MASTER’S PRESENTATIONS

WINTER 2015

Thursday, April 23, 2015

8:00 am – 4:00 pm
Room A-1-105 Mackinac Hall
Room A-1-111 Mackinac Hall
SCHOOL OF CIS  
WINTER 2015  
MASTERS PRESENTATIONS  
Thursday, April 23, 2015  

Schedule of Presentations MAK A-1-105:

8:00 – 8:30 am  
Anusha Allaparthi – MS Project, Advisor: Dr. Yonglei Tao  
“Vacation Package Recommender System”

8:35 – 9:05 am  
Jayaprakash Garaga – MS Project, Advisor: Dr. Yonglei Tao  
“Personalized Movie Database System”

9:10 – 9:40 am  
Isha Singh – MS Project, Advisor: Dr. Yonglei Tao  
“MEAL2SHARE – Neighborhood Home Cooked Good Sharing Web Application”

9:45 – 10:15 am  
Md Arman Ullah – MS Project, Advisor: Dr. Yonglei Tao  
“Digital Library for Plant Information with Performance Comparison between a Relational Database and a NoSQL Database (RDF Triple Store)”

10:20 – 10:50 am  
Namrata Pradhan – MS Project, Advisor: Dr. Yonglei Tao  
“Knowledge Sharing Application”

10:55 – 11:25 am  
Alexandros Plakida Ntasios – MS Project, Advisor: Dr. Jonathan Leidig  
“Senti-Author: A Web Application for Sentiment and Potential Biases of News Contributors”

11:30 – 12:00 pm  
Philip Davis – MS Thesis Research, Advisor: Dr. Greg Wolffe  
“Scalable Parallelization of a Markov Coalescent Genealogy Sampler”

12:00 – 12:30 pm  
BREAK

12:35 – 1:05 pm  
David Qorashi – MS Thesis, Advisor: Dr. Jonathan Engelsma  
“Exploring Alternative Control Modalities for Unmanned Aerial Vehicles”

1:10 – 1:40 pm  
Ehsan Valizadeh – MS Project, Advisor: Dr. Jonathan Engelsma  
“A Survey of Smartwatch Platforms from a Developer’s Perspective”

1:45 – 2:15 pm  
Emily Johnson – MS Project, Advisor: Dr. Jonathan Engelsma  
“Evaluation and Integration of a Javascript Graphing Library for a Nationwide Honeybee Hive Scale Network”

2:20 – 2:50 pm  
Eric Venlet – MS Project, Advisor: Dr. Robert Adams  
“YeaNay: An Open Source Tool to Rate the Votes of Members of the United States House of Representatives and Senate”

2:55 – 3:25 pm  
Daniel Slaughter – MS Project, Advisor: Dr. Robert Adams  
“Creating 3D Foldable Papercraft from Dynamically Generated Scalable Vector Graphs”

3:30 – 4:00 pm  
Frederic Paladin – MS Project, Advisor: Dr. Robert Adams  
“Zion: File System Simulator”
# MASTERS PRESENTATIONS

**Thursday, April 23, 2015**

## Schedule of Presentations MAK A-1-111:

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Abstract:
If you want to have a healthy life style, vacations play a vital role in our lives. Taking a good vacation can help our physical health, it helps in maintaining good family relations, improves mental health and reduces the chance of burned out. However, most vacation recommender systems nowadays available are more complicated and confusing and usually rely on explicit user ratings. However, user ratings for travel data are sparse, therein reducing their effectiveness in recommending travel packages. I propose to develop a system aimed at exploiting a travel data set and creating travel package recommendations based on the user’s interests and the spatial-temporal correlations that exist within sets of locations, seasons and attractions. Further, I will assess relationships between travel users so that common users can be arranged into travel groups or the people who wants to travel as a group with their family or friends can also be arranged into travel groups. This personalized vacation package recommendation based on the traditional models, which follow a recommendation strategy and has the ability to combine many possible constraints that exist in the real-world scenarios. This data mining approach uses collaborative filtering method and performs much better than the traditional systems. It can be used both by the travel agencies and the travel groups at low maintenance and cost. The Graphical user interface is designed for both novice and expert users. This project has been developed using NetBeans with java and MySQL. I choose NetBeans because it is free, open-source, cross-platform IDE with built-in-support for Java programming language. This package system can be considered as an experimental prototype, we can see that the proposed recommendation approach works very well for predicting the user travel preferences by exploiting the unique characteristics of vacation package data.
Personalized Movie Database System
Masters Project

Presented By: Jayaprakash Garaga
Advisor: Dr. Yonglei Tao

Abstract:
Personalized Movie Database System (PMDS) is a dynamic web application created for the purpose of viewing basic information about movies such as casting, trailers, ratings etc. It is designed as a one-stop destination for the user to access the movies that are Coming Soon, In Theatres or DVD/Blu-ray/Digital. Besides displaying the ratings from popular websites such as IMDB and Rotten Tomatoes, PMDS allows user to rate the movies. For the movies that are running in Theatres, PMDS displays movie show timings based on the user’s location. For the movies available in DVD/Digital versions, it provides the links to buy/stream them online. In addition to these, PMDS also suggests the similar movies that might interest the user.

PMDS application has a rich, user-friendly Graphical User Interface design developed using Wordpress and PHP. The movie data is obtained from available APIs provided by IMDB, Rotten Tomatoes and other official API providers. The data, which is static for a particular movie (Eg. Cast, Plot, Poster etc.), is fetched from the APIs and stored into MySQL database using JSON/XML. The data that may vary with time such as Ratings, Show times etc. are fetched in real time by calling the respective APIs.
Abstract:
The goal of this project is to develop a web application which will provide users a platform to share home cooked food. Today in fast pace busy life, it is nearly impossible to get started in meal preparation after returning home from work. Many a times we are away from our homes travelling or staying away for different reasons. Having food that is inferior to home food and compromising on fast food or restaurant food have resulted in diseases that were rare few decades back. Increasing obesity, diabetes or other metabolic diseases could be significantly controlled with good and healthy food habits. Therefore, to provide quality and healthy food as if it was from one’s own kitchen, this web application provides an easy solution where the healthy home food seeker “foodie” could interact with home food provider “cook”. This application is built in ASP.NET framework using MVC (Model View Controller) development model and requires SQL Server. This application brings an easy to use interface so that the provider user could share the food they have prepared in their kitchen with the price they want to sell it and the service receiver user could search the food they would like to eat and locate the cook in geographical proximity. Both users - cook and foodie have their dedicated user accounts to keep track of their food listings, order history and transactions. This web application brings its own advantage to both users- foodie and cook and thus will provides immense business opportunity to the service provider launching this ecommerce web application.
Digital Library for Plant Information with Performance Comparison between a Relational Database and a NoSQL Database (RDF Triple Store) 
Masters Project 

Presented By: Md Arman Ullah 
Advisor: Dr. Yonglei Tao 

Abstract:
This project is to develop a digital library that allows the user to browse, search, and retrieve information about plants. It uses plant information acquired from the United States Department of Agriculture (USDA), which contains native and naturalized plants in North American territories. In addition, the user is allowed to contribute information and the administrator is able to add or edit plant information. This project is built by using a relational database and also a NoSQL database (RDF Triple Store), allowing to compare performance between the two databases.
Abstract:

Information sharing these days is becoming very common in the Internet through various website, be it news website, be it educational forum, etc. Everyday people depend more and more on the sources available in the Internet.

However lot of people can’t acquire information and at the same time contribute information using the same platform on various topics.

The objective of this system is to provide platform to everyone who wants to contribute their ideas or any articles, or even ask questions, etc. that can be developed as an innovative Web based application called “Knowledge Guru” which is a knowledge sharing application.

This application allows users to register in the system using Username, email id, profession and creating a password. After they register, the system will create a profile for each user which would be accessible and viewable by other users. The users can then access this application using their email id and password. The users from profession or background can use the system. They can be anyone from doctors, programmers, teachers to students, historians, etc. This application would benefit large diversity of people wanting to share any information with among them.
Abstract:

Sentiment analysis (SA) has been a vibrant area of research over the past several years. By and large, SA has been used to extract sentiments from an aggregation of numerous contributors’ articles or reviews about a specific subject. For example, the cumulative evaluations of multiple reviewers are often examined en masse to determine whether customers have a positive or negative feeling toward a product or service. Similarly, the aggregated work of hundreds of journalists may be analyzed to estimate the political biases of an entire news organization. There are relatively few studies in the SA literature that examine the sentiments, and potential biases, of one given author by taking into account that author’s body of work over a period of time. To address the lack of exploration in this area, a web application was created which has access to all of the articles in The Guardian News’ database over the past five years, and displays indications of sentiment for a single contributor. Users are able to analyze particular authors regarding the themes, entities and aspects that occur most frequently in his or her most recent work. The ultimate goal of this project is to empower users to utilize the displayed information to draw their own conclusions about possible biases that the author may possess.
Abstract:

Coalescent genealogy samplers are effective tools for the study of population genetics. They are used to estimate the historical parameters of a population based upon the sampling of present-day genetic information. A popular approach employs Markov chain Monte Carlo (MCMC) methods. While effective, these methods are very computationally intensive, often taking weeks to run. Although attempts have been made to leverage parallelism in an effort to reduce runtimes, they have not been scalable solutions. Due to the inherently sequential nature of MCMC methods, their performance has suffered diminishing returns when applied to large-scale computing clusters. In the interests of reduced runtimes and higher quality solutions, a more sophisticated form of parallelism is required. The proposed research will attempt to apply a recently discovered generalization of MCMC for this purpose. The new approach will exploit the multiple-proposal mechanism of the generalized method to enable the desired scalable parallelism.
Exploring Alternative Control Modalities for Unmanned Aerial Vehicles
Masters Thesis

Presented By: David Qorashi
Advisor: Dr. Jonathan Engelsma

Abstract:

Unmanned aerial vehicles (UAVs), commonly known as drones, are defined by the International Civil Aviation Organization (ICAO) as an aircraft without a human pilot on board. They are currently utilized primarily in the defense and security sectors but are moving towards the general market in surprisingly powerful and inexpensive forms. While drones are presently restricted to non-commercial recreational use in the USA, it is expected that they will soon be widely adopted for both commercial and consumer use. Potentially, UAVs can revolutionize various business sectors including private security, agricultural practices, product transport and maybe even aerial advertising. Business Insider foresees that 12% of the expected $98 billion cumulative global spending on aerial drones through the following decade will be for business purposes. At the moment, most drones are controlled by some sort of classic joystick or d-pad model remote controller. While drone manufactures have improved the overall controllability of their products, most drones shipped today are still quite challenging for inexperienced users to pilot. In order to help mitigate the controllability challenges and flatten the learning curve, gesture controls can be utilized to improve piloting UAVs.

The purpose of this study was to develop and evaluate an improved and more intuitive method of flying UAVs by supporting the use of hand gestures, and other non-traditional control modalities. The goal was to employ and test an end-to-end UAV system that provides an easy-to-use control interface for novice drone users. The expectation was that by implementing gesture-based navigation, the novice user will have an overall enjoyable and safe experience quickly learning how to navigate a drone with ease, and avoid losing or damaging the vehicle while they are on the initial learning curve. During the course of this study we have learned that while this approach does offer some promise, there are a number of technical challenges that make this problem much more challenging than anticipated. This thesis details our approach to the problem, analyzes the user data we collected, and summarizes the lessons learned.
A Survey of Smartwatch Platforms from a Developer’s Perspective
Masters Project

Presented By: Ehsan Valizadeh
Advisor: Dr. Jonathan Engelsma

Abstract:
Technological innovation has made it possible to package a powerful processor and memory subsystem coupled with a high-resolution display and wireless communication and specific sensors into a device known as the smartwatch. This device introduces a new set of new challenges such as battery life, user interaction, and other how to write applications for it. Smartwatches are connected to the Internet and provide gesture interaction and the ability to continuously monitor a user’s physical activity. The smartwatch has access to the smartphone and therefore can be used as a second display to show users various notifications from the phone such as calls and messaging as well as information from the Internet, such as social networking apps (Facebook, Twitter etc.), to do lists and many other applications.

The objective of the project is to explore smartwatch technology from a developer’s perspective. A short history of smartwatch technology is given along with a discussion of the typical use cases. This is followed by a deeper technology dive into the two most popular smart watch platforms on the market today: the Apple Watch and Android Wear. We will look at the features of both devices side by side, and take a look at the development platforms available to create applications on them. We will discuss the frameworks, the tools, and some of the challenges we encountered in learning to build applications with them. A sample application for both platforms will be presented and discussed.
Evaluation and Integration of a Javascript Graphing Library for a Nationwide Honeybee Hive Scale Network Masters Project

Presented By: Emily Johnson
Advisor: Dr. Jonathan Engelsma

Abstract:
Since 2006, an unprecedented and alarming rate of honeybee disappearance has puzzled the apiculture community: approximately 30% of the bee population has been lost each winter. Since upwards of one third of the nation’s food is directly or indirectly produced by bees, this rate of depletion is cause for concern. The goal of the Bee Informed Partnership is to better evaluate, understand and reduce bee colony losses. One of their programs centers around a Hive Scale Portal being developed by GVSU. This network is designed to monitor key hive metrics and collect this data nationwide for research purposes. A web portal that gives beekeepers and entomologists insight into their data accompanies the hive scales deployed in the field. A key part of the Hive Scale Portal is an interactive graph of hive data. However, the original graphing software (Dygraph) was limited and in need of visual and technical updates. The purpose of this project is to enhance the portal by evaluating a series of JavaScript graphing libraries, implementing the best candidate, and extending or customizing its functionality as needed. A total of ten different open source graphing packages were evaluated based on the project requirements, and High Charts selected and integrated.
YeaNay: An Open Source Tool to Rate the Votes of Members of the United States House of Representatives and Senate
Masters Project

Presented By: Eric Venlet
Advisor: Dr. Robert Adams

Abstract:
Government transparency is typically regarded as the most viable way to strengthen its accountability to the public (Shkabatur, 2012). Even on the international stage, the right to access government information is regarded as fundamental to democracy (Bertot, Jaeger, & Grimes, 2011). In order to improve transparency, the US government made data, like bills and votes, available online (Brito, 2008, *Colum. Sci. & Tech. L. Rev*.). One popular way to organize the data available to the public is through the creation of voter guides. The method an organization used for developing a voter guide was analyzed for this project. In response to the method, a web application (YeaNay) was developed to take the largely manual process and make a highly automated solution. YeaNay utilizes HTML, CSS, and JavaScript to build the user interface and ColdFusion and PL/SQL to query the data necessary for the development of a voter guide. The data is either queried from the database or from Congress API v3 (provided by the Sunlight Foundation). One user, with minimal training, is able to use YeaNay to find and score legislation within minutes for use in a voter guide. YeaNay focuses the firehose of congressional information that is now available and presents it in a manageable and usable environment.
Abstract:
This project demonstrates the advantages of using Scalable Vector Graphics (SVG) over traditional image types (JPEG, GIF, PNG, etc.) for 3D modeling on the Web. The project uses an SVG to dynamically update the colors and layers, and apply it as a texture on a 3D model. Since the 3D model is based on a 2D texture, the project also demonstrates how to print and fold it back into a 3D papercraft.
Zion: File System Simulator
Masters Project

Presented By: Frederic Paladin
Advisor: Dr. Robert Adams

Abstract:
File systems are fundamental for computers and devices with data storage units. Without them, the content of a disk would be nothing but a long stream of meaningless bytes. File systems allow operating systems to understand and organize this stream of bytes and obtain readable files from them. There are a lot of file systems available in the industry, all with their own unique features, and sometimes it is hard to understand how they work and interact with the operating system. Zion was created with this in mind. Zion is a file system simulator, designed as a teaching and experimenting tool for Computer Science and Computer Engineering students. It allows students to understand how the I/O manager of an operating system interacts with the drive. Users can see and analyze the structure of a simple, flat file system (with no directories) provided with Zion, or simulate commercial structures such as FAT or NTFS. They can even create their own implementations and run them through the simulator to analyze their behaviors.

Zion runs on Windows machines, and the application is provided with a DLL that includes the interfaces of a file system and a volume manager. These interfaces allow students to create a project in Visual Studio using any .NET language (3.0 or above), and build their own file system or volume manager. The tool gives the users the power to adjust simulated architectural parameters such as volume and block size, or performance factors such as seek and transfer time. Zion runs workload of I/O operations such as create, delete, read, and write, and analyze the resulting metrics including I/O operations, read/write time, and disk fragmentation. The interface provided with the application, together with the expendability of the tool itself, allows Zion to be a potential lab tool for Operating System classes.
Abstract:

Viral hepatitis damages hepatocytes in the liver and is caused by at least six different viruses. Viral hepatitis is the most common liver disease and can lead to liver cancer. According to CDC (Center for Disease Control), an estimated 4.4 million Americans are suffering from chronic Hepatitis. Interestingly, most Americans are unaware that they are infected.

There is lot of information available online about factors causing hepatitis. However, the problem is that there is no means to show entire data in one single click with more understanding. Moreover there are no tools to make the data user-interactive. This project aims at creating a visualization tool by using a Web application framework for R (Shiny). The tool will allow inputting all data available online for Illinois state, and show the relation between each attribute in a single page and make it user-interactive in a best possible way. This project aims at designing an interactive visualization tool that shows the number of hepatitis-infected persons based on age groups and sex. It also helps to analyze various factors associated with the hepatitis statistically. The final results obtained might be used to educate people about the major factors associated with hepatitis.
An Interactive Visualization Tool Based on Google Maps
MBI Capstone

Presented By: Santhosh Dharmapuri
Advisor: Dr. Guenter Tusch

Abstract:
Geographic visualizations can be a powerful tool to support health researchers and public health officials with complex decision during catastrophic and epidemic events like Ebola. Infectious diseases such as AIDS, Flu, and Ebola have a drastic impact on economy of developing and underdeveloped countries. Considering the limited access of health care facilities and hospitals in developing countries, there is a need of inexpensive and real-world mitigation strategies such as web tools to visualize the spread of the diseases. The goal of this project is to develop a web-based geo-visualization tool to visualize and compare the spread of Ebola in the West African countries Ivory Coast and Senegal, using synthetic data sets.

These data sets were produced during a simulation study of Data for Challenge (D4D) data at Grand Valley State University, School of Computing and Information Systems. The original data was retrieved from Orange telecom; Orange is a prominent mobile network carrier in Senegal and Ivory Coast. Orange gave access to anonymous cell phone details records (CDR) for research and development. These data sets have rich source of geospatial and time series information that can be visualized on a map. The data sets contain over 300,000 records of anonymized and randomly selected users in West Africa. With help of this information we can track the population mobility and estimate the disease spread in a catastrophic event. This project foresees a mitigation strategy using a visualization tool in order to visualize the spread of Ebola (synthetic data) in Ivory Coast and Senegal.

Google Maps JavaScript API (open source software) was leveraged to build the visualization along with other technologies such as Java, JavaScript, JSON, Java Servlets, JSP, HTML, and CSS. Heatmaps were created for the time series data for a period of 150 days to discover the patterns of Ebola spread in these two countries. The tool allows visualizing and comparing the spread of the Ebola using heat maps. We are also using other ways to better visualize the data; more over this tool can also be used to visualize any data set containing the geospatial information. The application has the potential to be a powerful tool that can help healthcare researchers and public health officials in developing mitigation strategies.
Detecting Aberrant Expression in Breast Cancer Through Analysis of miRNA Microarrays

MBI Capstone

Presented By: Shahrzad Eslamian
Advisor: Dr. Guenter Tusch

Abstract:
The main goal of the current study is to discover significant differentially expressed (DE) dysregulator miRNA among all microRNAs in non-BRCA1/2 breast cancer. A second goal is to analyze the pathways of their target genes in order to find the connection between the dysregulator miRNAs and breast cancer.

This study is based on 30 samples from a study on blocked nonsense-mediated mRNA decay pathways with the original goal to identify additional high-risk breast cancer susceptibility genes. The data consisted of 48804 genes in all 30 samples. To discover the significant DE miRNA, a multiple testing procedure was applied.

miRNA databases such as miRFfocus (human miRNA information) and miRBase (published miRNA sequences and annotation) were utilized to identify those significant DE miRNAs with aberrant expression. The National Institute of Health’s DAVID Bioinformatics Resource was used to determine the function of genes within the modules and Gene Ontology (GO). The pathways of these RNAs and the connection between RNAs and non-BRCA1/2 breast cancer were determined with the help of the KEGG database. Furthermore, prefuse, a Java-based toolkit for building interactive information visualization applications, was used to visualize the association pathways of the aberrant expression genes.

52 significant dysregulator -miRNAs were identified. For three micro RNAs, let-7e-5p, miR-192-5p and miR-335-5p, databases revealed that the target genes, HMGCS1, WDR48, PDE4D and CTH, play some role in breast cancer.
Analysis of Current and Future Opportunities for Telemedicine and Telerehabilitation in Michigan
MBI Capstone

Presented By: Shilpa Sahini
Advisor: Dr. Guenter Tusch

Abstract:
The “triple aim” of the healthcare system is to improve patient outcomes, access to care and cost of healthcare. The implementation of telehealth would help our healthcare system to address directly two of these three aims – improving access to care and reducing the cost of healthcare. The idea of telemedicine has been around for over a decade, but its implementation has been picking up pace recently with increased emphasis on improving quality of care to patients. The benefits of telemedicine are evident – real-time video conferencing would help patient in remote areas where there is limited access to hospitals. It would enable healthcare providers to monitor the patient’s conditions from the comfort of their home and respond immediately when needed. These advantages clearly show that telemedicine would alleviate the burden placed on hospitals by addressing the patient’s conditions before they become chronic. Similarly, the disadvantages of the telemedicine are also evident – the cost of establishing the infrastructure, the reimbursement costs and also the quality of the interaction between the patient and the provider. Throughout this study, the prospectus of telemedicine and telerehabilitation in Michigan will be evaluated based on patient populations and the spread of particular patient groups. The study focuses on policy, strategic benefits, and analysis of patient discharge data in order to determine if the benefits of telemedicine outweigh its disadvantages.
Investigation of Ebola Virus Disease in the Creation of Disease Simulation Model Utilizing Call Data Records

MBI Capstone

Presented By: Christopher Theisen
Advisor: Dr. Guenter Tusch

Abstract:
The D4D datasets containing call detail records (CDRs) were analyzed to develop a fine-grained population distribution and human mobility models of the Senegalese population. Incorporating biological aspects of Ebola virus disease (EVD), D4D data enhanced a stochastic agent-based simulation model, called EVsim, to model EVD outbreak within the Senegalese population. By simulating individual entities representative of a population, an agent-based model enables investigations of an individual’s impacts on a population. The Ebola virus produces a serious, often fatal disease in humans. As EVD human-human transmission occurs via direct contact, assessing human mobility patterns may lead to better mitigation strategies, such as travel restrictions or safe burial practices, to reduce EVD spreading during an outbreak.
Abstract:
Many patients have difficulties to select the right hospital for a particular problem in a specific location. While it is relatively easy for most patients to do an online search for hospitals by zip code, it is much harder to determine which of those selected will be the right one for getting their disease or illness treated. The goal of this project is to develop an interface that helps based on zip code to visualize valid, credible, and user-friendly information about the quality of care delivered in the nation’s acute care, critical access, VA, and children’s hospitals. The results of the project can be used to help consumers make informed health care decisions and to support efforts to improve quality in U.S. hospitals.
Abstract:
The prevalence and permeation of technology in business has allowed for new and very creative ways to steal. With data breaches becoming more common (and more publicized), many people are aware of the threats that large companies face. However, the digital threats that a normal person faces are not as apparent. While many stories exist of people using technology to threaten or harass others, many are not necessarily aware of the threats these large scale data thieves pose to those who just simply own an always-on internet connection. This project was conceived as a way to see what threatens the common user. Using SecurityOnion, ESXI, and various exploitable systems a simple network intrusion detection system was created to capture the reconnaissance traffic being sent to a residential IP address.

The usage of ESXI allows for fast deployment of new exploitable systems as well as easy packet capture with virtual switches. SecurityOnion was used due to its’ ease of use and detailed tutorials. Honeydrive was used to create Linux-based high interactivity honeypots, but Windows XP and Server 2003 were also used to see if the OS being scanned played a part in attracting follow up traffic to the network. All unsolicited packets from unknown IP addresses were then analyzed for country of origin to gain statistics on where attackers are coming from (or where they wish to be seen coming from), as well as to see the most common ports that were being scanned for.
An Examination of the Complexity and Comprehensibility of Various Software Models
Masters Project

Presented By: Taran Staal
Advisor: Dr. Paul Jorgensen

Abstract:
In a discussion of the creation and evolution of the statechart, David Harel, the creator of the model, talks about his primary goals for making a good model. He emphasizes that a good model should be clear, precise, visualizable, and executable. A clear model is one that can be easily understood by someone unfamiliar with the system being modeled. A precise model shows the entirety of the system under consideration, without including extraneous information. A visualizable model is one that can be interpreted by a user using primarily visual information, meaning some words must exist for thing like labels, but the majority of the information contained in the model is expressed through symbols that are easily understandable. An executable model is one that can be developed and then applied to help users understand or even create the system that is modeled.

These ideas are indeed very important to the usefulness of a model, as a model that is lacking in one or more of these areas could be difficult to understand, use, or both. Today, however, there are dozens of different models that aim to show different aspects of systems, and many of these models may not have been designed with the same goals that Harel outlines.

This paper aims to examine the complexity of various software models, including UML models and other commonly used models. I will look at each model and attempt to determine areas of the model that are particularly hard to understand, or areas where ambiguity is possible within the model. I will discuss the implications that model complexity has on a persons ability to learn the model and to recall it at a later date. I will also discuss ways to improve a persons ability to remember the aspects of a model when they are an infrequent user or when they have not encountered that model in a long time.