forecasts.” - Wikipedia.org.

A time-series may be associated with geospatial information, but that usage is covered in the Geospatial Indexing Capsule Specification. It is anticipated that time-series data will be used in support of queries, visualization, simulation and for analysis, e.g. in SIGINT applications.

Time-series analysis methods fall into two main categories: time domain and frequency domain. When visualized, a time-domain graph shows how a signal changes over time, whereas a frequency-domain graph shows how much of the signal lies within each given frequency band over a range of frequencies. A frequency-domain representation can also include information on the phase shift that must be applied to each repeated group in order to be able to recombine the frequency components to recover the original time signal.

Although "*the*" frequency domain is spoken of in the singular, there are actually several different frequency domains, each defined by a different mathematical transform, which are used to analyze signals. These are the most common transforms used and the fields in which they are used:

- Fourier Series - repetitive signals and oscillating systems.
- Fourier Transform - non-repetitive signals.
- Laplace Transform - electronic circuits and control systems.
- Wavelet Transform - digital image processing and signal compression.
- Z Transform - discrete signals and digital signal processing.

Functionality

The Time-series Capsule supports the object model depicted in Appendix A. An object may be indexed by multiple Time-series indexes.

As a time-series can be represented in at least two ways - indexed by a time value or a frequency value, this capsule supports both representations and their variants. However, data items alone are useless without the accompanying mathematical functions that can be combined with them to perform transformations and other operations, so a TimeFrequency object has no attributes (fields) other than an optional vector of time or frequency values/ranges. It has TimeSeries and FrequencySeries subclasses that the user can subclass to add the data items appropriate to the functions that generate or use it.

The capsule provides tools or methods for:

- Creating, updating and deleting a scalable, TimeSeries index. Each index entry consists of one of the following:
  - A date/time value or range
  - A frequency or range of frequencies
  - A collection of OIDs of other index entries
  - A collection of OIDs of TimeFrequency objects that lie within the owning range. The OIDs may be for whole databases or containers.
- Using a sample, replaceable, placement model (segmenting the index and destination objects across databases and containers).
- Using the TimeSeries index in support of enhanced object queries.
- Finding all TimeSeries indices that reference an object.
- Finding all TimeSeries indices in a scope (federation, database or container).
- Creating a FrequencySeries object given the frequency interval and a TimeSeries object.
- Correlating two FrequencySeries objects to produce intersections or differences.
- Correlating two TimeSeries objects to produce intersections or differences.
- Autocorrelating a TimeSeries objects (i.e. with itself) to find repetitive patterns.

Platforms and Languages

- Windows and Linux.
- C++, Java and C# (later).

Suggested Pricing

- $250 per developer license, but requiring standard Objectivity/DB licenses to be useful.

Appendix A – Object Model for the Time-Series Capsule