

Visual analytics  
Revealing corruption,  
fraud, waste and abuse



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“Between the birth of the world and 2003, there were five exabytes of information created. We [now] create five exabytes every two days. See why it’s so painful to operate in information markets?”<sup>1</sup>

So said global technology executive Eric Schmidt in 2010 and anyone who has tried to clear their email inbox can relate to that. Schmidt’s comment shows why “the sexy job in the next ten years” will be “to access, understand, and communicate the insights you get from data analysis.”<sup>2</sup>

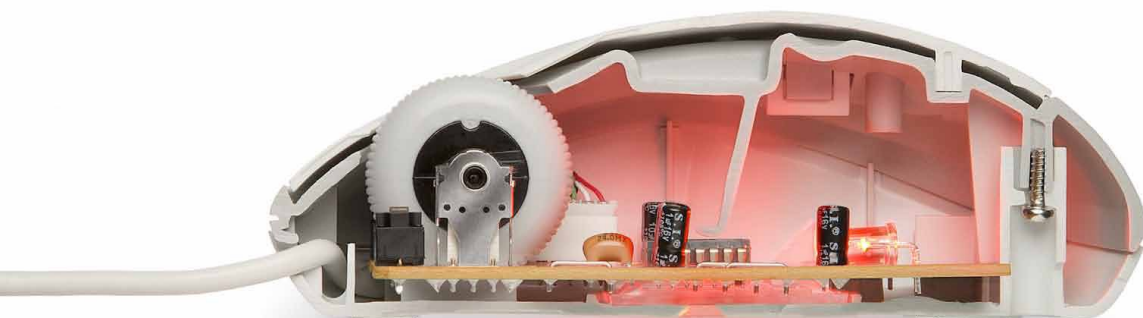
Although humans receive, evaluate and accumulate more information now than ever before, the rich insights within that data may be difficult to identify by traditional means and often remain hidden. Yet, in the realm of fraud detection for example, the ability to reveal relationships, communications, locations and patterns can make the difference between uncovering a fraud scheme at an early stage and having it grow into a major incident.

Against this backdrop, practitioners are turning to visual analytic tools and techniques to detect and reduce corruption, fraud, waste and abuse in the enterprise. From money-laundering schemes to bribery violations of the U.S. Foreign Corrupt Practices Act and other anti-corruption laws, from manipulating financial statements by reporting fictitious revenues to inappropriate purchases using p-cards, graphically representing and exploring data can bring clarity to executives’ concerns and to performance improvement opportunities.

<sup>1</sup> Eric Schmidt speaking at Zeitgeist Europe 2010, recorded at 19.48 minutes in the video [http://www.youtube.com/watch?v=Qr2-2XY\\_QsQ](http://www.youtube.com/watch?v=Qr2-2XY_QsQ).

<sup>2</sup> Hal Varian on How the Web Challenges Managers, *McKinsey Quarterly*, January 2009.

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# Beyond spreadsheets

While spreadsheets offer a quick way to understand simple facts and figures, their utility diminishes as the data grow in volume and complexity. Visual analytics builds on humans' natural ability to absorb a greater volume of information in visual than in numeric form and to perceive certain patterns, shapes and shades more easily than others.

Visual representations such as word clouds, which display words in a size that reflects their frequency of use (Figure 1), and social networking diagrams, which indicate relationships within a given community (Figure 2), are good examples of expressing complex data in a form that can be understood intuitively.

Using mathematical techniques to evaluate patterns and outliers, effective visuals can translate multidimensional data such as frequency, time, and relationships into an intuitive picture.

Consider a project to identify potential fictitious vendors that may have been created by an entity's employees to receive payments generated by phony invoices and purchase orders. A traditional detection technique would be to list the invoice or purchase order numbers on a spreadsheet and sort them to identify numbers that are repeated, occur out of sequence, or increase by unusually small amounts over time (suggesting the vendor has few or no other customers).



Figure 1. Word cloud

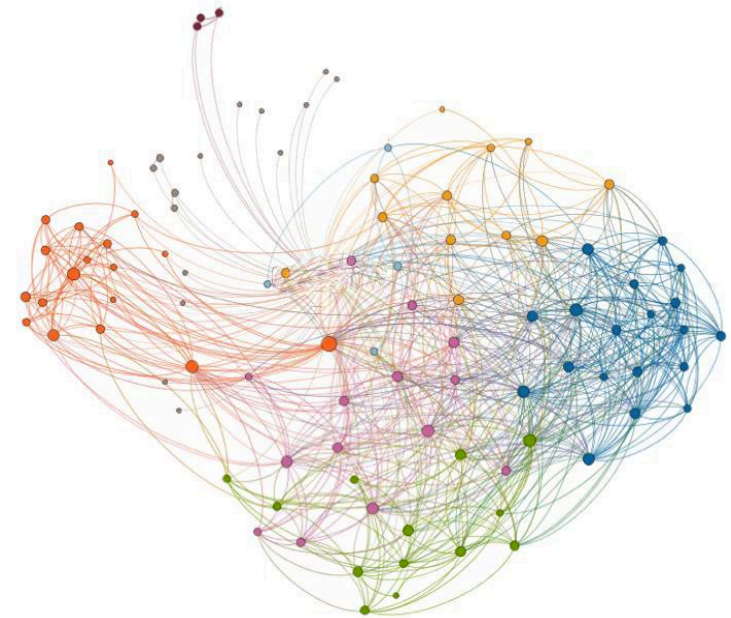


Figure 2. Social networking diagram

It may be easier to spot anomalies among a group of vendors by generating a graphic such as the one in Figure 3. This chart shows, for each of many vendors, lines connecting the purchase order numbers relating to each of that vendor's invoices over a three-year period. An analyst can identify some potential wrongdoing relatively quickly because the transactions highlighted in red have purchase order numbers that either are repeated or run out of sequence. There may be valid reasons for these anomalies, but experience suggests they merit further investigation.

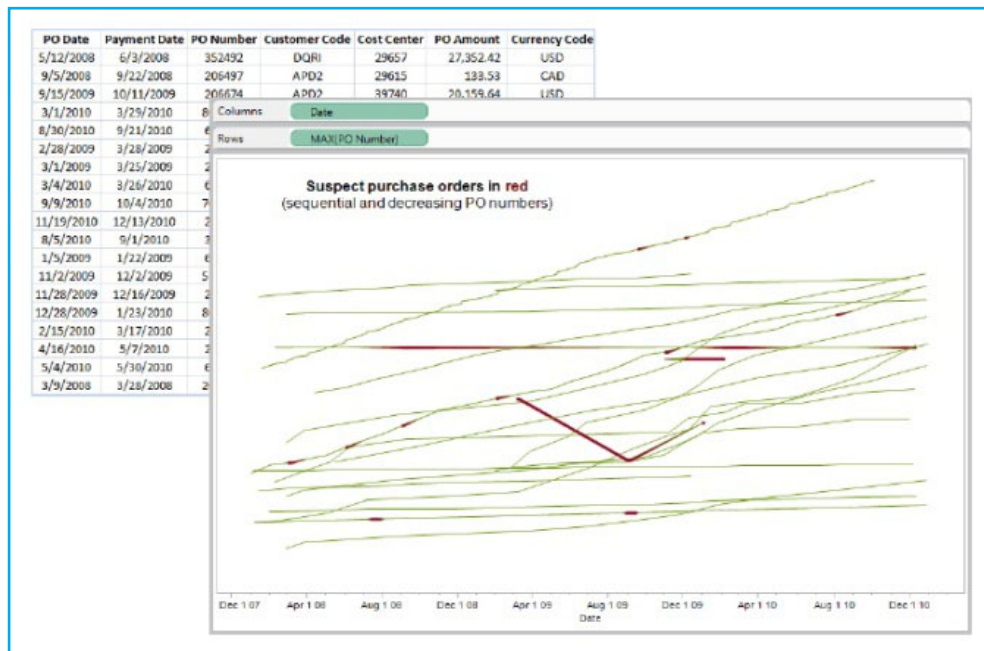


Figure 3. Purchase order numbers used for each of multiple vendors over a three-year period

This type of data analysis capability was once reserved for a small number of highly trained specialists. Yet recent software advances have made this capability available to people such as compliance officers, internal auditors, fraud investigators and operations personnel with just a short learning curve.

Where applications have traditionally offered static reports, these advances create dynamic environments that enable findings to be explored visually. Professionals with knowledge of their specific business domains can formulate hypotheses, test them and receive results instantly as they make changes to queries. As a result, visual analytics can augment one's ability to explore, test and confirm hypotheses more quickly.

# Visual whistleblowing?

In its 2010 *Report to the Nations on Occupational Fraud and Abuse*, compiled from a study of 1,843 cases of occupational fraud that occurred worldwide between January 2008 and December 2009, the Association of Certified Fraud Examiners highlighted that 40 percent of these frauds were identified by tips, the largest single method of fraud detection.<sup>3</sup> While the Sarbanes-Oxley Act of 2002 and the Dodd-Frank Act of 2010 included measures to encourage the use of whistleblowing to detect corporate fraud, this still leaves another 60 percent of frauds to be detected by other means. Data analytics, and visual analytics in particular, may be the breakthrough companies are seeking in anti-fraud techniques.

While financial services companies are at the forefront of using visual analytics techniques to combat money laundering, conduct trading analyses, and perform continuous monitoring, their use in other industries is growing as internal audit and compliance functions are often being asked to enhance risk management effectiveness but with fewer resources. The growing diversity of uses is matched by the variety of visual analytics techniques available, of which we present a selection below.

## Tree maps

Tree maps are a type of heat map in which a rectangular space is divided into regions, and then each region is divided again for each level in the hierarchy. The size and shading of the rectangles represent two additional data points, allowing the viewer to identify patterns in complex data. The original motivation for tree maps was to show the contents of computer hard disks with tens of thousands of files in 5-15 levels of directories. Tree maps are especially effective in showing data represented by several dimensions (e.g., region, facility, account, and product line). The hierarchical structure provided by tree maps can reveal such multi-faceted information more quickly than spreadsheets, bar charts or line graphs.

<sup>3</sup> Association of Certified Fraud Examiners, *Report to the Nations on Occupational Fraud and Abuse*, 2010 at 16.



### Link analysis

Identifying hidden relationships, demonstrating complex networks and tracking the movement of money is difficult using tabular methods. For this reason, link analysis, one of the more common visual analytics techniques, has been successfully deployed to combat those issues. This approach is particularly useful in anti-money laundering investigations. Figure 5 shows an example of using link analysis to identify unexpected relationships.

Here, based on data from multiple sources, visual connections are made between a variety of entities that share an address and bank account number and a fictitious vendor created to embezzle funds from a company. Link analysis is particularly effective for identifying indirect relationships and those that may be connected only through several intermediaries.

In the realm of electronic discovery, data analytics software can help lawyers to identify changes over time in communications and social networks, and let them explore clusters of various words and ideas – “concept clusters” – used by those involved in the matter.<sup>4</sup> Using link analysis to associate communications like email and instant messages with events and individuals may also reveal connections among custodians and new topics at the earliest stages of case assessment. These techniques can create efficiencies in the document review and production process, help craft discovery requests and responses, and impact strategic case decisions.

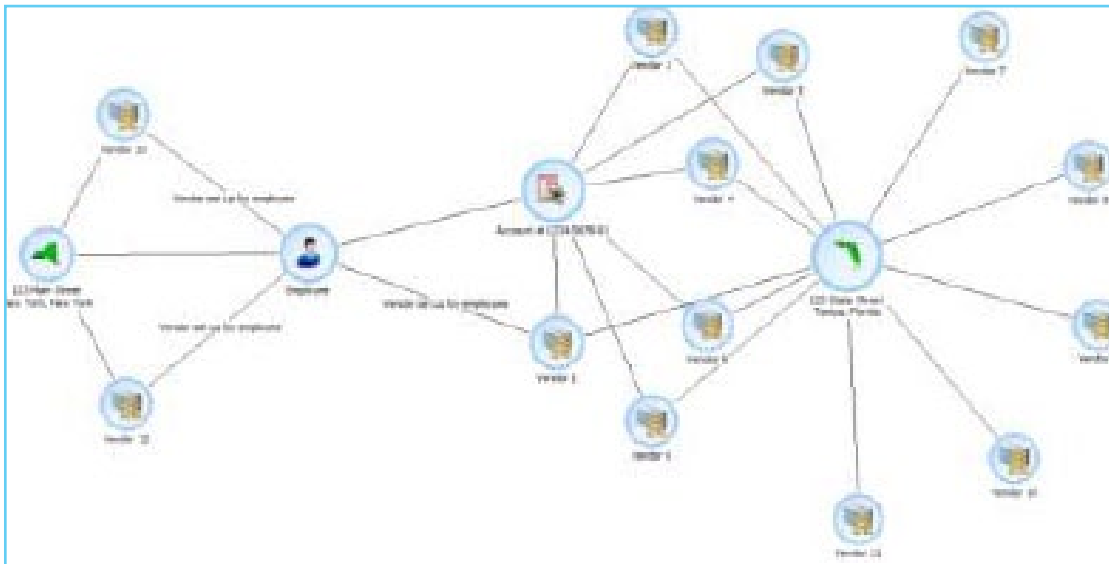


Figure 5. Link analysis showing a fictitious vendor, related entities and a shared bank account

## Geospatial analysis

Financial transactions, asset information, customer data, and contracts, among many others, are records that may contain a reference to a location including a place name and an address. In a geospatial analysis, visual analytics shows intersections between this data and its location, helping to uncover a hidden relationship.

Figures 6 through 9 show how a Geographic Information System (GIS) can be used to transform tabular data into location-specific clues to wrongdoing. This example relates to health care fraud.

Figure 6 illustrates geocoding, the process of converting an address, place name or location reference into latitude and longitude coordinates that can be placed on a map. Here, we show a list of certain health care clinic addresses in Miami, Florida, and their corresponding locations by latitude and longitude, shown as red dots.

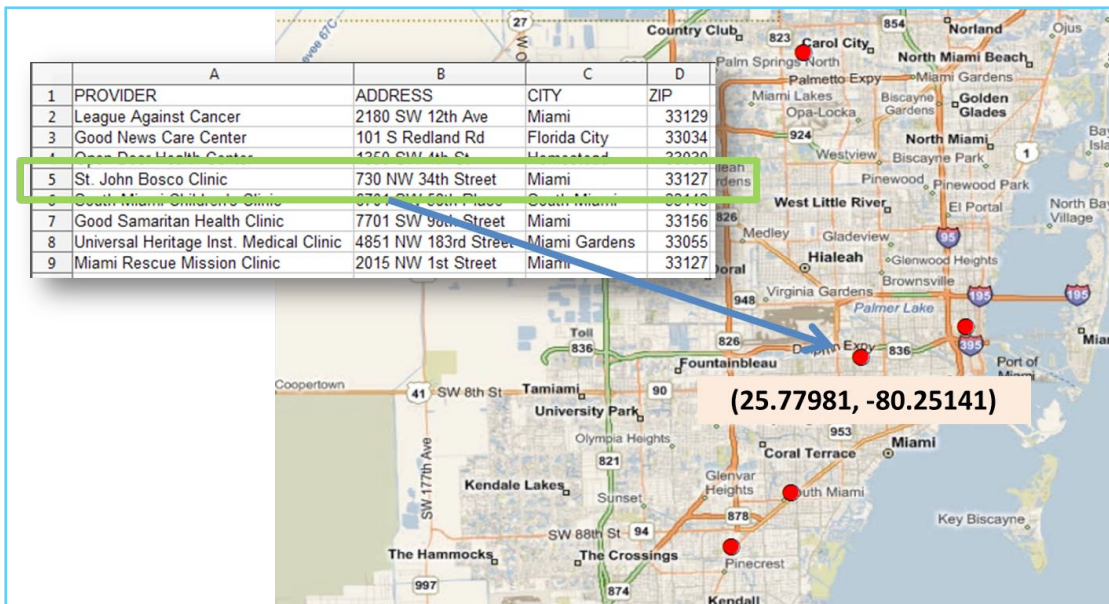


Figure 6. Geocoding an address into latitude and longitude coordinates

<sup>4</sup> John Markoff, Armies of Expensive Lawyers, Replaced by Cheaper Software, *The New York Times*, March 4, 2011.

A map symbol's size, shading and shape can each indicate an attribute of the clinic. In Figure 7, the symbol's size indicates the number of reimbursement claims submitted for services provided at each location to senior citizens. Further detail could be added by labeling each symbol with the attribute value itself, namely the number of transactions.

Figure 7 begins to tell a story of the transactions at issue by supplementing the location data with the number of claims filed for each facility.

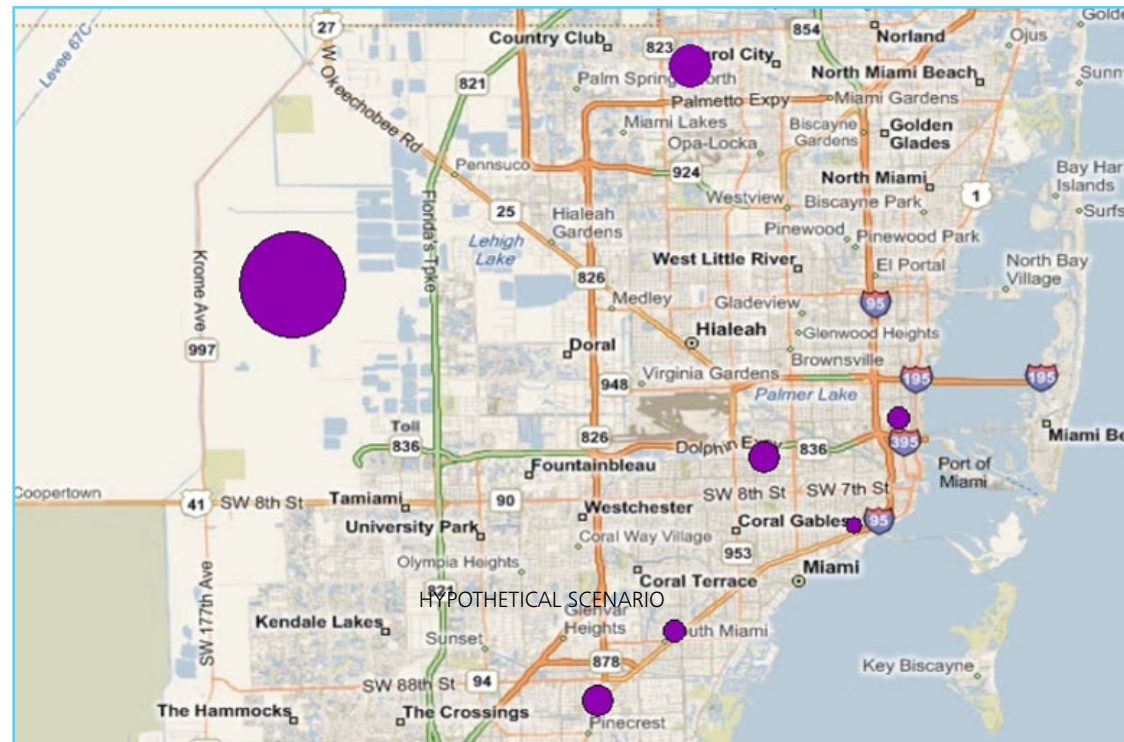


Figure 7. Map of certain clinics with dot size representing their volume of reimbursement claims

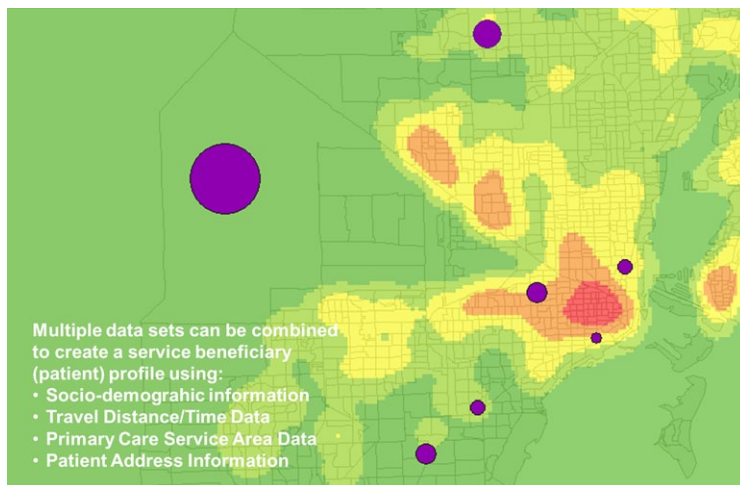


Figure 8. Heat map showing concentration of population age 65 & over

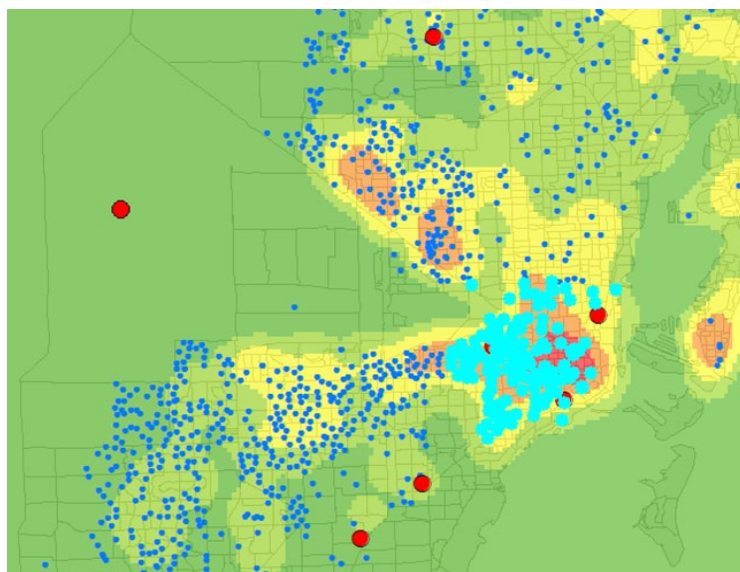


Figure 9. Overlay of patients' addresses (light blue)

One can easily identify the large outlier from the data simply by studying the purple dots, since it is so much larger than the other purple dots and is located away from the others. But one would also expect to see the largest number of claims in the area populated by senior citizens and lower income residents for whom services are eligible for reimbursement. The highest concentration of these people can be seen in red on the heat map in Figure 8.

A cluster analysis of patient addresses for the large outlier clinic (light blue points in figure 9) reveals:

- Patients are retirement or nursing home residents
- Patients are low income senior citizens
- They live outside the average drive-time distance to a clinic

Since the facility in question is located 20 miles away from the socio-demographic profile of a typical beneficiary (as indicated in Figure 9), this analysis raises additional red flags, justifying further investigation. Similar analysis could be used for the other clinics, which may reveal anomalies that are more subtle and harder to spot with simpler tests.

Visual analytics can help to focus investigations on particular activities and connect disparate pieces of information to form a cohesive story. In the above example, symbols depicting clinic locations and transaction volume, along with a patient profile attribute (such as the concentration of residents aged 65 and over, shown as a heat map) provide more vivid detail than the statistics themselves.

One could also overlay market segmentation data on the clinic addresses and run queries to determine statistically significant relationships between facilities.

# Conclusion

Identifying potential corruption, fraud, waste and abuse in large volumes of data has historically been difficult and quite costly. New visual analytics tools and techniques can enable compliance personnel, risk managers and others to “do more with less” by helping to identify previously hidden patterns. Entities should consider equipping their personnel to employ these techniques to meet the growing challenge of reducing corruption, fraud, waste and abuse in the enterprise.

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