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The Use of Data Visualization to Drive Social Change

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Abstract

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This paper examines the history of data visualization and its early and current uses in the business and political spheres. I then go on to theorize about the opportunities for data visualization use in the nonprofit space. Data visualization provides individuals and organizations with an opportunity to better understand and utilize data and information in the organization, allowing them to function more efficiently in service of their mission. It can also help to generate external support for social causes by presenting data around an issue and encouraging users to engage with the information. Due to a recent shift of data visualization experts away from the business world and into the nonprofit space, the increasing availability of user-friendly data visualization software, and the ability for contemporary data visualizations to capture an emotional connection and engage viewers with a subject, I conclude that data visualization has enormous upside potential and will soon be an established part of nonprofit work and become integral to the success of these organizations.

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Introduction

Data visualization aids us in our everyday lives and allows us to quickly synthesize information. Picture the graph that displays the Dow Jones Industrial Average, which flashes across the news every day. The trend line in the Dow Jones graph shows stock prices rise and fall over time on a fixed scale. That seemingly simple graphic helps us to understand the relative health of the economy. Imagine if we replaced that graphic with a table of numbers that listed stock prices over the past few days. It would be much more difficult to understand how the economy is doing in relative terms and draw conclusions about its progress over time. Unlike a table, the visual captures investors' attention and is easily understood because our brain can quickly pick out patterns and major changes in the data.

Data visualization, broadly speaking, is the display of information in a visual manner that allows individuals to quickly understand the significance of the data, like a graph of the Dow Jones Industrial Average over time. Data visualizations can also take the form of heat maps, which display values in colors, and info-graphics, which use pictures and short facts to visually represent statistics (see example in Figure 1)[1]. Data visualization is a growing area of interest in modern society and major news sources, such as the *New York Times* and *Wall Street Journal* use data visualization as part of their regular reporting, but the underlying purpose of data visualization has been utilized as an important tool to convey ideas and relationships throughout history. As I will discuss, the ability to present complex information in an accessible form has contributed to the evolution of human society by promoting the diffusion of knowledge throughout the general population. Breakthroughs in data visualization throughout history have led to a more informed populous and stronger knowledge economy. One of the earliest forms of

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[1] All figures are included in the Appendix at the end of this paper

data visualization was used in the development of the first recorded economy of Ancient Mesopotamia to keep track of economic units. Cuneiform characters were used in Mesopotamia to visualize quantities of goods in agricultural business and trading (Nissen et al. 1993). The development of these visualizations allowed individuals to engage in more complex trade agreements that could not be recorded by the human memory alone. Starting with this early example, visualization tools have continued to develop along with society and drive economic growth through the democratization of knowledge. Due to the explosion of available information in today's society, data visualizations have become more important than ever to help people keep up with the increasing complexity of everyday life. Many of today's organizations are processing 1,000 times more data than ten years ago and the amount of available data is growing by 35%-50% annually (Beath et al. 2012). Visual displays can help people to synthesize complex data sets by breaking them down into small digestible parts, making data more accessible to individuals and driving understanding in areas such as business, politics and social causes.

Data visualization techniques have found their predominant use in arenas where the stakes are high or there is money to be made, such as political campaigns and businesses. I intend to focus attention on a sector that has received far less attention but, I believe, holds significant promise for the utilization of data visualization techniques—the non-profit sector. There has been a recent influx of inexpensive and easy to use data visualization tools, as well as a shift of talented data scientists from high paying corporations to cause-based organizations. These trends indicate the potential for data visualization's growth in nonprofit work. Additionally, the interactive aspects of modern data visualization help to trigger an emotional response on the part of their audiences, especially when displaying data for a social cause. Contemporary data visualization differs from its historically static counterparts and is often

defined by the ability for viewers to manipulate and interact with the data (Simon 2014). Nonprofit organizations can successfully leverage these new trends in data visualization to raise awareness and support for their mission. The remainder of this paper summarizes the use of data visualization throughout history, highlights major breakthroughs, explores how data visualization is used in today's business and political arenas and, finally, discusses the future of this expanding field into cause-based nonprofit organizations. I will argue that while data visualization has had a significant impact on other industries, opportunities in data visualization tools are rapidly increasing to help nonprofits present their work on social issues both internally, to improve effectiveness, and externally, to generate public engagement.

Approaches to Data Visualization

As one of the most widely referenced authors in modern data visualization theory, Edward Tufte has set the stage for in-depth theoretical analysis of visually displayed information with the publication of *The Visual Display of Quantitative Information* (2001), which has come to be regarded as one of the most important books written on the topic of data visualization and a foundation for modern research in the field (Cook 2002). His book concisely outlines the field of graphical representation and uses several historical examples of successful and unsuccessful graphical designs. Tufte asserts that data can be best interpreted by using pictures that represent quantities and that these statistical graphics should reveal data to the viewer in a coherent and straightforward manner (2001). Recent advancements in data acquisition and new technological innovations have hugely impacted the data that is available to use in statistical graphics; however, Tufte notes that progress in the field of statistical graphics has lagged behind other areas of study (2001), however, the recent expansion of interest in data visualization may help to change this historical stagnation. Tufte argues that the creation of effective data visualization

requires combined skills in visual-artistic, as well as statistical-quantitative areas (Tufte 2001).

Many other scholars in the field echo Tufte's sentiments. Stephen Few, a data visualization

consultant and scholar, describes how a basic understanding of human visual perception and

cognition, along with statistical knowledge, is essential to communicating visual information

effectively, (Few 2006). The study of data visualization carefully balances the science of

quantitative processing with the art of aesthetics in order to create the most effective means of

communicating complex information. For example, Colin Ware, Director of the Data

Visualization Research Lab at the University of New Hampshire, combines his advanced degrees

in the psychology of perception and computer science to study this growing field. The necessary

integration of visual studies with data analysis characterizes the complexity of the data

visualization field.

Ware's (2013) research on the neurological basis for visual understanding has helped to

identify many of the design tactics used in modern visualizations. The majority of human

perception of information is visually driven; however, the brain is only capable of picking up on

visuals that are immediately accessible and related to our current tasks (Ware 2013). In his book

Visual Thinking for Design, Ware outlines the two types of neural activity that occur when one

processes information displayed in a graphical design (2008). As information is passed through

the optic nerve to the back of the brain, attention-driven neural activity simultaneously picks up

on the most relevant visual information and dims the relative perception of less immediately

relevant information (Ware 2008). In this manner, data visualization has the power to affect the

neural mechanisms that drive attention and improve human perception of visuals. A neuro-

scientific study from Baker et al. (2004) has also concluded that statistical learning can be

affected by visual cues, and designers have the power to direct a viewer's attention to specific

elements of a data visualization in order to support an idea. As a result, information graphics should be designed in a manner that enhances the rapid and accurate processing of visual information, so as to not mislead the viewer (Ware 2008). In the study of data visualization it is important to keep in mind what the viewer brings to a visualization through their brain's natural processing.

Data visualization has the power to engage its audience using visual cues to convey information, but effective visualizations integrate and synthesize complex data sets and are a product of the quality of data that goes into them (Tufte 2001). The quantity as well as (often) the quality of data has tended to increase rapidly as humans develop more sophisticated methods to sift through and record it. The recent explosion of available data has sparked interest in data analytics methods that can help simplify large amounts of data into coherent and actionable insights. The growing complexity of the modern world provides an opportunity for data visualization to help the average person benefit from the masses of new data that are available to them and allow them to make better-informed decisions. Through an overview of the history of visualization it is possible to see the development of more effective data visualizations closely linked with the innovations of human societal development.

Earliest Data Visualization

To best understand new opportunities in the space of data visualization, it is useful to outline the field's long and rich history. In the evolving world of data visualization, everything might appear to be a breakthrough unless one has a baseline understanding of its history (Friendly and Denis 2001). The general definition of data visualization as a means of communicating information visually can encompass a variety of visual information graphics from pie charts to maps to 3-D interactive representations, and can be traced back over centuries

of human existence. Cuneiform tablets from ancient Mesopotamia represent the earliest forms of

human number systems and are representative of information in a visual form. Research by

Nissen et al. (1993) provides an examination into the social and economic context of early

Cuneiform characters. The authors use modern computer analysis to decipher these ancient

tablets, to examine the impact of Cuneiform on the economic development of early

Mesopotamian society and the use of these characters in the administration of small-scale

economies rather than in the context of recording language (Nissen et al. 1993). The

representation of quantitative information and visualization of early economic transactions

makes Cuneiform a fascinating example of earliest data visualization.

Cuneiform provided a visual representation of economic units for the people of ancient

Mesopotamian communities. Each symbol represents a single unit or set of units that belong to

an individual in their rudimentary agricultural trade economy (Nissen et al. 1993). The

information recorded on the Cuneiform tablets indicated the data around trade that were

collected in that time period and reflect the limited representations that could be created by the

data that was available. These early representations were very simple and might be more

accurately compared to a modern day data table rather than a modern statistical graphics or

multivariate comparisons. The use of small data sets in a non-comparative setting is usually best

represented in a table format (Tufte 2001), and the people of ancient Mesopotamia had not

developed their economy to a level of complexity that merited the creation of comparative

multivariate statistical representations. However, even given the ancient time period, these

Cuneiform tablets helped display relatively complex information given the era. The tablets

granted a means for individuals to record their own wealth in terms of relative value and thus

made participation in the trade economy much more accessible. Individuals went on to increase

the complexity of their transactions because they were able to record and communicate information to one another. This visual style of communication helps to simplify and engage people in today's society and can be traced back to the earliest economy.

Data visualizations can succinctly provide information about complex issues and continue to aid in economic dealings to visually track the progress of one's personal wealth or the relative health of a business. In the case of Cuneiform tablets, the ancient Mesopotamian economy had reached a level of relative complexity that required recording mechanisms to keep track of personal assets and drive economic efficiency (Nissen et al. 1993). These early forms of data visualization helped to simplify and provide a platform for understanding the relatively complex economic dealings of this early society. From similar studies of other early societies, it is clear that economic structures were used in the pre-literate society long before visual representations were created, with the transactions having previously been recorded by human memory (Nissen et al. 1993). The increasing complexity of economic dealings required visual representations to extend the record of transactions beyond what the human memory was capable of. Data visualization was used at that time and continues to be used as a means to communicate information and thus simplify transactions and increase understanding within a community. Diffusion of knowledge has been central to economic development over time (Adler 2001). The Cuneiform tablets of ancient Mesopotamia allowed individuals to record their own wealth and data visualization has historically helped to drive individual participation in the broader economy by providing tools for the general population to interact with and understand complex information.

Data visualization has progressed significantly since its early beginnings, and there have been a series of breakthroughs throughout its long history. The 19th century has been described

as the "Golden Age of Modern Statistical Graphs" (Friendly 2008). The invention of the line graph, bar chart, pie chart and circle graph by William Playfair during this period exemplifies some of the major innovations in data visualization that characterized the 19th century. A political economist from Scotland, Playfair is credited with substantial advancement in statistical graphics (Tufte 2001). Playfair's improvements in graphical design at the beginning of the 19th century sparked major interest in the field of information displays (Friendly 2008), and his breakthrough work in data visualization was formed from a new focus on multivariate comparisons (Tufte 2001). Multivariate comparisons in graphic displays help to show relationships between two or more measures of data, such as increases population over time. Playfair was one of the first to utilize new techniques to visually highlight changes in spatial and positional relationships, such as those shown in Figure 2, which depicts some of Playfair's earliest pie charts. His charts represent relative population size and economic revenue of various countries by the area of the circle (Friendly 2008). Playfair's work demonstrates graphical representation's ability to present comparative relationships and the information in his displays is much more easily interpreted when it is presented in this visual medium rather than in a table format. His invention of the first scatterplots, said to be one of the greatest inventions in graphical designs, along with other graphical breakthroughs such as the pie chart, were accurate and visually intuitive portrayals of multivariate data (Tufte 2001). The new statistical graphic techniques that emerged in the 19th century developed a visual language that improved people's ability to visually grasp concepts and relations between meaningful numbers (Friendly 2008). The display of data in a clear and concise graphic form allowed people to draw their own conclusions based on data that was displayed to them, making information accessible to the general population in a way that it previously was not.

Playfair's background in economics led him to focus on the subject of economies in his graphics. This economic emphasis is shown clearly in Figure 2, his graph *Inquiry into the Permanent Cause of the Decline and Fall of Wealthy and Powerful Nations*, which showed the relationship between the population of the British Colonies and the tax revenues that were collected from them (Playfair 1805). Playfair also designed the first chart that depicted the steep rise of government debt over time in 1786 (as discussed in Tufte 2001). This invention started a trend that continues to today, and the visualization of government debt and spending continues to be one of the most frequently printed graphics (Tufte 2001). The work of Playfair and other economically focused statisticians empowered people to think critically about fiscal policies. The accessible display of information illustrates the role of statistical graphics in the democratization of knowledge, decision-making, and action. Government spending and debt information would previously have been too complex for the average person to understand, but with the help of visual aids, the information is more easily synthesized. Early data visualizations of Cuneiform tablets and William Playfair's pie charts were both geared towards displaying economic factors that had an important influence on society in that period. Statistical graphics continue to be integral to the data collection necessary for planning and commerce in the development of economies. The ability of graphics to simply and powerfully communicate information makes them a useful tool in large-scale projects (Friendly 2008). The display of powerful knowledge in a simple and relational form has linked data visualization to the overall development of economies and these graphics add immense value to the ever-developing wealth of knowledge within a society.

Data visualization's role in promoting the understanding of economic dealings is not unique to William Playfair and his graphics of the British economy's composition. Charles

Joseph Minard, a French civil engineer and famous data visualization theorist, was creating

brilliant visualizations to drive economic development at a similar time in France. Minard held a

position as a visual engineer for the French government and assisted the government in driving

large-scale public projects by visualizing city data (Friendly 2008). Minard's graphical work was

largely focused on the subjects of trade and commerce, as well as city planning and

transportation. He worked with the French government to capitalize on the opportunities that

were uncovered by visualizing city data in an accessible manner. The albums of graphic work

that were recorded in the 19th century, such as *L'Album de Statistique Graphique*, exemplify the

recurrent theme of visual city planning, development, and public projects based on quantitative

economic data (Friendly 2008). Throughout the breakthroughs in statistical graphics that defined

the 19th century the focus remained on displaying economic development within communities.

The use of graphical representations subsequently spread to other governments, such as the

United States. Statistical bureaus in Europe and the U.S. became aware of the power of visual

displays and started work on statistical atlases and albums to record their own government's data

(Friendly 2008). The creation of important job titles in data visualization, such as 'visual

engineer' demonstrates how government organizations of the 19th century were beginning to

recognize data visualizations could add significant value in driving development. The innovative

methods used in graphical design during the 19th century aided in the clear representation of

complex data and the result was an increased dissemination of knowledge throughout the general

public.

Data visualization differs from other methods of human communication in its ability to

reveal data to the viewer through interaction. Messages that are communicated through text or

other visual means, such as film, have stronger control over the progression of information that is

displayed to the audience (Segel and Heer 2010). Data visualization can provide a linear

narrative, but can also provide an opportunity for the viewers to engage with the information and

discover new relationships on their own (Segel and Heer 2010). Charles Minard's 19th c entury

work examining military campaigns is an early example of data visualization's ability to engage

the audience. In addition to his work in statistical graphics for the French government, Minard

was also responsible for one of the most notable data visualization breakthroughs in history. His

map titled *Napoleon's March* (Figure 3) shows the French Army's losses during Napoleon's

1812 Russian Campaign (White 2010). This graphic tells a complex story based on multiple

factors and displays six variables: the size of the army, the direction of their movement, the

passage of time, geography, the army's path, and the temperature—all on a single illustration

(Tufte 2001). Minard's depiction of Napoleon's Russian Campaign of 1812 is widely regarded as

the best example of an information graphic ever drawn (Tufte 2001). E.J. Marey, a French

scientist and famous contributor to the development of aviation, cinematography and cardiology

at the time of Minard's work, describes how the graphic "defies the pen of the historian in its

brutal eloquence" (Friendly 2008, 512). Minard focused specific attention on the viewer's

interaction with his graphics. He worked to maintain proportions of the quantitative data in his

visual representations in order to provide an accurate picture for his audience to engage with

(Minard 1862). Effective data visualization draws on the both the simplicity and complexity

embedded in Minard's graphic. His graphic exemplifies the powerful message that can be

conveyed to an audience with a simple representation of multiple data sets. Minard's graphic of

Napoleon's Russian Campaign presents the data in a relational display that forces the audience to

engage with the data and track the army's progress over time and space (Tufte 2001). The viewer

can draw on their prior knowledge of geography, spatial relations, and climate to understand the

unfolding and the end result of Napoleon's military strategy. The graph successfully interacts

with the audience and appeals to human emotion to create brilliant breakthrough data

visualization.

Current Data Visualization and Business Performance

The history of data visualization shows the ability of visual representation tools to extend

the capabilities of human decision-making. As human society grows in relative complexity and

the quantities of available data increase, the need for tools to handle these intricacies becomes

more important than ever. Society currently generates an overwhelming amount of data, and it is

projected that by 2025 the Internet will have collected more data than the combined brain

capacity of every person living on the planet (Davis 2012). In order to sift through this vast

expanse of potentially useful data and utilize it for effective decision-making, many businesses

find that it is necessary to invest in tools such as data analytics and data visualization that can

summarize this information in an accessible format. As I have illustrated above, there has been a

long and sustained historical focus on development of economic and financial process using

data-driven insights. Modern data visualization continues this trend, with top-performing

corporations at the forefront of data analytics and visualizations. MIT's *Sloan Management

Review* collaborated with the IBM Institute for Business Value to examine the financial value of

using currently-available data analytics tools. Their study included surveys of over 3,000

business executives, managers and analysts from global organizations in 108 countries

comprising over 30 industries (LaValle et al. 2011). The top data analytics tool, projected to have

the most increase in value over the next two years, was unanimously determined to be data

visualization. The results of the study pointed definitively towards the immense economic value

of using data visualization methods in business practices to better utilize data for informed

decisions within a business setting.

The accessibility of information throughout a company is essential to a successful

business and data visualization allows employees at all levels to explore data and draw out

insights to improve their own performance. A key finding in the MIT/IBM report regarded the

relative performance of firms that used data analytics tools, such as visualization software, and

concluded that data analytics are used five times more often at top-performing organizations

compared to poorer-performing organizations (LaValle et al. 2011). The results of this study

demonstrated evidence that better-performing firms utilized data analytics more often to inform

their business decisions than poorer-performing firms; although the direction of causality could

not be ascertained from this cross-sectional study (high performing firms may have more

resources, enabling them to invest in the most sophisticated data-analytic tools). Half of the

study's respondents indicated that one of their organization's top priorities was the expansion of

information and analytics tools to manage data, and 20% of respondents said they felt significant

personal pressure to utilize sophisticated analytics approaches and back up their business

decisions with data (LaValle et al. 2011). The results of this study point to the increased

awareness of data visualization's capabilities in the business world.

Firms have begun to realize that they need to empower their employees with greater

access to high quality data that can be disseminated across the firm. Tools such as data

visualization can increase transparency within an organization, provide actionable insights across

the firm, and help democratize knowledge within an organization (LaValle et al. 2011). The

insights that can be gained from interaction with information graphics allow employees to work

more efficiently. The diffusion of knowledge and increased transparency within an organization,

provided by data visualization tools, helps employees to make more informed decisions when faced with situations that previously may have been ambiguous. These results hold for top-performers in both large and small business categories so the link to business performance and data-driven decision-making cannot be explained by larger capital investments in new data analytic software that are tied to absolute scale or size. The surveyed executives collectively agreed that ability for employees to access and understand data, through tools such as data visualization, directly impacts business success and accelerates the company's growth (LaValle et al. 2011).

The effects of data visualization on economic growth can be traced throughout history to the development of the first economy with Cuneiform tablets as described earlier in this paper. The complexity of the business dealings and trade of ancient Mesopotamia had surpassed the capabilities of human memory and so data visualization was incorporated into the society to ensure the efficiency and trust in the economy (Nissen et al. 1993). Buyers and sellers within the early economy were able to keep track of more complex trade dealing and that brought down barriers to trade in order to grow society's economic capabilities. Data visualization presents itself throughout history as a clear driver of the democratization of knowledge as well as economic development. Statistical graphics have long allowed people to understand complex economic issues and make the most profitable decisions. The contemporary growth of jobs around data visualization shows an increasing focus on data visualization as a means to drive business development, similar to the 19th century's creation of jobs such as 'visual engineer' for the French government in this historical boom of data visualization theory. A 2012 *New York Times* article titled "The Age of Big Data" interviewed Erik Brunjofsson, an economist at MIT's Sloan School of Management on the growing interest in data visualization and its potential

impact on the modern economy (Lohr 2012). Brunjofsson (as quoted in Lohr 2012) predicts, "In business, economics and other fields, decisions will increasingly be based on data and analysis rather than on experience and intuition." This statement is potentially problematic, as data should not completely erase the importance of experience and the value of human intuition cannot be quantified into a data set. However, this sentiment demonstrates the increasing importance of data in modern business dealings. New employees will have a head start if they have more access to company specific information through the exploration of data visualization. The process of extensive training and onboarding activities can be a major investment for a company. Data visualization has a potential to reduce the learning curve for new employees by giving them more access to company data through interactive visualizations to aid in their decision making.

Major corporations are currently using data visualization tools to drive business growth and have seen enormous success. Netflix, the online video-streaming provider, is a famous example of a data-driven business that utilizes data visualization to improve their product offerings (Mavinkurve et al. 2014). The company's recommendation system works from subscriber data on viewing habits and accounts for 75% of all content watched on the site (Amatriain 2012). Netflix employees regularly use data visualization tools to solve problems and inform business decisions including examples such as the development of their $100 million show *House of Cards* (Simon 2014). Every element of the show, from the story line to the cover art, was carefully chosen to reflect the most popular consumer-viewing preferences based on the enormous pool of data that Netflix has collected. In this case, an analysis of Netflix subscriber data showed an opportunity with viewers who prefer politically themed BBC mini-series, movies directed by David Fincher, and films starring Kevin Spacey, and the creation of *House of Cards*, was able to incorporate all these elements (Schweidel 2014). Figure 4 shows a comparison of

color charts depicting the pixels used to create the PBS miniseries *Macbeth* in comparison to those used to create *House of Cards*. Netflix purposely drew from the color scheme of the successful PBS miniseries *Macbeth* cover as a prototype to develop their cover for the *House of Cards* series and the commonalities between the two are striking (Magnusson 2013). Netflix relies on the philosophy that data should be available to everyone within the company and used to drive everyday business decisions (Magnusson 2013). Through the extensive use of data visualization tools, Netflix effectively democratizes knowledge within the organization and facilitates more effective business processes.

To fill the growing demand in data analytics, an increasing number of data visualization software and consulting companies have entered the market, offering valuable resources to businesses. Stephen Few, in a presentation at the University of California, Berkeley (2009), describes that the need for simple data visualization tools is actually much greater than the need for sophisticated techniques, with more complex and expensive data visualization tools not necessarily applicable to the majority of business issues. However, the deployment of data visualization tools has previously focused preponderant attention on complicated tools that require the user to have sophisticated knowledge of statistical analysis. Few (2009) argues that data visualization tools can be made more effective by relying fundamentally on human tendencies to detect patterns rather than requiring firms to invest significant amounts in the training of employees to use complex tools. The ability for data visualization tools to democratize information within a firm is reliant on the tools being easy for anyone to use. The imbalance between the supply and demand of data visualization tools presents an opportunity for providers of simplified data visualization tools in the business software market.

Many companies, have stepped forward to help automate and simplify the data visualization process, which will enable a greater number of people to create visualizations that are easy for the general public to understand. Tableau Software, is a data visualization software company that has been at the forefront of innovation in the field of data visualization. Tableau works to help make data more accessible to all people with user-friendly tools that help individuals deal with overwhelming data sets by helping them visualize the data to understand it, detect patterns, and use it for effective managerial action. Tableau's mission statement is to "help people see and understand data," and the CEO, Christian Cabot, believes that "there's a tremendous opportunity to help people answer questions, solve problems and generate meaning from data in a way that has never before been possible" (Nasri 2013). Their business started the inclusion of visual tools in their analytical software to provide additional functionality for customers, and they have dominated this market since their inception in 2003 (Clancy, 2014), with a record earnings of over $100 million in the 3rd quarter of 2014 (Jarman 2014a). The founding goal of Tableau was to make data analytics tools easier for the average businessperson to use, and Tableau focuses their products to business users and creates value for their clients by allowing employees at all levels to interact with their data and draw conclusions from it, giving employees a greater opportunity to have data driving their everyday decisions. For example, one of Tableau's clients is Rosenblatt Securities, an agency in the wealth management industry, who deals with an enormous amount of customer trading data every day and needed a more effective way to understand and assess the information that was being created from their trades. Tableau provided a solution for the employees to easily analyze and interpret the data through clear visualizations, without the support of an IT team, and Scott Burrill, a partner and managing director at Rosenblatt Securities is quoted (on Tableau's website) as saying, "we've done things

with Tableau with a team of five people that would have taken 50 a significant amount of time to do" (Burrill 2011). Tableau has significantly increased efficiency at a number of client companies by allowing employees to explore and manipulate data on their own through simple visualizations. Tableau has driven business development in many industries by making knowledge more accessible within an organization and ensuring each employee can contribute with data-backed suggestions to the success of the firm. A scientific software engineer at Harvard's Center for Astrophysics, Chris Beaumont, describes how commercial businesses have been the first to adopt data science techniques such as visualization. However, he notes that data analytics and visualization practices will quickly spread into other industries (Harvard Extension School 2014). Companies such as Netflix, have seen immense business growth from using visualization to manage and communicate their data, but the expansion of data visualization has already begun to proliferate in other segments, such as the political and nonprofit sectors.

Current Data Visualization Capabilities in the Political Sphere

In the political sphere, data visualization can be used as a campaign tool to allow politicians to gauge support of specific constituencies among the general population. Similar to business, political campaigns tend to be at the cutting-edge of technology due to the presence of significant capital investment in political advertising. Given the steep increase in political ad spending [doubling from about $3 billion in 2000 to $6.2 billion in 2014 (Prokop 2014)], the influx of companies providing new technological tools to optimize political campaigns is a natural response to this demand. Innovations around data access have long been an integral piece driving political campaigns, starting with the increased accessibility of census data and computer-based research to understand voter sentiment regarding particular political issues (Moriarity 1970). Data visualization tools, have entered the political domain to help in better

understanding voter preferences and patterns and to assist in strategy development for campaigns. In high-stakes political campaigns, each candidate is eager to gain any edge they can in order to win the majority vote, and these campaigns become the perfect arena to test out new advanced technology tools, such as data visualization software.

Data visualization tools have recently been used to display the voting preferences in the past Obama presidential campaigns based on various variables, as well as offer insights for campaign managers to take into account in planning future campaigns. The *New York Times* provides a great example of some political data visualizations in their article "How Obama Won Re-Election" (Bostock et al. 2012). The article includes two images to illustrate the section "Hispanic Voters Increase Support" (Bostock et al. 2012). The first image displays the change in Florida's Hispanic population from 2008 to 2011, showing enormous increase in the South Florida areas of Miami-Dade and Broward just before the 2012 presidential election. The second image portrays the shifts in votes to more Democratic or more Republican and displays the large increase in the Democratic margin of victory that correspond to the same to areas of Miami-Dade and Broward. The combination of these two data maps allows the viewer to easily discern the similarities in patterns. The use of these data visualization maps of Florida confirms to the viewer that increases in the Hispanic population of Florida contributed significantly to Obama's success in his 2012 campaign. These maps display this data in a much more coherent and accessible fashion than a data table displaying similar demographic and political data as a series of numbers. This example from the New York Times utilized visual representations of data imposed on a map of Florida and allowed for a more rapid synthesis and understanding of information by readers. The presentation of the change in share of votes can also help politicians better target geographic areas and demographic groups in their campaigns.

The 2012 Obama presidential campaign utilized data in an innovative way that had not previously been seen in the political sphere, and these tactical approaches revolutionized the nature of how campaigns were conducted subsequently (Romano 2012). After accepting the position of campaign manager, Jim Messina said "We are going to measure every single thing in this campaign" (Scherer 2012). The focus on quantitative measurements in political campaigning shows a fundamental shift in campaign strategy, as Nickerson and Rogers outline in their article "Political Campaigns and Big Data," which explains that candidates and campaign managers tend to be trained in non-quantitative capacities, such as law rather than number-driven disciplines, such as statistics or computer science (2014). Thus, campaigns have traditionally most often focused on reaching voters and promoting policy stances, rather than data analytics or other key quantitative aspects of campaign management. They go on to assert that ignoring statistical methods in campaign management has been one of the biggest obstacles in implementing more effective, data-driven, campaign strategies (Nickerson and Rogers 2014). Messina's data analytics department for the 2012 campaign was five times larger than the one used in Obama's 2008 campaign, and the campaign team believed data to be their greatest competitive advantage over the Romney campaign (Scherer 2012). The Obama campaign's most useful innovation was their highly interactive dashboard, a data visualization tool, which provided easy communication and organization across the campaign (Romano 2012). In the field of information management, a dashboard refers to a simple readable interface that graphically presents information on an organization's performance and that allows for detailed tracking of information within an organization. A dashboard often connects directly to a database to allow for real-time updates based on new data over time and allows organizations to better keep track of their progress data in a simple visual format that was available to all members of the campaign

team, not just the data analytics department. The dashboard created by the Obama campaign was publicly available on barackobama.com (image in Figure 5) and provided a network for volunteers to track campaign progress, as well as connect with each other about their efforts to support the campaign. Users could log on to the dashboard from all over the globe and visually see how their volunteer efforts compared to the work of others (Balz 2013). The dashboard leveraged the power of both a social network, by allowing users to remotely interact with each other, and data visualization, by displaying real time information about the campaign's progress that volunteers could engage with (Balz 2013). Dan Carson, Lead Interactive Designer for Barack Obama's 2012 re-election campaign, points out that volunteers who utilized the dashboard were significantly more productive than volunteers who did not (Carson 2013). The use of data visualization techniques, such as the dashboard, helped the campaign to run more efficiently by engaging volunteers worldwide and monitoring how the campaign message was getting out to voters.

The inventive data visualization practices utilized by the Obama campaign helped ensure the most effective expenditure of almost $1 billion that was raised for the campaign on effective political ads (Scherer 2012). Figure 6 shows a heat map data visualization created by the political vendor Catalist LLC that aggregates data on Ohio voters and compares three variables. The likelihood of voter turnout is shown along the y-axis, voter political affiliation along the x-axis, and the number of contacts that were made by the Democratic Party campaign is shown by the color scale of the map with red indicating fewer contacts and green indicating more direct contacts with voters (Nickerson and Rogers 2014). Based on the data displayed from 2004, the Democratic campaigns were placing most of their efforts on voters at the far left of the spectrum who were already likely to vote for the Democratic candidate. By 2012 the campaign strategists

were able focus on voters most likely to show up at the polls on Election Day, providing a relevant and significant example of how data visualization tools can be used to simplify complex data into actionable insights. Campaigns used this additional, more detailed data and insight to contact citizens and generate more engagement with voters through opportunities for donations, volunteering, and other forms of involvement. The data can also be used for predictive models created by campaign teams to better market directly towards responsive audiences that are most likely to be convinced into supporting a certain candidate (Nickerson and Rogers 2014). The ability to collect more data and visualize it in a coherent manner helps campaigns to develop effective strategies and actions that more effectively leverage the available data. Previously, campaigns would often ignore citizens living in particular areas because the voting patterns of the majority in those places were not favorable to the campaign. In-depth analysis and resulting visualizations of voter data has allowed candidates to target likely voters in regions dominated by their opponent (Nickerson and Rogers 2014). In the case of the Obama re-election campaign, by 2012 the Democratic Party was more effectively able to target voters on the margin, rather than focus their advertising efforts on only on their own supporters who did not need to be convinced.

As shown in the example above, campaigns are concerned largely with voters at the margins. Swing voters drive political campaigns, and it is important that campaign ads reach voters who do not already have a strong party affiliation. By collecting information about individuals and predicting reactions to various political ads, the Obama campaign was able to better target these voters at the margin of affiliation. The Romney campaign outspent Obama by about $83 million on TV advertising (which makes up 75% of campaign spending), but Obama outspent Romney in online advertising, a medium that allows more data collection and micro-targeting (Romano 2012). Obama's campaign used data and developed predictive models to

ensure that all political ads targeted the right voters with the right message and resulted in the predicted response (Nickerson and Rogers 2014). The effective use of individual data has only become possible in recent years due to the significant advances in technology used to collect and summarize all the available data in a visual format. Data visualization acts as a useful tool to simplify complex data, drive informed decisions and has recently become a major player in aiding political campaign teams.

The use of data visualization tools in the political sphere has also brought up important issues concerning the ethical use of data on citizens, such as their past voting behavior. The same issues of privacy and personal data collection that affect marketers are present in the use of data to drive campaign results. However, some may see important ethical differences in collecting individual data for product marketing and collecting data to use in swaying voters. In both cases, there is a lack of regulation in terms of who is allowed to collect and use the data. Businesses and political campaigns have both implemented web trackers to collect information on user Internet activity. Websites of presidential candidates contain a large number of different tracking programs; for example, before the 2012 election, barackobama.com contained about 76 unique tracking programs and mittromney.com contained about 40 different tracking programs (Singer and Duhigg 2012). These trackers help with micro-targeting ads to users who have visited the site in the past. However, there are significant privacy concerns surrounding the use of data on individual's predicted political views. At the American Civil Liberties Union, Christopher Calabrese, legislative counsel for privacy, has expressed apprehension about these practices and stated "We simply don't know how this information is going to be used in the future and where it is going to end up" (Singer and Duhigg 2012). Businesses, such as Best Buy, implement similar tracking devices on their websites to understand consumer online purchasing

behavior, but in most cases the use by private firms to utilize information on their past customers is less controversial (Singer and Duhigg 2012). The use of data in both business and politics is a hotly contested issue. However, given the sensitive nature of personal political views, campaigns have been asked to be more transparent in providing information to visitors of their sites about how their data will be used and kept secure. The use and display of personal data around political preferences and voting behavior, which have always been viewed as an activity where individuals make their choices independently and anonymously, without the threat of coercion, is a major ethical dilemma for political parties to consider, and many privacy activists are working to regulate the use of citizen information. I believe there should be some regulations in place to prevent mass collection of voter preferences. Voters should have the option to offer up information to political parties, which may help campaigns understand which issues are most important to the American people, but the collection of personal information without consent of the voters is unethical and should be regulated with legal action.

Political campaigns have always collected data on citizens in order to run their campaigns. However, the modern practice of using data visualization to display information, along with the increased amount of data that is collected, makes this data more accessible, which may be concerning to citizens. The sheer amount of data produced in campaigns is too large to be processed or used effectively in its raw, quantitative form. Processing methods and visualizations, such as the Figure 6 example, allow campaign leaders to distinguish avid supporters from voters on the margin and use this information to target and convince those undecided voters. Political campaigns use data visualizations to keep track of individual political activity and can successfully target ads to the right viewers in order to alter political outcomes. Due to the ease of understanding and sharing visualizations, in contrast to cumbersome tables or

spreadsheets, it is more important than ever to proceed with caution when the data that is being visualized contains personal information. The issue of privacy is present in many debates around data analytics tools, not just visualization software. Data analytics draw information out and allow others to understand and manipulate it. Data visualization takes this to another level by presenting the data in a simple format and provides avenues for widespread information dissemination. For this reason, the use of data visualization in politics is a controversial issue and should be approached with the privacy rights of voters in mind.

Despite the ethical issues around data collection and dissemination through visualization, political uses of data visualization have been immensely successful. The work that data visualization has done in the political arena to efficiently run campaigns internally and engage voters externally provides an example of data visualization being used to drive change within society. The earlier historical examples of data visualization tools used to democratize information, in major corporations such as Netflix, and promote development in economies, such as the ancient Mesopotamian trade economy, focus largely on for-profit organizations. Due to the increase in tools that provide simple data visualizations for the general public, such as Tableau, the power of data visualization is, for the first time, in the hands of people and not locked away in the data analytics departments of highly funded firms. This shift in the field of data visualization provides an exciting opportunity for the future use of information graphics to move beyond its historical roots in an economically driven environment.

The Potential for Data Visualization in Cause-Based Organizations

Contemporary use of data visualization shows the impact it can have on the business world and even the political domain. Netflix has effectively leveraged their subscriber data and created simple data visualizations to develop award winning television shows and build their

video streaming empire valued at about $20 billion. The Obama administration transformed the campaign using data visualizations to assist in the analysis of the data that led to their 2012 victory (Romano 2012). The proliferation of data visualization approaches and uses presents an opportunity for these tools to not only drive monetary success, but also to have an impact on social issues. Data visualization can be leveraged to present data on social problems to the public and can help nonprofits to quantify the impact they have had on a community. By communicating more effectively through the use of data in a visual narrative, and illustrating data on how donations impact their cause, nonprofits can capture the attention and support of sponsors. Additionally, non-profits could use data visualization tools internally to gather data-driven insights into human behavior and more effectively target their campaign messaging to appeal to individuals around their specific interests. In this way, the spread of information through data visualizations can be used to solve major world issues rather than just to sell a product or a political candidate to consumers.

The ability to gain insights into human behavior through data visualization is immensely useful for cause-based organizations in the nonprofit space. Many recent innovations in the design and widespread use of data visualization contribute to the potential shift from data visualization for monetary gains to data visualization to raise awareness and support for different issues. First is the upsurge in less expensive and more accessible data visualization software tools. These tools make access to data visualization available to smaller-scale users, rather than exclusive to organizations willing to spend millions of dollars on the most sophisticated tools and hire statistical experts (Clark 2014). A second important trend is the increased interest from data visualization experts to use their skills in support of a cause rather than to earn enormous salaries from big-name companies. A significant proportion of the best data visualization talent is turning

their interests towards a social mission and eluding recruiters from major corporations (Tansey 2014). The socially conscious nature of many of these data scientists along with the widespread availability of user-friendly data visualization tools, will help contribute to data visualization technology's impact on the nonprofit sector.

Employment trends in data visualization

Data visualization scientists often have skills beyond user-friendly data visualization software tools that are intended for the general public. They have pioneered the complex space of data presentation and are capable of turning the most complex data sets into simple, visually appealing graphics. Due to the shortage of these experts, data visualization specialists are in high demand and have the opportunity to earn exceptionally high salaries at top firms. A study from the McKinsey Global Institute projects that by 2018 the United States will face a shortage of about 1.5 million managers and analysts with many of these necessary skills, including data cleaning and visualization skills, to effectively use data for business decision making (Manyika et al. 2011). Universities such as Harvard have created courses in data science designed to equip their students with marketable data skills in order to fill this scarcity. The course at Harvard focuses on the following five data skills: data cleaning, management, exploration, generation of prediction using the data, as well as visualization, which encompasses the ability to effectively communicate the data findings to others (Manyika et al. 2011). Businesses are struggling to find sufficient talent to fill their data visualization needs. Aziz Cami, a creative director who advises businesses on their strategy and brand identities using data visualization, describes the challenge of finding design talent to create effective visualizations. He notes, "Not that great talent isn't out there. But often, data visualization wizards have more than big financial rewards in mind –such as creative exploration, a social mission, or the admiration of their peers" (Tansey 2014). The

trend of talented data visualization designers to move from business to the nonprofit arena is a driver of data visualization use in nonprofit work.

Experts in the data science field have discovered extensive opportunities for data visualization work in the nonprofit sector. There is a widespread trend among data visualization professionals to use their talents to support socially responsible work. Data scientists are not satisfied by with only creating profit driven data visualizations that are highly valued by corporations. They feel that data is an extremely powerful tool that can drive efficiency and progress in any organization. For this reason, many data scientists choose to offer their services to a cause they are passionate about and assist non-profit organizations in leveraging data to optimize organizational performance and enact social change. With cause-based visualizations in mind, Eric Rodenback founded the studio Stamen Design, which combines data visualization services for clients in large companies with advocacy based data visualizations (Tansey 2014). The company has a major focus on presenting environmental threats, such as global warming, through powerful visualizations. Rodenback was inspired to found the company because he says, "I didn't want to make money doing annual reports for cigarette companies during the day, and then do Greenpeace brochures at night" (Tansey 2014). The creation of Stamen Design allows him, and other data visualization experts to use their skills on projects that they are passionate about. The demand for quality data visualizations is so high that "studios like Stamen are unlikely to lose commercial business by taking a stand on controversial issues such as global warming," and the short supply allows these studios to "be picky about the clients they'll accept" (Tansey 2014). Due to the scarcity of data visualization skills in the modern workforce, individuals with the right skills are able to pick and choose the most meaningful projects to

spend their time on. The shift of design experts towards cause-based visualizations is an integral part of the overall opportunity for growth in non-profit data visualizations.

The increase in socially conscious data visualization projects has resulted in a higher level of designer passion for the information and how it is displayed. An example of this trend of passion projects is a visualization from Stamen Design titled *The Surging Seas Project*, which maps the land lost to rising sea levels across the U.S. (Stamen Design 2013). Stamen Design partnered with Climate Central to develop this interactive map, which displays the projected level of the ocean, as well as the population and social vulnerability of the area in question (Stamen Design 2013). The combination of these different data sets on a single detailed visualization creates an interactive map that more effectively engages the audience. This example nicely demonstrates some of the tangible benefits of a visualization as compared to general presentation of data. It is one thing to read text that states the number of feet that an ocean is expected to rise; it is quite another to visually see the effects of rising sea levels. These spatially accurate images help engage site users within affected communities by showing the tangible effects of an environmental phenomenon that has not yet occurred. The project allows site visitors to search their own zip code and the map will display the current, as well as the projected, water levels along with numbers on population and homes. The ability to focus on data related to their own community to display this data helps personalize it for the audience members. The emotional effect of the data visualization increases the impact and helps drive the underlying point of climate change awareness. The interactive and personalized elements of data visualization make it a perfect avenue to promote social causes and drive change through personalized engagement.

Visual environmental projects, such as the Surging Seas Project, have grown in popularity over the years. A similar project called, The Digital Coast, was done by The Nature Conservancy in 2010 and demonstrated its value in helping develop policies around climate change by identifying key areas for policy makers to focus on (Newkirk 2010). The visualizations created by the Digital Coast project used previously available data to identify threatened natural resources along with areas with vulnerable economic resources in order to identify opportunities to minimize losses, as well as pinpoint areas that are in the best position economically to address these conservation efforts (Digital Coast 2010). The Digital Coast project takes into account ecological and socioeconomic issues around rising sea levels to provide the most complete information set to policy makers and voting community members (Newkirk 2010). Figure 7 pinpoints economically at-risk areas, based on the value of building structures in the area, and Figure 8 illustrates the most vulnerable areas in terms of natural resources. These images can be used together to help conservationists and policy makers make effective decisions. The information on these data maps gives them the evidence they need to minimize the effects of rising sea levels on the most exposed human and natural communities. The visualizations also include predictive modeling in order to display future scenarios to the viewer based on potential policy decisions (Gilmer 2010). The interactive component of the Digital Coast visualizations allows the viewer to engage with the information and understand how different policy changes can affect specific communities. These visualizations have been presented at conservation conferences and similar visualizations have now been adopted for the United States Environmental Protection Agency site to promote education and engagement with US citizens.

Democratization of data visualization tools

The ability to turn complex data into beautifully simple visualizations was initially restricted to technology experts, and the short supply of these experts resulted in a relatively slow proliferation of data visualization. Since then, data visualization tools and software services have been developed that allow even those without extensive computer knowledge to easily manipulate complex data sets. Phil Simon, prominent technology and information management journalist, states that "today an organization need not spend hundreds of thousands or millions of dollars to get going with dataviz. These tools have become progressively more powerful and democratic over the last decade" (Clark 2014). Services such as Tableau, R, SiSense and Visual.ly are pioneering the data visualization space and offer user-friendly tools that allow non-technical individuals to interact with their data (Clark 2014). This is promising for small businesses as well as nonprofits, allowing them to more effectively use data to make more informed decisions to drive success (Blasé and Curran 2013). Beyond the business space, nonprofits can also benefit significantly from the widespread availability of inexpensive data visualization tools. Similar to small businesses, nonprofit organizations seldom have the funds to invest in expensive data tools and hire experts to use them. The widespread use of data visualization tools will allow nonprofits to gain more insights from their data, and these tools provide a huge opportunity for growth in data visualization use in the nonprofit space.

Nonprofits, such as environmental groups, have access to large amounts of data to support their mission, as in the case of the *Surging Seas Project*, but they can easily become paralyzed by an overabundance of data with no means to understand it. A significant number of volunteers are necessary for data-gathering and processing in real-time in order to make this information available to affected populations in disaster zones (Meier 2012a). Access to data alone will not create a societal benefit, but producing widely accessible and useful visualizations

puts important information in the hand of the public to address social problems such as the rising

sea levels caused by climate change. Many companies have stepped forward to help automate the

data visualization process, which will enable more people to create these visualizations for the

general public.

Tableau has been at the forefront of innovation in the field of data visualization, working

to help make data more accessible to all people with user-friendly tools that help individuals deal

with overwhelming data sets. Tableau's mission is to "help people see and understand data," and

the CEO, Christian Cabot, believes that "there's a tremendous opportunity to help people answer

questions, solve problems and generate meaning from data in a way that has never before been

possible" (Nasri 2013). This altruistic vision of helping people to solve problems across the

globe makes Tableau a promising partner to help nonprofit organizations increase their use of

data visualizations in support of a cause.

Tableau has become a dominating force in the business world by providing universal

access to data visualization with their easy to use software. The company has also recently

acknowledged the immense potential for data visualization use in nonprofit work. Tableau

Software initially developed their data visualization offerings to target business customers in

order to turn a profit. At the time that Tableau was developing its cutting-edge data visualization

software, businesses were the organizations in the best position to invest in these tools. The

company has just recently shifted some of their focus to the nonprofit space in order to return to

their original mission, "Tableau helps people see and understand their data," which focused more

on helping people and giving them access to powerful data tools (Tableau Software 2013). In

December of 2014 Tableau announced the creation of the Tableau Foundation as a part of their

Corporate Responsibility Program (Jarman 2014b). The Foundation strives to combine data with

the company's passion for making the world a better place, with a focus in three key areas: strategic grant making and initiatives, community and disaster relief, and employee matching grants and volunteering (Myrick 2014). Neal Myrick, the Corporate Social Responsibility Director at Tableau Software, describes the mission of the Foundation; "to encourage the use of facts and analytical reasoning to solve the world's problems" (Myrick 2014). Tableau has become aware of the opportunities for using data visualization to drive social change and believes that their software tools can drive progress in nonprofit work. Tableau offers a 25% discount to nonprofit organizations for the use of their data visualization software and has engaged in two initial partnerships with health focused nonprofit organizations, Dimagi and PATH, as part of the Tableau Foundation. Tableau's new focus in nonprofit work is a promising sign of data visualization's ability to drive effective problem-solving in support of social causes and generate more public awareness about these important issues.

Public health nonprofits have been some of the first to adopt data visualization software and data visualization's ability to draw patterns out of large data sets makes it an attractive tool for epidemiologists. Data visualization has proven to be particularly successful in the accurate illustration of the spread of disease and in helping with containment efforts. Tableau has engaged in a partnership with PATH, an international nonprofit that works in health advances in drugs, vaccinations, health services and technologies. A central focus of PATH is on health improvement for women and children. With support from the Tableau Foundation and the United States Agency for International Development, PATH is working to address the HIV epidemic in Western Kenya (Myrick 2014). Data visualizations created by Tableau present disease data in small African villages to help local doctors and health workers understand the spread of disease (Myrick 2015). Tableau has also formed a partnership with Dimagi, a global nonprofit

organization that provides cutting-edge health technology to impoverished communities. Dimagi has received grants from The Tableau Foundation to help use data to further their mission and is also working with Ericsson and the Earth Institute at Columbia University to create a mobile data reporting system that will help organizations to better address the Ebola outbreak in West Africa (Myrick 2014). Tableau's partnerships with health organizations as part of their shift in focus to the nonprofit sector is positive sign for more data visualization work to occur within cause-based work.

Tableau's partnership with Dimagi has proven to be immensely successful in helping health workers address the Ebola epidemic. Through this and other partnerships, Dimagi has developed "CommCare" technology to help health professionals to identify and diagnose individuals who may have come in contact with the Ebola virus in African communities (Jatvetski 2015). This technology also provides accessible information for correct handling procedures to aid in decision making for the workers on the ground (Jatvetski 2015). Along with client management capabilities, CommCare has a robust Active Data Management component, which allows data from mobile connections to be processed to uncover key action items for the organization to address (Dimagi Inc. 2015). Data on the disease and potentially afflicted individuals had previously been collected on sheets of paper from door-to-door house calls. This data was then typed, combined, and finally sent to coordinators after two or three weeks to aid in organizing more effective containment and prevention strategies (Jatvetski 2015). When dealing with a highly contagious virus, such as Ebola, time is of the essence. Health organizations do not have two or three weeks for data processing and potentially infected citizens need to be identified immediately. The data processing services provided throughout the CommCare application in collaboration with Tableau's donation of data visualization software allows health

workers to quickly identify and contain the virus within a population. The app is freely available to anyone and the increased number of mobile phone users in the developing world has contributed to the success of this innovative technology. Tableau's data visualization tools in partnership with Dimagi's CommCare application, have enabled local clinics to organize fragmented mobile data into easy to understand visualizations that depict the growth and spread of the Ebola virus. These health technologies have been pivotal tools in aiding containment and eradication efforts and provides a significant opportunity to effectively visualize health data in Tableau and use data to make evidence-based decisions (Myrick 2015).

Data visualization's mapping capabilities have been recognized by many nonprofit health organizations to efficiently distribute medical supplies and prevent the spread of disease, as shown by Dimagi's work on the Ebola epidemic in West Africa. These tools can also be used to pin point regions in need during a natural disaster and deliver the necessary supplies to those areas. The 2013 World Disasters Report asserts that in natural disaster zones, information availability can be as integral to the survival of populations as food and water (World Disasters Report 2013). During natural disasters, affected communities produce data in the form of social media posts and other digitally recorded activities (Meier 2012a). If aid organizations can access and make use of this data, there is a great opportunity to provide information to the communities themselves to aid in the recovery. The proliferation of mobile devices and social media in the developing world provides an especially rich avenue for individuals to both produce data and access information in a digital world. In the 2010 Haiti earthquake, digital humanitarians emerged to provide crucial information to affected populations in a time of crisis (World Disasters Report 2013). Data from social media posts, text messages, and popular media was used to create a detailed street map of Haiti that displayed the location of aid-stations and camps

(World Disasters Report 2013). This effort to produce a data map of the Haiti disaster, titled the

Ushahidi Haiti Project or UHP, is shown in its early stages in Figure 9 (Morrow et al. 2011).

The map uses information from Twitter, and the circles depict areas where the most urgent

Tweets have come from (Meier 2012b). Users can interact with this real-time map by clicking on

particular areas to access individual reports represented by the numbers in the red circles (Meier

2012b). The project moved beyond just mapping Tweets and provided a public number for

Haitians in crisis areas to text for aid, and the US Marine Corps used the data on the Ushahidi

Site to save countless lives in Haiti (Meier 2012b). This project received high praise from a

number of aid organizations and provides an excellent example of data visualization used in a

nonprofit context to drive social impact. The Ushahidi Project has sparked interest from data

visualization enthusiasts around the globe to use these tools for the betterment of humanity.

The role of emotional connection in data visualization

Data visualization shows great promise in the non-profit sector due to the shift of data

visualization tools and services into cause-based work, but there is also immense potential for

data visualization growth in advocacy because of the interactivity and emotional engagement that

it provides viewers. True to data visualization's historical goal of appealing to human

engagement, social issues have a tendency to draw on human emotion in a way that

economically driven issues may not. Data visualization strives to present information in the

clearest format to enhance the brain's natural process of data collection and storage in the human

memory (Ware 2008). Neuro-scientific and psychological research has been done to affirm the

role of emotional connections in improving human memory (Phelps 2004), and cause-based

issues tend to appeal to the emotions of their audience in order to gain support. Modern data

visualizations are characterized by interactive components that allow viewers to manipulate the

data and engage with the content on a personal level. The personalization and interactivity of contemporary visualizations provides a more emotional connection from the viewer to the data. The trend towards interactive data visualization and their ability leverage human emotions points towards the increased opportunities for data visualization in the nonprofit space and in driving social change efforts.

Interactivity in data visualizations is a growing trend in modern visualizations and helps the audience to feel a deeper connection with the information presented. Data visualization has previously been used to present complex quantitative evidence in an accessible manner, but the most successful visualizations offer an interaction with the viewer that leads to greater insight and can change or modify the user's beliefs (Tufte 2001). Often, the best visualizations seen today in the *New York Times* and *Wall Street Journal* allow the viewer to manipulate different data sets within the visualizations and in real-time, the image adjusts to the new inputs. The article "Four Ways to Slice Obama's 2013 Budget Proposal" from *The New York Times* provides a visualization of Obama's 2013 federal budget and exemplifies the interactive capabilities of data visualization (Carter 2012). On the *New York Times* site, the viewer can click on the tabs above the image to filter different Types of Spending, Changes, and Department Totals. The figure is interactive – the user can decide on varying levels of government spending in different programs depending on their beliefs and preferences, and the image will adjust in real-time to alter the data inputs. The static image provides a great starting point to see the relative size of budgets across departments, but the interactive aspects available on the *New York Times* site provide a whole new level of understanding for the user. Visualizations can have a much greater effect on the audience when audience members become contributors to the final product. Interactive visualizations provide a more intuitive understanding of complex data sets and can be

extremely powerful in helping the user sift through the data. Increasingly, data visualizations incorporate real-time features that can alter the image based on certain situations. Allowing the user to change inputs and alter the data helps to solidify their understanding and brings the data visualization to life. These new features are particularly successful in cause-based data visualizations. Organizations can more clearly get their point across to audience members when the audience becomes a part of the process. This trend of interactive tools in data visualization is a very promising aspect of data visualization's opportunities for use in a nonprofit context.

Data visualization has the power to distribute information in real time to masses of people, and in many cases, the immediacy of this information spread can drive an emotional reaction from its audience. This capability makes data visualization a powerful tool to drive social awareness and change. If the general population can remain more informed about important social issues then they will be more engaged to help solve them. *The Surging Seas Project* brought the realities of climate change to life by displaying the particular areas that would be destroyed if no action was taken. This visualization then took it a step further by offering action items to conservationists and policy makers in order to solve this problem. *The Ushahidi Project* during the Haitian earthquake demonstrated the power of data visualization in collaboration with social media to drive rescue efforts from those on the ground in Haiti and inform remote volunteers of what areas needed the most attention from aid groups. These two projects and many others have shown how powerful data can be when it is synthesized and presented in a visual format. Both projects allowed individuals to contribute information and learn from the information that was presented. The involved organizations encouraged engagement from all viewers, rather than isolating information to their data analytics departments. By making this information available to the masses, these nonprofits effectively

created more awareness about the issues they were combating. Additionally, the data

visualizations they created were able to be used by others to contribute to the cause. The US

Marines used *The Ushahidi Project* in their rescue efforts and policy makers used *The Surging*

Seas Project to understand the most effective policies to pass. Data visualization not only has the

ability to drive awareness, but is also capable of driving change in many key areas for social

good.

The Importance of Visualization in Data Presentation

Data analytics is a broader concept focused on the practice of drawing out conclusions

from raw data. All data analytics tools strive to simplify and highlight the important concepts

that the data represents. However, data visualization differs from other data analytic tools

because it provides visual cues in order to direct an individual's attention to the most important

aspects of the data. Data visualization achieves this effectively by illustrating important aspects

of the data in a striking visual manner so that the relevant information is highlighted within the

data set. The visual cues created by effective visualizations, lead the observer to pay attention to

certain aspects of the data and disregard others (Ware 2008). It is the visual mechanism of this

technique that separates it from other methods of data summarization. For a simple example, the

colors and spatial differences displayed by a bar chart allow one to observe important differences

between two data sets more easily than a table of numbers would. Modern visualizations

incorporate even more spatial recognition, such as mapping, in order to grab the attention of the

viewer. The successful use of visualization capabilities permits the display of data in a dramatic,

eye-catching, manner which can be more easily understood and retained by the observer. Ethan

Zuckerman, a media scholar and director of the MIT Center for Civic Media, describes this kind

of a visualization as a "holy shit visualization," which "turns a statistic you might have flipped

past in a book…into something that you can't forget. It's a visceral reminder of the power of images and the power of looking at dry numbers in human terms" (2015). Visualizations have a way of appealing to one of our most powerful human senses, vision, in a way that other summarizations of data cannot.

The power of visualization in comparison to simple data summarizations or statistics is displayed clearly in the work of Mike Evans and his visualizations of the housing foreclosure situation in Detroit, shown in Figure 13 (Zuckerman 2015). Fifty percent of Detroit properties were at risk of foreclosure in 2014 (Zuckerman 2015), and one would think that statistic alone should be enough to grab the attention of the city government. However, it was not until Evans visualized the situation and presented it to the county treasurer that the full impact of the issue was understood and addressed (Zuckerman 2015). His visualization displays properties in tax distress (in yellow), under tax foreclosure (in orange), and properties that have been foreclosed (in red). What is striking about this image is the amount of orange that represents properties under tax foreclosure. The map presents a visual representation that resonated more dramatically with the people of Detroit and their leaders than a simple statistic. The map helped Detroit property owners better understand the status of the real estate market and recognize if they were in danger of losing their homes (Zuckerman 2015). The information was put in the hands of the local people who were in the best position to help each other and take action. Detroit church groups used the program to look up houses of their members and join together to raise funds in order to prevent foreclosures or at least give families some extra time to pay off their loans (Zuckerman 2015). The visualization of the foreclosure situation in Detroit not only illustrated the information to city officials more clearly, but it also distributed the information in a way that helped the Detroit population be proactive in taking measures to then prevent foreclosure.

Publicly available data visualizations have provided a means for people to more easily understand what is occurring in their environment and subsequently take action. Data visualization goes beyond other forms of data analytics by putting vital information in the hand of those who can make the biggest impact, the general public, and displaying data in this format has been shown to lead to more community engagement around critical societal issues.

Limitations of Argument

Data visualization has penetrated many different fields including business, public health, and environmental policy. It broadens the ability of a greater number of people to utilize complex information in hopes of educating them and helping them to make important decisions based on the data. A potential limitation in the ability of data visualization to democratize information and affect individual decisions about important social issues is that the general public does not bring the same methodological rigor to these visualized issues as data scientists. As data visualizations become more accessible in, for example, the nonprofit arena, viewers may risk misinterpreting issues, or may be more easily manipulated by those with a specific agenda they are trying to advance. The proliferation of accessible data visualization tools allows users to create visualizations and depict patterns without the painstaking process of cleaning and analyzing raw data. Data visualization technology is to the point where an advanced degree in statistics is no longer necessary to create impressive visual displays with complex data sets. For this reason, data visualization viewers have a certain responsibility to think critically about the data that is being presented and the methods that the designer used in creating the visualization.

There may also be a greater opportunity for deception in statistical graphs. Concerns over the general population's blind trust in graphical information have been around since before the 19th century, when the British prime minister, Benjamin Disraeli, famously said, "there are three

kinds of lies: lies, damned lies, and statistics" (Twain 1924, 246). Many argue, however, that statistical graphics are no more prone to lie than other forms of communication such as textual descriptions (Tufte 2001). A potential advantage of visualized graphics also calls into question an important weakness: people are much more inclined to believe information that is presented visually. William Playfair notes in his book, *The Commercial and Political Atlas and Statistical Breviary,* that the general public is more easily convinced by the representation of monetary values in spatial relationships (Playfair 2005)**.** There has historically been a great deal of mistrust of statistical graphics by academic scholars (Tufte 2001). It is more important than ever to maintain transparency with the viewer when creating interactive data visualizations, so that the viewer may discover information about the data themselves in an accurate manner. A viewer's perception of a visual representation depends significantly on the context in which it is seen (Berger 1972). To combat misperceptions, graphic designers should ensure that they communicate information as clearly as possible in their graphical representations, so as to ensure accurate perceptions in a variety of contexts. The numerical information contained in a graphic should be consistent with the visual representation that is displayed (Tufte 2001). This is especially important given the tendency for data visualizations to represent economic and social issues. The increased availability of clearly presented information is helpful for citizens to draw their own conclusions about an issue. However, when the data sets have been ambiguously collected, information graphics can be misleading and create the potential for misinformed public policy and community sentiments around social problems.

The democratization of data visualization tools allow for information graphics to be created and accessed by almost anyone. There are potential limitations to the good that can be done with these easy-to-use tools when one does not have significant experience in modeling

data. An early paper published in *The Journal of the Learning Sciences* by Gordin et al.

addresses this issue to argue for the use of data visualization in scientific education. Scientists

that use visualizations to present their findings have extensive training in the proper collection

and synthesis of data (Gordin et. al 1995). When students are asked to use these tools, without a

background in statistics, the resulting visualizations can be skewed by a student's preconceived

notions around an issue or a misinterpretation of data (Gordin et. al 1995). As data visualizations

become a more popular medium through which to present social issues to the general public,

viewers should proceed with caution and think critically about whether the visualization is

accurately representing units and scale before they draw conclusions based solely on their first

impressions of the data.

     Despite the immense success that data visualization has already shown in the nonprofit

space, from assisting disease eradication efforts in Africa to supporting victims of housing

foreclosures in Detroit, there are some inherent problems with displaying extremely complex

personal experiences in terms of numbers. The use of data visualization to present social issues is

limited because it can reduce emotional and inherently human social problems to a set of

calculations. This limitation of data visualization in displaying cultural phenomena is studied by

scholars in the field of humanities, who have begun to utilize visualizations in order to conduct

and present humanistic research. Sub-fields, such as "Spatial Humanities" have emerged to

incorporate digital tools in the humanities disciplines. Spatial Humanities utilizes data

visualization and digital mapping tools to research spatial relationships within the context of

human experiences (Knowles 2014). Spatial Humanities scholars learn a great deal about human

interactions based on visualizing their physical relation to one another. Mapping technology is

often used by historians to uncover more information about a historical event in the context of

spatial relationships. For example, the "Terrain of History" Project from Stanford University has a created a precise digital map of Rio de Janeiro in 1866 (Frank 2013). This map allows scholars and students to explore spatial relationships and understand the urban development of Rio de Janeiro with specific focus on the creation of the favelas, which exemplify the intense economic inequality that is present in Brazil (Frank 2013). Humanities scholars seek to represent very personal narratives of people and struggle with the somewhat impersonal aspects of data visualizations. This same issue of detachment in data visualizations can limit presentations of social problems in nonprofit work because the issues often deal with data in the context of human lives and experiences.

Data visualizations can be useful to portray human experiences in a broad, overarching manner. Often visualizations are designed with the human eye in mind and so they present big patterns and sweeping generalizations that are easy for the viewer to pick out (Frank 2013). Frank takes issue with the tendency of many data visualizations to present data in aerial views, which effectively removes the viewer from the situation (Frank 2013). Data visualizations should instead engage the viewer in a very personal way, especially when dealing with social issues and data about real people. Data visualization can be limited by its tendency to exclusively deal with quantitative data. However, a few of the examples that were explored earlier in this paper such as the "Ushahidi Haiti Map" in Figure 9 attempt to incorporate some of these more humanistic features into visualizations. The map of Haiti shows red circles at varying sizes that represent the amount of distress Tweets that have been recorded in that particular location after the earthquake. The largest circles have numbers associated with them that even more clearly represent the number of people in need of assistance. Individual people are mapped onto the visualization and their personal messages are represented, which endeavor to give a more

intimate feel to the audience. Even the utilization of design techniques to impart a more emotional feeling on the viewer does not erase the fact that the victims and their unique experiences of the earthquake are still being reduced to numbers and spots on a map. The reduction of the human experience is unavoidable when creating data visualizations that inherently generalize major patterns. The overarching views provided by data visualizations can be problematic when dealing with subjects of a tragedy, such as in the trauma experienced by victims of the Haitian Earthquake. The ability of data visualization projects to offer a broader, overarching picture can limit their effectiveness in fully representing social issues. However, there is increasing research being done on data visualization design, and many scholars attempt to incorporate these deeply emotional aspects into their visualizations of human experience.

Data visualizations that are used to engage viewers with a social issue should attempt to draw out the emotional aspects of an issue in addition to presenting the quantitative data about the subject matter. It is difficult to visualize qualitative data such as human emotion or a state of mind, but scholars continue to experiment in this area of visualization. Frank uses the example of his visualization project on "The Yellow Fever Epidemic of 1850: Scale, Time, and Space," an animated data visualization of yellow fever's spread in Rio de Janeiro. The project attempts to express emotional qualities along with quantitative data by (Frank 2013). He wanted to show the terror and intensity that characterized the yellow fever epidemic, and he uses the closeness of time and location of the yellow fever spread to attempt the visualization of intensity (Frank 2013). He explains that tuberculosis ends up killing the same number of people, but the panic that was present during yellow fever is a product of the proximity of the cases and the small amount of time in which they occurred (Frank 2013). He focuses on these temporal and spatial variables in his data visualization in hopes of capturing the experience of panic and death at this

time in history. There are some techniques that can be used in expressing the qualitative aspects of the data, but the intensity of emotions that are often present in social and historical issues may not be fully communicated through the medium of data visualizations.

Conclusion

Data visualization has proven to have many successful applications in the fields of business, politics and non-profit work. The advanced technology that is used in modern day visualizations allows for quicker processing and deeper understanding of complex information. The role of data visualization in nonprofit work is linked closely with the democratization of information, which can be leveraged by populations to address education, as well as other social issues. The dissemination of knowledge through accessible visualizations is a way to both educate the general public about important issues and teach students about different topics.

The use of data visualization in the non-profit sector is a recent phenomenon that is gaining more traction and attention every day. Data scientists, the pioneers of this growing field, have shifted their focus to visualize social issues and this presents a tremendous opportunity for the creation of complex and beautiful visualizations to proliferate in the nonprofit world. There is also an influx of firms that provide simple data visualization software, which is designed for the average person and allows more people to access the insights generated by data visualization. These market trends exemplify the major changes that are happening in the field of data visualization and have had major implications for the often under-funded non-profit sector that had previously not been able to afford to make major investments in data processing and presentation. The growing interest of both data visualization professionals and software companies has made data visualization more accessible to non-profit organizations without consuming too much of their budgets. Data visualization has already been embraced by many

organizations used to address public health issues, provide aid to victims of natural disaster in Haiti, inform policy makers of the threat of rising sea levels, and draw attention to the housing foreclosure crisis in Detroit. In these examples, the data visualization tools served to present large amounts of information in simplified formats that help viewers to quickly pick out trends and draw conclusions. The viewers of these visualizations can include workers within a nonprofit, who can use their personal findings from the visualization to better address a social issue, or it could be members of the general public to help them engage with issues on a more personal level, based on their own insights from a data visualization. The widespread use of data visualization has already immensely revolutionized the fields of business and politics. Due to the positive market trends in data visualization software, increased social interest from data visualization experts, and the engaging interactive components of contemporary visualizations, the field of data visualization shows great promise in the nonprofit sector both in engaging average individuals, as well as in improving the efficiency with which nonprofit employees can make decisions around an issue. I believe that data visualization will help non-profit organizations to streamline their internal processes and garner more support from outside donors. However, data visualization cannot be used in all situations, as it is impossible to quantify every aspect of life. Data visualization is a fantastic tool that provides many people access to information that they previously did not have, but it cannot and should not serve as a substitute for human experience and emotion.

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Appendix:

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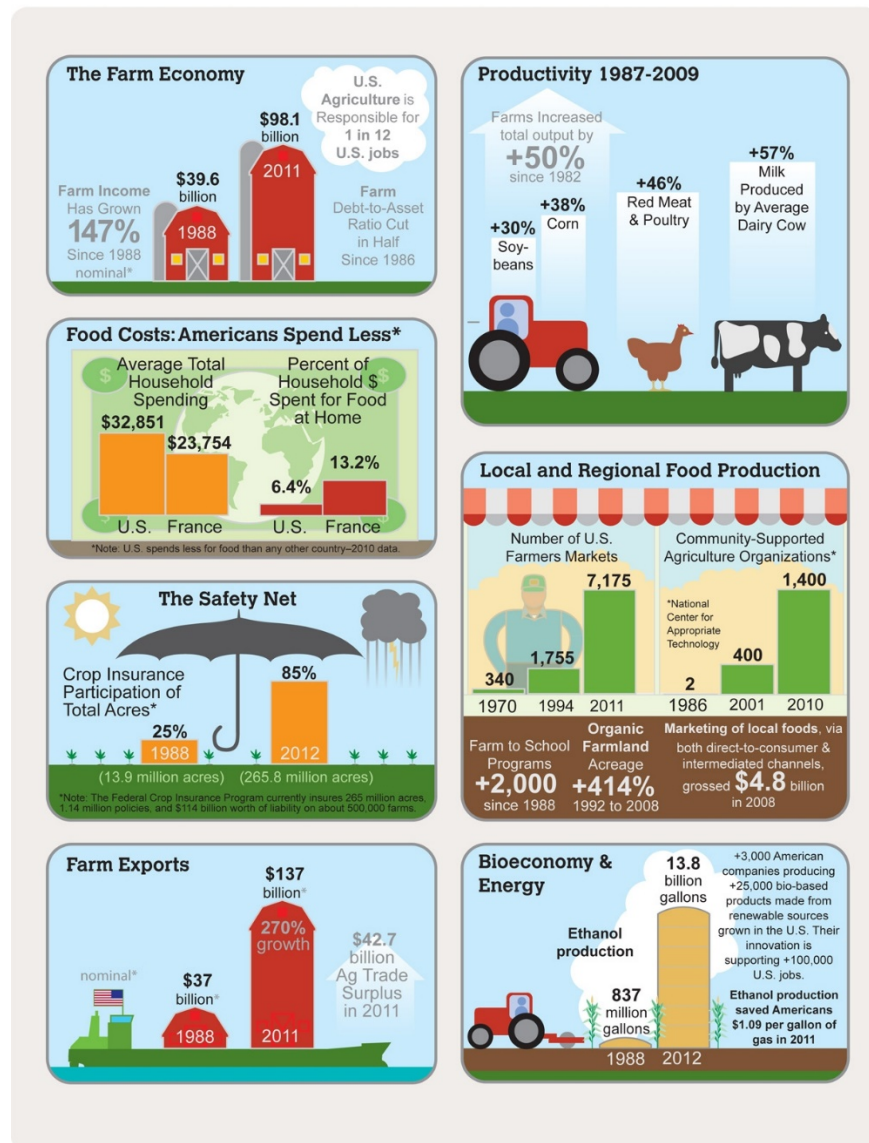
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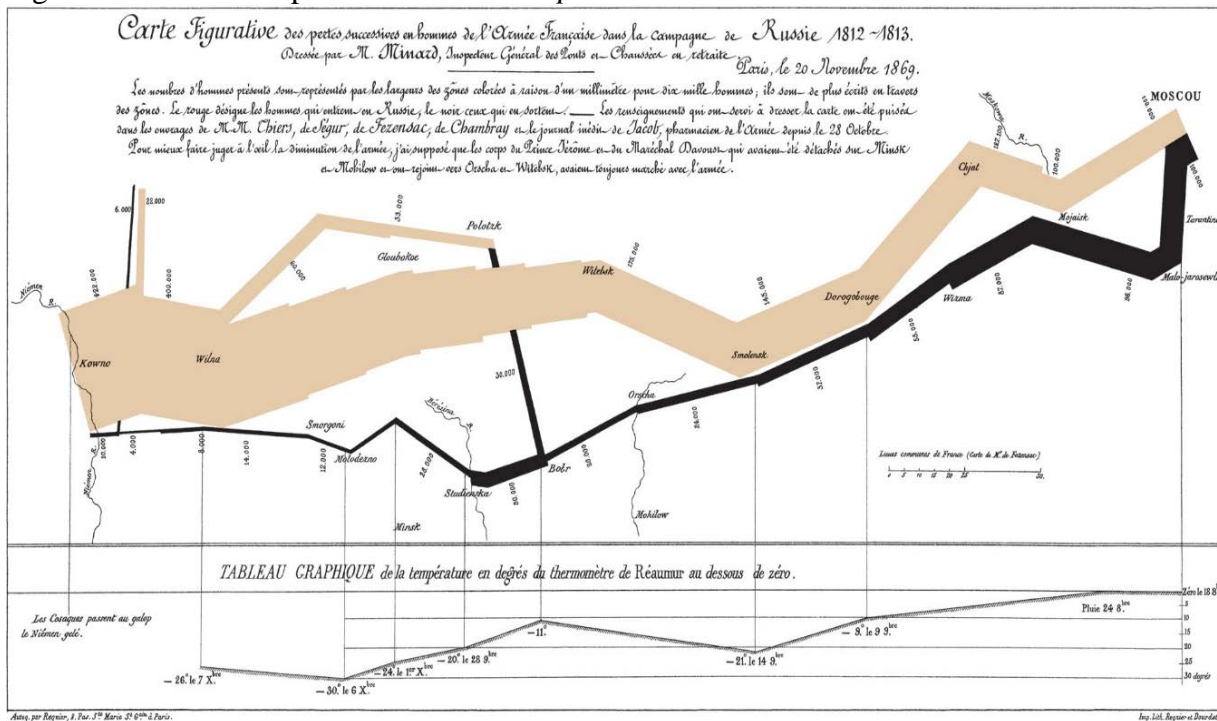
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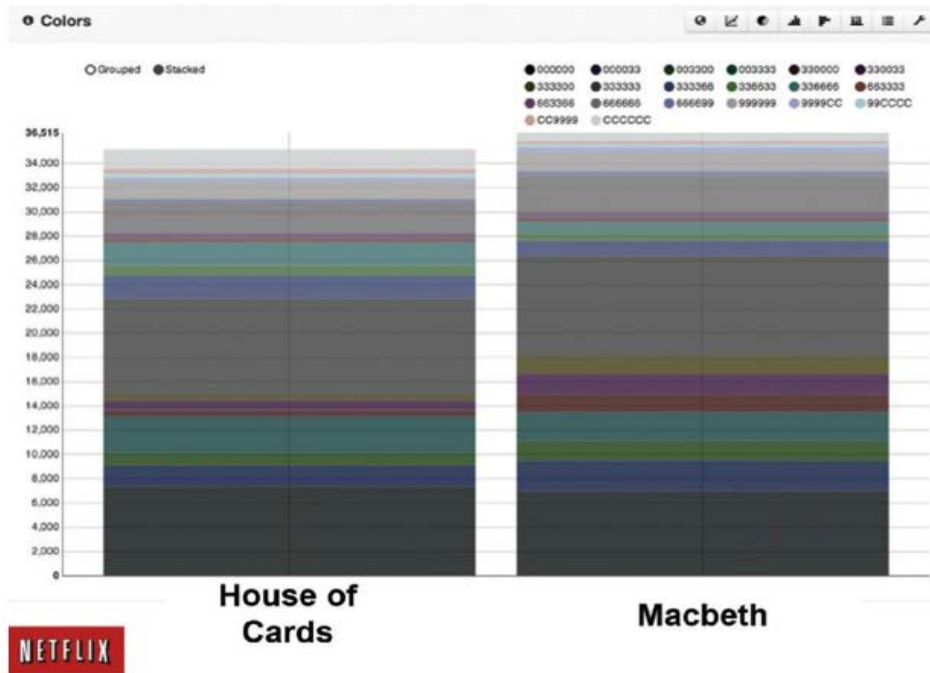
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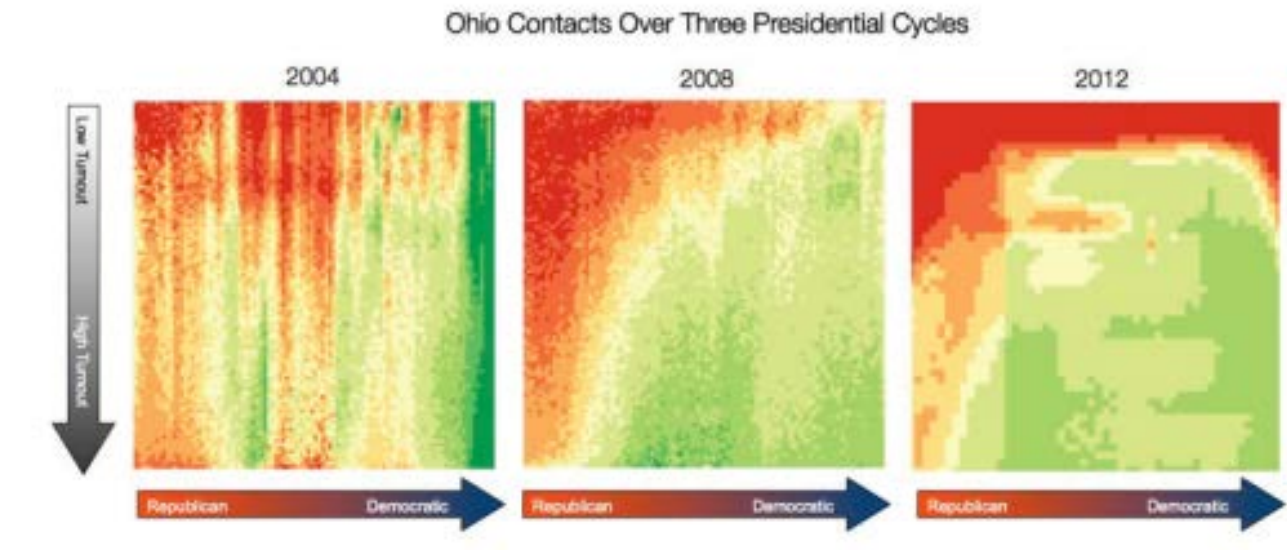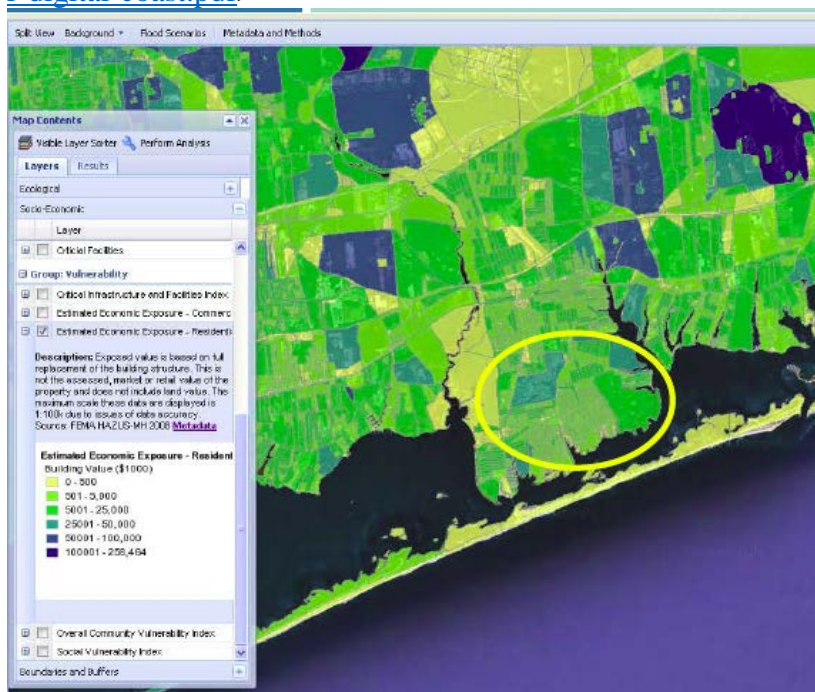

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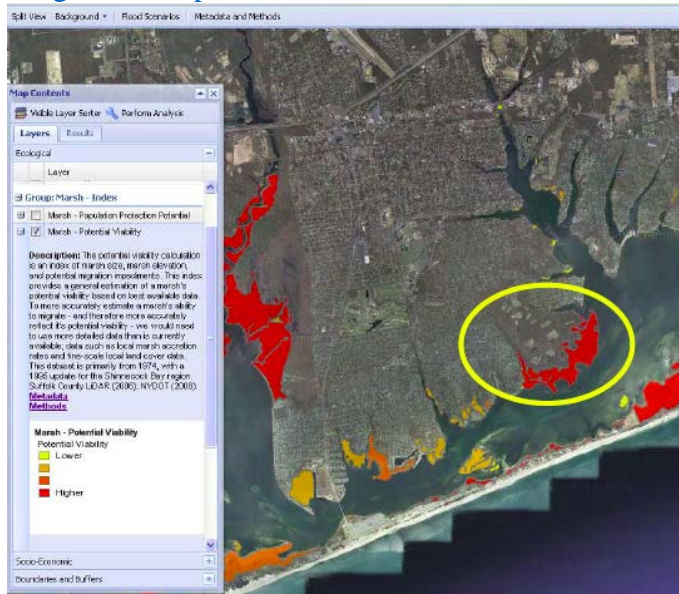

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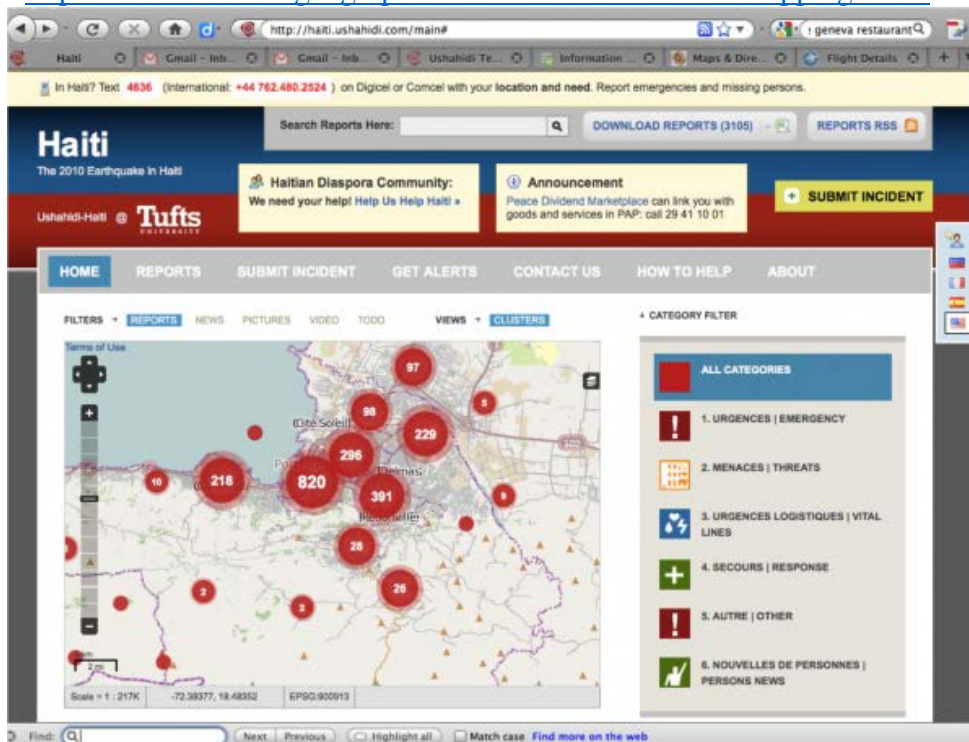
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