FINESSE: A Financial Information Spreadsheet

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Abstract

We outline a spreadsheet-based system for visualization of real-time financial information. Our system permits the user to define arithmetic and presentation relationships amongst the various cells of the spreadsheet. The cells contain primitives that can be numbers, text, images, functions, and graphics. Presenting financial information in this format allows its intended clients, the financial analysts, to work in the familiar environment of a spreadsheet and allows them the flexibility afforded by the powerful interface of the spreadsheet paradigm. In addition, our system permits real-time visualization of the financial data stream allowing its user to visually track the changing market trends in two and three dimensions.

1 Introduction

In this paper we address one of the application areas of information visualization, financial information visualization. Visualization of financial information is a challenging task due to several reasons. These include (a) multi-dimensional nature of the input data making it difficult to select which dimensions to display, (b) real-time data fluctuations that have to be conveyed to the users in real time, (c) choice of an appropriate user interface that is intuitive and expressive, and (d) access to numeric data underlying the visualization for making final market decisions (as opposed to using the visualization for observing general trends and patterns). In this paper we outline a financial information visualization system – FINESSE, that handles the above challenges in an elegant and consistent manner.

FINESSE is based upon a spreadsheet paradigm that allows interactive display of real-time financial data in various formats – text, numeric, two-dimensional heat maps, images, and three-dimensional graphics. Real-time updates are made possible through multi-resolution renderings. In addition, users can point-and-click on any part of the displayed graphic to get up-to-date information on the appropriate variables.

2 Related Work

Computer graphics has been used for well over a decade in visualization of trends and patterns in financial markets. Jarett and Johnson [4] use computer generated bar charts for comparing the expenditure patterns of several companies that deal in different currencies. Beshers and Feiner [1] present the idea of "worlds-within-worlds" to allow a user to explore a multidimensional dataset with several nested frames of reference. Wright [11] presents some of the best laid-out examples of financial information visualization. Pintado [8] presents effective two-dimensional visualizations of the Markowitz plane.

The framework of a generalized spreadsheet for two- and three-dimensional visualization of data has been used in the past with some success by Piersol [7], Palaniappan et. al. [6], and Levoy [5]. They allow cells to contain objects such as images, widgets, movies, volumes, files, and even other spreadsheets. The idea of creating links that control data display in independent windows has been implemented in the LinkWinds system [3].

FINESSE shares some of the attributes found distributed in the above work, such as generalized cell primitives including, text, numbers, formulas, images, and three-dimensional graphics, and easy definition and plugging-in of financial data analysis modules such as option pricing. In addition to the above, FINESSE also allows its users to create inter-cell arithmetic and presentation relationships, uses multiresolution renderings to achieve faster update rates for high complexity two- and three-dimensional graphic displays, and permits real-time bindings of incoming data-streams of financial data to particular display formats such as heat-maps. Recently, Applix Inc. has also announced the feature of real-time data bindings in its generalized spreadsheets [10]. Generalized spreadsheet framework has been commercially successful in the financial markets primarily because of its intuitive structure and an easy-to-understand interface for its intended clients, the financial analysts, since it generalizes their familiar concept of a conventional numeric spreadsheet.

3 Implementation Overview

FINESSE has been implemented over OpenGL and X/Motif using C in a UNIX environment. The underlying data-structures are very general and facilitate easy implementation of different kinds of primitives and relationships.

3.1 Primitives

Each cell of the spreadsheet has a general primitive type that is a pointer to: a memory buffer, a data stream, or a function. Inter-cell relationships are very easy to implement using such a scheme since we can now simply redirect them via a function or a memory buffer. This also simplifies adding plug-in modules that can be added as pointers to functions. FINESSE primitives are outlined next.

Numeric, Text, Image Data: Numbers can be associated with each cell, just as in a conventional numeric spreadsheet. In addition, the incoming streams of text data from a financial information provider can be bound to one or more cells (Figure 1). Similarly, cells can contain images that either represent the two-dimensional visualization results from other cells or reflect incoming data from files or real-time feeds.

Heat Maps: Users can specify one-dimensional color coding of data in a heat map as shown in Figure 2. Heat maps allow a visually appealing display that can draw the user's attention to "hot" spots of activity or to any "alarm" conditions (a stock's price dipping below or rising above some threshold) by flashing and/or using visually dominant colors. The two axes of the heat map could represent ordering by portfolio contents and risk or return.

Graphs: FINESSE allows users to specify functions for two- and three-dimensional plotting. The parameters of these functions can be either directly manipulated or based on incoming data streams and from functions computed in other cells. The values of the variables of these functions can change in real-time allowing one to visualize the corresponding changes in the functions. Figure 3 shows an example of a two-dimensional function controlled by slider-bar parameters in neighboring cells. Figure 4 shows results of a plug-in module for computing American call and put option prices (plotted against domestic and foreign interest rates and volatility) [2]. Figure 5 shows bid-prices for stocks in a landscape format.

Access to underlying data for the above primitives has been implemented through a simple image-space *pick* operation. Several operations on assignment of primitives to cells including, load, cut, paste, copy, move, and clear have been implemented.

3.2 Relationships

FINESSE permits users to define several kinds of relationships amongst its cells. The cells amongst which relationships are defined can be selected either according to rows, columns, rectangular regions, individually, or by any combination thereof. Such a scheme allows great flexibility in the definition of what constitutes a "group" of inter-related cells. At present our system allows arithmetic and presentation relationships. These relationships are defined only for cells that have compatible primitives.

Arithmetic Relationships: These relationships are extensions of the corresponding relationships found in a conventional numeric spreadsheet. For instance, a cell group C can display the real-time results of a mathematical operation on the two heat-maps defined in other cell groups A and B.

Presentation Relationships: Groups of cells can be related in FINESSE via presentation interdependencies. These interdependencies could be as simple as having a common color map or font across a group of related cells, or they can be more sophisticated such as linking the geometric transformations for viewing three-dimensional graphics in two or more cells. This proves extremely useful in visually comparing similar graphics in different windows. These could be used for instance, in comparing smoothness of similar real-time yield curves under different models and for comparing heat maps of portfolios showing risks, returns, or bid prices of component stocks with identical color codings. We have implemented presentation relationships through shared memory across different display processes.

FINESSE implements arithmetic and presentation relationships independently of one another. Arithmetic relationships amongst cells are directional and are implemented as a directed acyclic graph; cycles are not allowed. However, presentation relationships are non-directional and all cells related by a presentation relationship "share" a common set of presentation attributes. FINESSE has a *relationship-display mode* in which the presentation and arithmetic relationships can be displayed by means of directed and undirected lines, as shown in Figure 6.

4 Conclusion and Future Directions

FINESSE gracefully extends the ideas of numeric and image-based spreadsheets proposed in the past and provides a flexible and powerful framework for visualizing and manipulating real-time financial information. It can allow several kinds of graphical and arithmetic primitives to be defined and related in a consistent and intuitive manner. We are considering the following extensions to FINESSE at this time:

Collaborative Applications: FINESSE is a powerful single-user tool at present. We are currently exploring the idea of a distributed spreadsheet in which different cells are defined locally on different computers on a network. Java might be a language of choice for this.

3D Spreadsheets: Having a three-dimensional set of cubical cells, or voxels, might make a better presentation and analytical tool for certain applications where inter-relationships are best described in a three-dimensional form. Hierarchies of nested financial data, say stocks by types (e.g.: technology → computer companies → graphics companies), in particular should fit such a three-dimensional display paradigm well. *Cone trees* [9] might be relevant here.

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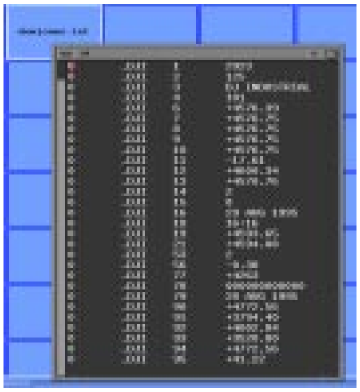

Figure 1: Text binding

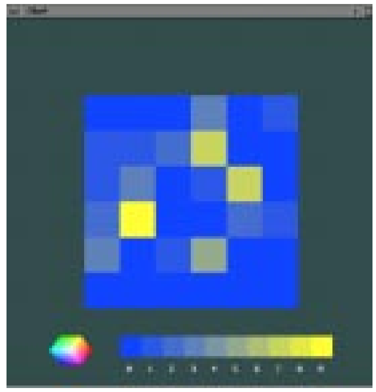

Figure 2: Heat Map

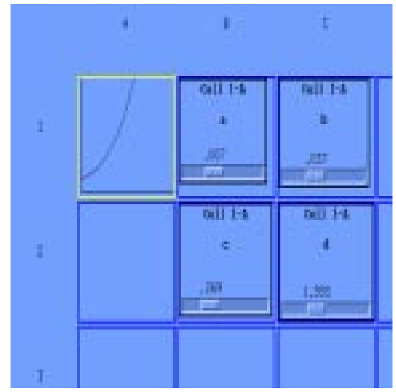

Figure 3: Two-Dimensional Function

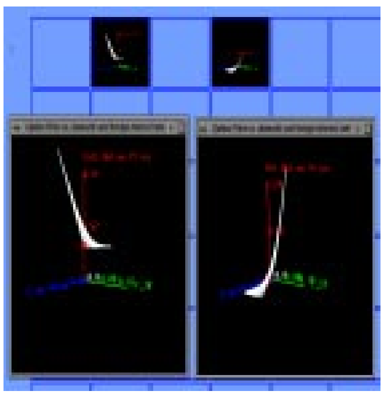

Figure 4: 3D Option Pricing Module

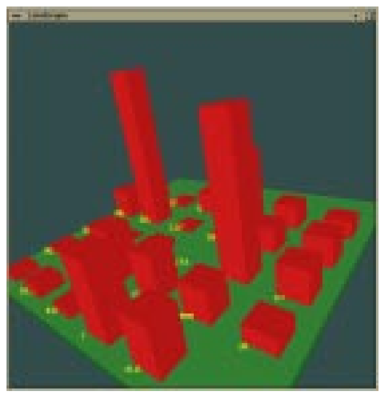

Figure 5: Landscape Module

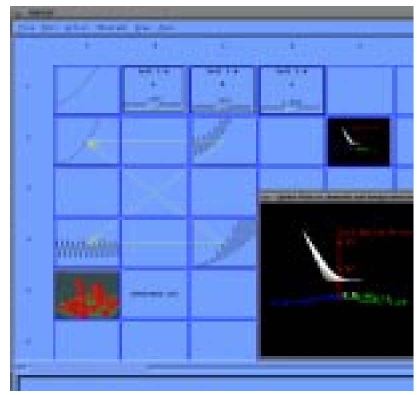

Figure 6: Relationships in FINESSE