Use Cases in Big Data Software and Analytics

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Chapter 1

Preface

1.0.1 Disclaimer

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  volume =    {1},
  series =    {i523},
  address =   {Bloomington, IN},
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  pages =     {FILLIN},
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342	Udoyen, Nsikan	Still under consideration
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Big Data Applications for Vehicle Crash Prediction

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ABSTRACT

The idea of predicting car crashes used to be a fruitless endeavor - relegated to mere guesswork. However, advances in big data applications have allowed law enforcement to more accurately predict when and where car crashes are likely to occur, thus lowering first response times and taking proactive actions to prevent accidents in high-risk corridors. This paper shows several different approaches different agencies have taken using the power of data to solve this critical problem.

KEYWORDS

Big Data, Vehicles, Crashes, HID310, I523

1 INTRODUCTION

Car crashes are the top cause of death for Americans between ages 5 and 34.[8] Although the rate of car crashes has been dropping steadily over the last few decades [2], they remain a constant hazard for any who travel on our roads.

While most of the talk regarding car crashes and big data usually involves the development of self-driving cars (and understandably so), more immediate measures are being developed to meet this problem. A common usage of data in this domain is the prediction of high-risk crash areas.

The idea of predicting when and where crashes would occur used to be pure guesswork on the part of experienced police troopers[5], but advances in big data analysis has allowed law enforcement agencies to begin predicting and mapping exactly when and where high-risk areas will occur. Advocates contend that these tools allow first responders to act more efficiently both reactively and proactively, making our roads safer on which to travel.

We will outline the initial problem being addressed by these tools, the ultimate goal of such an exercise, and briefly explore two approaches to this solution. We will determine what outcomes these applications had, as well as whether they can be fully evaluated at this time.

2 TRENDS AND GOALS

In 1975, the United States had a rate of 3.35 deaths per 100 million miles traveled.[2] In 2015, that rate stood at 1.13 deaths. In fact, during that time frame, the amount of miles traveled on our roads has more than doubled, while the average annual number of fatalities on our roads has dropped by more than 10,000. The National Highway Traffic Safety Administration (NHTSA) credits this to the successful implementation of the Four Es of traffic safety:

- Enforcement
- Engineering
- Education
- Emergency Medical Services [8]

However, the NHTSA and other safety groups are not satisfied with merely lower numbers. They are driven by an initiative called Toward Zero Deaths which, as the name implies, strives toward the elimination of traffic related deaths.[8]

But how can highway safety groups reach this lofty goal? And what are they already doing about it? It should come as little surprise that the powerful utilization of big data has been rising in this field.

3 BIG DATA SOLUTIONS

A lot of data points can be collected from current activities undertaken through the Four Es. These include things such as traffic volume at the time of the crash, vehicle speed, road and construction conditions, and emergency response times. [8]

In addition, state agencies have found that other extraneous factors contributed to the likelihood of a crash, such as events like football games, major holidays that correspond with an increase in drunk driving (such as New Year's Eve and Super Bowl Sunday), and concentrations of establishments that serve alcohol.[5]

Unfortunately, these data points were previously siloed off in different agencies and formats, making dynamic usage of this information difficult if not impossible. However, some states are beginning to utilize this data in an effective way. They are beginning to collect data in a deliberate way so as to coordinate information between agencies in order to create applications and tools for use by troopers, other emergency response, road planners, and the public at large. [5]

States are going about this problem in different ways. This will allow us to approach the issue from different angles and see which approaches yield superior results. However, since these applications are still so new, it is not yet possible to fully evaluate their effectiveness on outcomes. This paper is examining two state approaches: Tennessee, which was one of the first initiatives in the nation, and Indiana, which was modeled after Tennessee's program in a more comprehensive way.

3.1 Tennessee

The origin of Tennessee Highway Patrol's Predictive Analytics program began in 2008, when state troopers switched from paper-and-pen crash reports to an electronic interface. This allowed Tennessee's agencies to use real-time data to create prediction software for car crashes. According to the State of Tennessee, the program uses SPSS software to apply three different statistical models with machine-learning algorithms in order to provide troopers with risk areas for certain types of crashes. [4] The models used were:

(1) Crash Reduction Analyzing Statistical History (CRASH). Using risk factors and historical crash data, this model gives probabilities on a fatal or injury-causing accident over four-hour blocks over a one week period, which is then illustrated on interactive maps.
(2) Driving Under the Influence (DUI). Calculates the probability of a crash related to a DUI from 4 pm to 4 am.
(3) Commercial Motor Vehicle (CMV). Calculates the probability of a crash related to a commercial motor vehicle (such as a semi truck).[4]

The program was implemented in 2013. Using this technology, troopers stationed themselves in more statistically advantageous positions in order to decrease response times to crashes, and take preliminary actions to prevent crashes such as setting up traffic direction or more aggressive enforcement on speeding and reckless driving.

From 2013 to 2015, Tennessee traffic deaths fell 3 percent, compared to a 7 percent increase across the nation. This cannot yet be directly tied to the performance of the program, but according to officials such as the THP Statistics official Patrick Dolan, the effect is clear.

Information coming out of the Predictive Analytics program driving targeted enforcement "has allowed us to deploy our resources more effectively to execute our mission successfully," Dolan reported to the Tennessee government's Traffic Safety Innovations 2016 newsletter. [4]

However, the trend became murkier in 2016. Tennessee traffic deaths spiked 8 percent, matching the national trend. Officials are still unclear whether the model is to blame. According to Dolan, average police response time dropped nearly 33 percent between 2012 and 2016. [5]

3.2 Indiana

In March 2014, then-Indiana Governor Mike Pence create by executive order the Management Performance Hub (MPH), a subagency tasked with driving "a coordinated effort by state agencies to share data and improve and strengthen services, maximize the utilization of available resources, and ensure that state services are available to all Hoosiers."[3]

One of the first projects undertaken by MPH was the Crash Prediction Website. Inspired by Tennessee's program[7], the MPH worked in tandem with the Indiana State Police to create an interactive map (Figure 1) showing the probability of both fatal and nonfatal traffic accidents.

[Figure 1 about here.]

The model grew out of several factors:

(1) The concept was borrowed from Tennessee's aforementioned Predictive Analytics program, though Indiana had a greater range and depth of data available.
(2) The core of the model is built upon data from 2 million crashes going back to 2004. The data was cleaned so only relevant crash data was included in the forecast.
(3) The probability of a car crash is ranked from "very low risk" to "high risk", which is then indicated on the map through color-colded 1 square kilometer blocks over three hour time blocks.[6] This is more granular than Tennessee's maps, in both time and space scale. These probabilities are ranked based off of weather forecasts, traffic congestion, road conditions, time of day, historical information, and census data.
(4) The map is populated with different colored dots to represent past car crashes - red for injury-causing, grey for non-injuries. Users can then click these to identify unique details of actual car crashes.[7]
(5) The model is updated automatically with fresh crash reports, providing the software with dynamic information.

Unlike Tennessee's program, Indiana's crash map is completely available to the public for their own personal use, though its usage will primarily be used by police and first responders.

Although it is still too soon after launch to evaluate the effectiveness of this model, Indiana officials are optimistic. Indiana's Office of Management and Budget, the parent agency to the MPH, estimates that even a one percent reduction in Indiana crashes could net up to $30 million in annual savings, besides the obvious benefits of fewer road casualties.

With the groundwork laid in the crash map, officials are hoping to utilize the technology in other ways. Major Michael White of the Indiana State Police, in an interview with Statescoop.com, said with the technology developed through this initiative, they hope to move on to using it to map crime data as well.[6]

4 CONCLUSION

While these applications and initiatives are still too new to fully evaluate, there does appear to be preliminary results that show promise.

Tennessee showed quick decline in car crashes and police response times, while Indiana built upon Tennessee's example to provide a more comprehensive look at all risk factors involved in a car crash, while opening this tool up to the public for personal use.

These applications also show promise in application to other domains, such as the Indiana State Police's interest in creating a crime risk map using the same principles.

It is also encouraging to view these as an example in various state agencies coordinating in order to share data and collaborate on applications. If Indiana's Management Performance Hub is any indication, these collaborations will continue, at least in Indiana. Hopefully more states follow suit in creating data sharing hubs and protocols in order to streamline government data utilization.

Ultimately, what is primarily needed is more time to evaluate the effectiveness of these initiatives, as well as metadata related to utilization of the map (for example, what is the average response times of a trooper using the map versus one who is not using the map). As more states grow their own initiatives, we can also evaluate whether certain approaches are more effective than others.

ACKNOWLEDGMENTS

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Do not worry about the figure placement if they are at a different location than you think. Figures are allowed to ffoat. For this class, you should place all figures at the end of the report.

DONE:

In case you copied a figure from another paper you need to ask for copyright permission. In case of a class paper, you must include a reference to the original in the caption

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Figure 1: The map shows the probability of a crash through color-coded blocks.[1]

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Big Data Applications in the Energy and Utilities Sector

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Bloomington, Indiana
nrawat@iu.edu

ABSTRACT

Efficient management and utilization of energy and other utilities is the need of the hour. The plethora of real-time data generated during day-to-day operational activities can be used to detect consumption patterns and predict outages, shortages and surges in power usage, while simultaneously improving the use of renewable resources as sustainable alternatives. Intelligent big data analytics can help the energy and utilities sector by reducing costs through devising efficient operational strategies, becoming more self-sufficient and productive in their performance and improving customer satisfaction and interaction by making valuable suggestions to the consumers on how to use their resources better.

KEYWORDS

i523, HID224, Smart Grids, Energy Disaggregation, Demand-Side Management, Sustainability, Water Management

1 INTRODUCTION

Big data is often defined as "data that exceeds or is beyond the capabilities of the organization to store or analyze for accurate or timely decision making" [11]. It is characterized by features such as its volume, velocity and variety. Two other characteristics that have been recently added to these are veracity and volatility, referring to the uncertainty and dynamic nature of such data [11]. Despite the unstructured nature of such data, it presents us with a variety of opportunities which make it so appealing.

The hospitality sector too generates a huge amount of data in its day-to-day processes about its customers, operational processes such as electricity and water consumption and the daily revenue generated. Some of the questions that can be addressed using this data are - What is the country of origin of the customer? What are his/her particular preferences in terms of food or other amenities? What booking channel did they use? What was the time/season of booking? How is the performance of the hotel relative to the local market? What is the monthly energy consumption and other expenditures?[1].

Using the data generated internally by the administrative units and different departments, gathered externally from the web - from sites of aggregators such as Expedia and Trivago and from social networking sites such as Twitter, hotels can derive quite useful insights into the opportunities they can utilize and the challenges they should overcome.

2 THE ADVENT OF BUSINESS INTELLIGENCE

Business Intelligence has been a part of the Hospitality sector for some time now. Earlier though, it was used mainly in traditional revenue management systems to deal with duration of stays and promotional programs [6]. However, it was not developed well enough to provide additional insights into other areas of hotel management. The emergence of companies which worked as online booking platforms, such as Expedia and Travelocity, led way to a new form of data, which though unstructured, could be leveraged as a window into the customers' preferences. Few hotels such as Mariott, InterContinental Hotels, Hilton and Hyatt utilized these opportunities presented by business intelligence to get ahead in the game, but were not very successful due to insufficient planning and technical expertise, lack of executive support and wide-spread adoption [6].

Figure 1: Hospitality Business Intelligence System [2]

3 BIG DATA AND HOSPITALITY

With the advancement of technology, the generation of data increased manifold. Researchers from UC Berkeley had estimated that "the world had produced about 1.5 billion gigabytes of information in 1999 and in a 2003 replication of the study found out that amount to have doubled in 3 years" [12].

The Hospitality sector too found data from a variety of sources - social media, review data, data from search engines like Google and other customer data sources [1]. As a result, business intelligence systems were made more structured, driven by advanced IT technologies and machine learning algorithms. Figure 1 shows a Hospitality Business Intelligence System

The vast amount of data now is used for a variety of tasks in the hotel management field. The most essential ones are - Customer Satisfaction and Marketing, Yield/Revenue Management and Operational Effectiveness.

Figure 2: Structure of the Customer Response Evaluation System [4]

3.1 Customer Satisfaction and Marketing

Customer loyalty is the main driver behind the hospitality business. The use of big data analytics has worked towards providing hoteliers with insights about what their guests want. This information can be used by the hotels to improve existing customer satisfaction as well as develop marketing techniques to attract new customers. This helps convert "high-spending customers to repeat customers" and increases the hotel's profitability [8].

An excellent example of the use of analytics for customer satisfaction is the new system introduced by the US chain of hotels, Denihan Hospitality [7]. Using IBM analytics technology, they worked towards combining their internal customer and transactional data with the review data found on the web. This was used to implement various data-driven solutions regarding the quality of the rooms, bathrooms and other facilities. They even went ahead to create interactive dashboards and "putting analytics in the hands of the frontline hotel staff" who received real-time updates as to the requirements of their customers [7].

In order to implement the above hotel evaluation structure, one can use the services of WebCrawlers and cloud computing platforms like Hadoop. A similar system created by Ming-Shen Jian, Yi-Chi Fang, Yu-Kai Wang and Chih Cheng uses cloud technologies coupled with data mining algorithms to create a customer response and evaluation system [4]. The system uses Hadoop to implement a multi-node cluster on the cloud server, programs a WebCrawler to retrieve review data from websites, extracts the informative adjectives using MapReduce and a text segmentation system and gives the word count using Hadoop's WordCount program. Weights are assigned to the different words using a neural network which are then clustered and analyzed for classification using a clustering algorithm. The final results are averaged for all reviews for a particular hotel to determine its score [4]. Figure 2 shows a Customer Response Evaluation System

Marketing too profits from the availability of such data by using search data generated by aggregators such as Expedia and TripAdvisor to develop discount programs and other offers to attract customers. The data history of customers available with hotels can also be used to analyze the requirements of customers at particular times and seasons of the year to create effective marketing strategies. Loyalty programs can be developed to retain long-term customers which can be identified using this data. Events and important occasions can be kept track of in order to release special offers, promotions and advertisements. Data gathered from social media sites is one which can be used most efficiently, through sentiment analysis techniques, to modify marketing strategies according to the different customer demographics.

3.2 Yield Management

Yield or Revenue Management deals with price optimization of the different resources offered by a hotel according to different internal as well as external factors. These factors could be the weather or season, the demand and supply in the local market or any internal pricing strategy being implemented.

As mentioned earlier, revenue management was among the first areas where business intelligence was used. Traditional revenue management tools were improved considerably with the advent of big data. Data available on booking sites and on search engines provided different customer channels, resulting in more sources of revenue but also more complexity in the economic management of a hotel. This data however could be leveraged to gain insights about the different customer channels and types so as to align the revenue system accordingly. One example of the above is the *innRoad* Real-Time Revenue Management System [3].The innRoad system consists of three components - a forecasting module, a network optimizer and a suite of channel-level optimization modules. It uses real-time data to forecast property demand rates according to different segments and dates and then uses these forecasts for economic evaluation and allocation of rooms. The channel optimization modules use these evaluations along with the data they receive from various channels (rankings, reviews, etc.) to generate real-time prices for different channels, thus providing valuable information regarding the demand and supply view for the hotel [3]. Figure 3 shows the innRoad Real-Time Revenue Management System

The result of such an optimized system is an increase in revenue and decrease in management time and effort. The variety of data being generated online can be gathered and structured to create a big data warehouse which can be leveraged by such revenue systems to provide fast and useful real-time business analytic solutions.

3.3 Operational Effectiveness

There are several internal operations such as energy and water consumption, which can be optimized to ensure effective resource planning in any hospitality industry. Big data can prove to be a major tool in this area too, especially for big chains. Internal data from hotels belonging to a particular chain can be consolidated and analyzed to gain information about the resource utilization by different hotels and in different areas. Necessary strategies can

Figure 3: innRoad Real-Time Revenue Management System [3]

then be devised to ensure optimum use of resources.

As mentioned by Kahn and Liu, the administrative data from a hotel can act as "laboratory" for researching different methods to improve energy efficiency [5]. In their study on a major United States hotel chain, they utilized energy consumption data from all hotels in the chain and used a multivariate linear regression technique to understand the factors that affected consumption rate in different areas. One conclusion that they arrived at was that consumption rates were lower in California, which was explained by the stringent energy efficiency laws in California. Conduction of various randomized control-trials also revealed that strategies such as informing people about the downside of increased energy consumption and offering performance bonuses to hotel managers who reduced consumption along with maintaining customer satisfaction, worked in favor of reducing energy costs [5].

The above case study demonstrates how use of even the regular internal energy consumption data generated by hotels over time can prove an essential source of information about the resource utilization in a hotel. Such data mining strategies to contain energy consumption can help decrease not only the operational costs of the hotel but also improve the eco-friendly aspect of the hotel due to reduction of harmful carbon emissions.

4 RECOMMENDATION SYSTEMS

Recommendation systems for travel and hotel sites such as Trivago, Priceline and Expedia are major business intelligence entities in the hospitality sector. These systems deal with huge volumes of data and analyze them to return useful recommendations. The most commonly used recommendation models are - Content-based, Collaborative Filtering and Hybrid. Content-based models provide recommendations based on previous ratings by the user, Collaborative Filtering models provide recommendations based on preferences of similar users and Hybrid models combine the above two i.e. the user's choice as well as the popularity of the recommended hotels [9].

An example of an effective Collaborative Filtering recommendation system is the KASR (Keyword-Aware Service Recommendation) system [9]. The model was implemented by extracting keywords from user comments to generate a list of keywords which were matched with a domain thesaurus (both for the current user and previous users). Similarity between the current user and any previous user recommendations were calculated using approximate and exact similarity methods. Weights were assigned according to the number of such keywords and personalized ratings were calculated to generate recommendations for the current user. The system was implemented on Hadoop and using MapReduce for better scalability [9].

Similar to above, recommendation systems for the other two models, using the original algorithm and modified, have also been implemented. These recommendation systems provide users with the convenience of searching and booking optimum travel and stay packages in one go. Hopper, a useful travel application, uses its predictive analytics to inform users of the best time to fly to get cheaper rates on airline tickets. Doing so, it raised 16 million in a growth funding round in 2016 [10]. Expedia, a well-known travel application, partners with 231,000 hotels and 400 airlines to provide useful deals to customers [13]. These recommendation systems not only serve as useful tools for their customers but also valuable sources of business data for their client i.e. the hospitality sector.

5 CASE STUDIES

Big data analytics has increased tremendously across all service sectors, and the hospitality sector is moving further up the ladder in this era of business intelligence. However, there are a some pioneers which must be mentioned as shining examples in this race. Red Roof Inn, a US economy hotel chain, struck upon the idea of having hotels close to the airport in the winter of 2013-14, as the flight cancellation rates were around 3 per cent at that time and travelers searched for hotels nearby to stay. They used data available publicly regarding flights and weather conditions to launch a marketing strategy that resulted in a 10 per cent increase in business in the targeted areas [7]. Starwood Hotels and Resorts, a large chain with around 1,200 hotels around the world, used local and worldwide market data along with seasonal weather data to update their pricing system and launch marketing campaigns. This resulted in a 5 per cent increase in their revenue-per-room [7]. Marriott Hotels, present at over 3,500 locations and generating 12 billion USD in revenue, revealed their success strategy as being "driven by internet availability". The launch of the *Marriott Reward Program*, based on a business intelligence system which gives real-time information on the member loyalty status, duration of stay, and possible pricing models, has greatly boosted customer satisfaction [6]. InterContinental Hotels in San Fransisco gathered data regarding the energy profiles of their hotel buildings and leveraged it to reduce their

energy costs by 10-15 per cent [14]. Choice Hotels improved their business intelligence program by incorporating *Business Objects*, a business intelligence focused company, in their process to attain real-time data about revenue and occupancy rates. The dashboards with all the key data was provided to all their executives to assist in their decisions, thus empowering the company from within using big data analytics as a tool [6]. These case studies truly reflect the impact and growth of big data in the hospitality sector.

6 CONCLUSIONS

Big Data has revolutionized the field of Travel and Hospitality, and continues to grow as a major factor in all business decisions. What started as a simple revenue management structure, has grown into an intelligent, sustainable system affecting more than one area in the hotel management arena. Launching marketing campaigns, deciding prices and resource allocations, optimizing energy and water consumption, renovating the IT structure, and improving customer comfort and satisfaction, have all been transformed by the arrival of Big Data and business intelligence. There are challenges still to the smooth integration of business intelligence into the day-to-day processes in the Hospitality Industry - overcoming a silos mentality, improving technical expertise to implement the complex Business Intelligence infrastructures needed, and gathering the resources required to support these structures. However, we have observed how the use of big data analytics and intelligence has reformed the hotels who used them. Integration of Big Data and intelligent systems as part of the decision-making process has the potential to become the next 'big thing' for the Hospitality Sector.

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[14] Mark van Rijmenam. 2017. Why Hotels Should Apply Big Data Analytics To Provide a Unique Guest Experience. (2017).

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53: \newline In order to implement the above hotel evaluation
    structure, one can use the services of WebCrawlers and cloud
    computing platforms like Hadoop. A similar system created by Ming-
    Shen Jian, Yi-Chi Fang, Yu-Kai Wang and Chih Cheng uses cloud
    technologies coupled with data mining algorithms to create a
    customer response and evaluation system \cite {jianfangwang07}.
    The system uses Hadoop to implement a multi-node cluster on the
    cloud server, programs a  WebCrawler to retrieve review data from
    websites, extracts the informative adjectives using MapReduce and
    a text segmentation system and gives the word count using Hadoop's
    WordCount program. Weights are assigned to the different words
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    been implemented. These recommendation systems provide users with
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    get cheaper rates on airline tickets. Doing so, it raised 16
    million in a growth funding round in 2016 \cite {hopper1613}.
    Expedia, a well-known travel application, partners with 231,000
    hotels and 400 airlines to provide useful deals to customers \cite
    {expediahopperskyscanner13}. These recommendation systems not only
    serve as useful tools for their customers but also valuable
    sources of business data for their client i.e. the hospitality
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    relative to the local market? What is the monthly energy
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31: \newline Using the data generated internally by the administrative
    units and different departments, gathered externally from the web
    - from sites of aggregators such as Expedia and Trivago and from
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40: \newline The Hospitality sector too found data from a variety of
    sources - social media, review data, data from search engines like
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    were made more structured, driven by advanced IT technologies and
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52: \newline An excellent example of the use of analytics for customer
    satisfaction is the new system introduced by the US chain of
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    technology, they worked towards combining their internal customer
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    real-time updates as to the requirements of their customers \cite
    {bmarr06}.

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65: \newline As mentioned earlier, revenue management was among the first areas where business intelligence was used. Traditional revenue management tools were improved considerably with the advent of big data. Data available on booking sites and on search engines provided different customer channels, resulting in more sources of revenue but also more complexity in the economic management of a hotel. This data however could be leveraged to gain insights about the different customer channels and types so as to align the revenue system accordingly. One example of the above is the {\em innRoad} Real-Time Revenue Management System \cite {bigdatarevenue09}.The innRoad system consists of three components - a forecasting module, a network optimizer and a suite of channel-level optimization modules. It uses real-time data to forecast property demand rates according to different segments and dates and then uses these forecasts for economic evaluation and allocation of rooms. The channel optimization modules use these evaluations along with the data they receive from various channels (rankings, reviews, etc.) to generate real-time prices for different channels, thus providing valuable information regarding the demand and supply view for the hotel \cite {bigdatarevenue09}.

77: \newline As mentioned by Kahn and Liu, the administrative data from a hotel can act as ``laboratory'' for researching different methods to improve energy efficiency \cite {kahnliu10}. In their study on a major United States hotel chain, they utilized energy consumption data from all hotels in the chain and used a multivariate linear regression technique to understand the factors that affected consumption rate in different areas. One conclusion that they arrived at was that consumption rates were lower in California, which was explained by the stringent energy efficiency laws in California. Conduction of various randomized control-

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    trials also revealed that strategies such as informing people
    about the downside of increased energy consumption and offering
    performance bonuses to hotel managers who reduced consumption
    along with maintaining customer satisfaction, worked in favor of
    reducing energy costs \cite {kahnliu10}.

78: \newline The above case study demonstrates how use of even the
    regular internal energy consumption data generated by hotels over
    time can prove an essential source of information about the
    resource utilization in a hotel. Such data mining strategies to
    contain energy consumption can help decrease not only the
    operational costs of the hotel but also improve the eco-friendly
    aspect of the hotel due to reduction of harmful carbon emissions.

82: \newline An example of an effective Collaborative Filtering
    recommendation system is the KASR (Keyword-Aware Service
    Recommendation) system \cite {kasr11}. The model was implemented
    by extracting keywords from user comments to generate a list of
    keywords which were matched with a domain thesaurus (both for the
    current user and previous users). Similarity between the current
    user and any previous user recommendations were calculated using
    approximate and exact similarity methods. Weights were assigned
    according to the number of such keywords and personalized ratings
    were calculated to generate recommendations for the current user.
    The system was implemented on Hadoop and using MapReduce for
    better scalability \cite {kasr11}.

83: \newline Similar to above, recommendation systems for the other
    two models, using the original algorithm and modified, have also
    been implemented. These recommendation systems provide users with
    the convenience of searching and booking optimum travel and stay
    packages in one go. Hopper, a useful travel application, uses its
    predictive analytics to inform users of the best time to fly to
    get cheaper rates on airline tickets. Doing so, it raised 16
    million in a growth funding round in 2016 \cite {hopper1613}.
    Expedia, a well-known travel application, partners with 231,000
    hotels and 400 airlines to provide useful deals to customers \cite
    {expediahopperskyscanner13}. These recommendation systems not only
    serve as useful tools for their customers but also valuable
    sources of business data for their client i.e. the hospitality
    sector.

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29: Big data is often defined as ``data that exceeds or is beyond the
    capabilities of the organization to store or analyze for accurate
    or timely decision making'' \cite {phillipswrenhoskisson01}. It is
    characterized by features such as its volume, velocity and
    variety. Two other characteristics that have been recently added
    to these are veracity and volatility, referring to the uncertainty
    and dynamic nature of such data \cite {phillipswrenhoskisson01}.
    Despite the unstructured nature of such data, it presents us with
    a variety of opportunities which make it so appealing.

30: \newline The hospitality sector too generates a huge amount of
    data in its day-to-day processes about its customers, operational
    processes such as electricity and water consumption and the daily
    revenue generated. Some of the questions that can be addressed
    using this data are - What is the country of origin of the
    customer? What are his/her particular preferences in terms of food
    or other amenities? What booking channel did they use? What was
    the time/season of booking? How is the performance of the hotel
    relative to the local market? What is the monthly energy
    consumption and other expenditures?\cite {bigdatapredictive02}.

35: Business Intelligence has been a part of the Hospitality sector
    for some time now. Earlier though, it was used mainly in
    traditional revenue management systems to deal with duration of
    stays and promotional programs \cite {kortefrolick03}. However, it
    was not developed well enough to provide additional insights into
    other areas of hotel management. The emergence of companies which
    worked as online booking platforms, such as Expedia and
    Travelocity, led way to a new form of data, which though
    unstructured, could be leveraged as a window into the customers'
    preferences. Few hotels such as Mariott, InterContinental Hotels,
    Hilton and Hyatt utilized these opportunities presented by
    business intelligence to get ahead in the game, but were not very
    successful due to insufficient planning and technical expertise,
    lack of executive support and wide-spread adoption \cite
    {kortefrolick03}.

39: With the advancement of technology, the generation of data
    increased manifold. Researchers from UC Berkeley had estimated
    that ``the world had produced about 1.5 billion gigabytes of
    information in 1999 and in a 2003 replication of the study found
    out that amount to have doubled in 3 years'' \cite {gpress04}.

40: \newline The Hospitality sector too found data from a variety of
```

sources - social media, review data, data from search engines like Google and other customer data sources \cite {bigdatapredictive02}. As a result, business intelligence systems were made more structured, driven by advanced IT technologies and machine learning algorithms.

43: \caption{Hospitality Business Intelligence System \cite {businessintelligencetools08}}

51: Customer loyalty is the main driver behind the hospitality business. The use of big data analytics has worked towards providing hoteliers with insights about what their guests want. This information can be used by the hotels to improve existing customer satisfaction as well as develop marketing techniques to attract new customers. This helps convert ‘‘high-spending customers to repeat customers’’ and increases the hotel’s profitability \cite {mauricio05}.

52: \newline An excellent example of the use of analytics for customer satisfaction is the new system introduced by the US chain of hotels, Denihan Hospitality \cite {bmarr06}. Using IBM analytics technology, they worked towards combining their internal customer and transactional data with the review data found on the web. This was used to implement various data-driven solutions regarding the quality of the rooms, bathrooms and other facilities. They even went ahead to create interactive dashboards and ‘‘putting analytics in the hands of the frontline hotel staff’’ who received real-time updates as to the requirements of their customers \cite {bmarr06}.

53: \newline In order to implement the above hotel evaluation structure, one can use the services of WebCrawlers and cloud computing platforms like Hadoop. A similar system created by Ming-Shen Jian, Yi-Chi Fang, Yu-Kai Wang and Chih Cheng uses cloud technologies coupled with data mining algorithms to create a customer response and evaluation system \cite {jianfangwang07}. The system uses Hadoop to implement a multi-node cluster on the cloud server, programs a WebCrawler to retrieve review data from websites, extracts the informative adjectives using MapReduce and a text segmentation system and gives the word count using Hadoop’s WordCount program. Weights are assigned to the different words using a neural network which are then clustered and analyzed for classification using a clustering algorithm. The final results are averaged for all reviews for a particular hotel to determine its score \cite {jianfangwang07}.

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56: \caption{Structure of the Customer Response Evaluation System
    \cite {jianfangwang07}}

65: \newline As mentioned earlier, revenue management was among the
    first areas where business intelligence was used. Traditional
    revenue management tools were improved considerably with the
    advent of big data. Data available on booking sites and on search
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    (rankings, reviews, etc.) to generate real-time prices for
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    the demand and supply view for the hotel \cite {bigdatarevenue09}.

68: \caption{innRoad Real-Time Revenue Management System \cite
    {bigdatarevenue09}}

77: \newline As mentioned by Kahn and Liu, the administrative data
    from a hotel can act as ``laboratory'' for researching different
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    consumption data from all hotels in the chain and used a
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    laws in California. Conduction of various randomized control-
    trials also revealed that strategies such as informing people
    about the downside of increased energy consumption and offering
    performance bonuses to hotel managers who reduced consumption
    along with maintaining customer satisfaction, worked in favor of
    reducing energy costs \cite {kahnliu10}.

81: Recommendation systems for travel and hotel sites such as Trivago,
    Priceline and Expedia are major business intelligence entities in
    the hospitality sector. These systems deal with huge volumes of
```

data and analyze them to return useful recommendations. The most commonly used recommendation models are - Content-based, Collaborative Filtering and Hybrid. Content-based models provide recommendations based on previous ratings by the user, Collaborative Filtering models provide recommendations based on preferences of similar users and Hybrid models combine the above two i.e. the user's choice as well as the popularity of the recommended hotels \cite {kasr11}.

82: \newline An example of an effective Collaborative Filtering recommendation system is the KASR (Keyword-Aware Service Recommendation) system \cite {kasr11}. The model was implemented by extracting keywords from user comments to generate a list of keywords which were matched with a domain thesaurus (both for the current user and previous users). Similarity between the current user and any previous user recommendations were calculated using approximate and exact similarity methods. Weights were assigned according to the number of such keywords and personalized ratings were calculated to generate recommendations for the current user. The system was implemented on Hadoop and using MapReduce for better scalability \cite {kasr11}.

83: \newline Similar to above, recommendation systems for the other two models, using the original algorithm and modified, have also been implemented. These recommendation systems provide users with the convenience of searching and booking optimum travel and stay packages in one go. Hopper, a useful travel application, uses its predictive analytics to inform users of the best time to fly to get cheaper rates on airline tickets. Doing so, it raised 16 million in a growth funding round in 2016 \cite {hopper1613}. Expedia, a well-known travel application, partners with 231,000 hotels and 400 airlines to provide useful deals to customers \cite {expediahopperskyscanner13}. These recommendation systems not only serve as useful tools for their customers but also valuable sources of business data for their client i.e. the hospitality sector.

86: Big data analytics has increased tremendously across all service sectors, and the hospitality sector is moving further up the ladder in this era of business intelligence. However, there are a some pioneers which must be mentioned as shining examples in this race. Red Roof Inn, a US economy hotel chain, struck upon the idea of having hotels close to the airport in the winter of 2013-14, as the flight cancellation rates were around 3 per cent at that time and travelers searched for hotels nearby to stay. They used data available publicly regarding flights and weather conditions to

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    launch a marketing strategy that resulted in a 10 per cent
    increase in business in the targeted areas \cite {bmarr06}.
    Starwood Hotels and Resorts, a large chain with around 1,200
    hotels around the world, used local and worldwide market data
    along with seasonal weather data to update their pricing system
    and launch marketing campaigns. This resulted in a 5 per cent
    increase in their revenue-per-room \cite {bmarr06}. Marriott
    Hotels, present at over 3,500 locations and generating 12 billion
    USD in revenue, revealed their success strategy as being ``driven
    by internet availability''. The launch of the {\em Marriott Reward
    Program}, based on a business intelligence system which gives
    real-time information on the member loyalty status, duration of
    stay, and possible pricing models, has greatly boosted customer
    satisfaction \cite {kortefrolick03}. InterContinental Hotels in
    San Fransisco gathered data regarding the energy profiles of their
    hotel buildings and leveraged it to reduce their energy costs by
    10-15 per cent \cite {hotelanalytics14}. Choice Hotels improved
    their business intelligence program by incorporating {\em Business
    Objects}, a business intelligence focused company, in their
    process to attain real-time data about revenue and occupancy
    rates. The dashboards with all the key data was provided to all
    their executives to assist in their decisions, thus empowering the
    company from within using big data analytics as a tool \cite
    {kortefrolick03}. These case studies truly reflect the impact and
    growth of big data in the hospitality sector.

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Using Big Data to Battle Air Pollution

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ABSTRACT

We have come a long way from the stone age to build large scale industries, big cities, bullet trains, and a booming automobile industry. Technological and industrial advances are making our cities smarter by the day and yet a nagging side-effect is air pollution. Air pollution is not only creating local health hazards like respiratory and heart problems, but also directly leading to an increase in temperatures and contributing to global warming. We show how the advances in *Big Data*, *Cloud Computing*, and *Internet of Devices* can be used to combat air pollution.

KEYWORDS

i523, hid231, big data, environment, air pollution, global warming

1 INTRODUCTION

Air pollution is no longer a local problem. It is a global environmental issue which involves individual countries to come together and device measures to combat it [5]. It it causing about 3.7 million premature deaths worldwide from cardiovascular and respiratory diseases and also ruins the crops that feed the world [5]. Air pollution also has a direct effect on a number of environmental issues like global warming, depletion of ozone layer, acid rains, and impacts wild-life [5].

Back in the year 1990, the job of a typical air quality scientist was to develop atmospheric dispersion models to evaluate the air pollution caused by industries and make sure that it is within the permissible level suggested by the *Environmental Protection Agency* [2]. These models gather historic data of many years from airports and weather balloons to predict the pollution with the help of meteorology theory [2]. Although the methods used to derive the values were good enough, the limitations with respect to the technology posed a real challenge which took weeks to run the simulations, only to be cut-off in the middle due to power and storage issues [2]. The data processing engine was built on Sun-Solaris workstations with tapes handling the data storage [2]. The work-stations set up in major points in the country would communicate using a very slow network connection [2]. The data processing would be done locally and later written to all the servers which would then be split and distributed among many machines and consolidated in the end [2]. "If only we had that much more data and that much more ability to handle it, we could iterate through the model at a much finer scale. Real-time data processing remained a pipe dream" [2].

2 AIR POLLUTION AS A BIG DATA PROBLEM

The advent of *Big Data* and the technological advances changed the way the data is ingested and analyzed [2]. The network speeds have increased, wide range of sensors are available to collect data with a lot of precision which would feed the high speed data processing systems. Batch processing has become easier with *Hadoop* and *Map-Reduce*. The storage mechanisms have become cheaper and more disaster proof.

IBM is helping Beijing combat air pollution by analyzing huge amounts of data using a data analysis platform *Green Horizons* [3]. IBM has signed up partnerships with different cities in China and India to deploy *Big Data Analytics*, *Machine Learning* and *Internet of Things* to improve traffic, keep a check on the pollution from industrial machines, and other pollution causing agents [3]. *IBM* will deploy sensors in various places to collect data in real-time and analyze previous weather forecasts, and build improved iterative models over time [3]. The system continuously streams data from the sensors and improves the forecast by learning over time using *Machine Learning* algorithms [3]. Figure 1 shows the Green Horizons air quality management for Beijing.

[Figure 1 about here.]

IBM is collaborating with the United Nations to push the use of technological advances by every country for the common good of the world [3]. More and more cities and countries are opening air quality data to public where you can get reports in real time [1]. The *BreezoMeter* is the first mobile application that provides real-time information of the street's air quality information using geo-location maps [1]. *Copernicus* is another monitoring service that ingests data from satellites and on site sensors on land, air and sea to provide continuous information to the users [1]. *Open Data Week* is an intergovernmental organization where 34 states come together to bring reforms and discuss how to use technology and services like *Copernicus* that use *Big Data* to test prototypes of new products to ensure they operate within the permissible levels of pollution [1].

While these initiatives help bring awareness about the seriousness of the issue, each state and country should take strict measures to bring out reforms that will help eradicate pollution. *Big Data* might never replace the environmental responsibility but it will help to plan the vision for environmental awareness and its tools make it easier to achieve the vision [1]. These tools can also be used to gauge the alternative sources of energy and the feasibility of tapping into other natural resources ensuring responsible consumption of energy [1]. For example, *IBM Bluemix* analyzed data from a steel industry and the analysis uncovered an interesting insight that the furnace wastes a lot of energy to offset the temperature of the smoke which resulted in optimizing its operation [2].

3 BIG DATA TECHNIQUES TO COMBAT POLLUTION

3.1 Random Forest Approach for predicting air quality in Urban Sensing Systems

Air pollution in an urban setting is very important to monitor because of the population density. Air quality in these areas varies a lot in various parts of the city owing to traffic and presence of industries [6]. A random forest approach ingests data from meteorology, urban sensors, road information, and real-time traffic and predicts the air quality with utmost precision [6]. Real-time air quality information consists of measuring the concentration of $PM_{2.5}$, PM_{10}, and NO_2 [6].

The *Air Quality Index* AQI is the measure that is used to understand how polluted the air is [6]. AQI is measured by reading the concentration of 6 pollutant gases namely, sulfur dioxide SO_2, nitrogen dioxide NO_2, air particles smaller than 10 μm PM_{10}, air particles smaller than 2.5 μm $PM_{2.5}$, carbon monoxide CO, and ozone O_3 [6]. Based on the level of AQI, the air quality is classified as shown in Figure 2.

[Figure 2 about here.]

Traffic Congestion Status TCS, explains the traffic status at the current hour [6]. Figure 3 shows how colors are used to represent the traffic congestion [6].

[Figure 3 about here.]

3.2 RAQ Algorithm

The RAQ algorithm collects data from air monitoring station AQI, meteorology data MD, traffic congestion TCS, road information RI, and point of interest POI which is the specific location that someone is interested to visit [6]. The data refresh rate is one hour and the data is collected from different parts of the city which are divided in grids from G_1 to G_n [6]. The data is divided into training and testing data sets to train the model and evaluate the model [6]. Figure 4 shows the structure of the data.

[Figure 4 about here.]

A decision tree is used to split and classify the data and the results are aggregated by collecting the data from all the sub-trees [6]. Figure 5 illustrates the procedure of RAQ.

[Figure 5 about here.]

The *Random Forest* algorithm is employed using the tree type classifier to recursively partition the dataset and generate sub-trees and finally aggregate the results of each sub-tree [6]. Each sub-tress is constructed using *Bootstrap Aggregating* where each data set is divided into different buckets by using statistical samples [6]. Once the trees are constructed, each subset of data is fed into a decision tree and the estimated AQI index is calculated [6]. The final AQI index is determined as the maximum value out of all the individual values [6]. Figure 6 shows the step-by-step RAQ algorithm.

[Figure 6 about here.]

4 MACHINE LEARNING MODELS

Machine Learning deals with augmenting computers with the ability to learn from data and program themselves [4]. These algorithms can be used to evaluate the air quality [4].

4.1 Artificial Neural Network Model

Artificial Neural Network Model tries to solve the problem by simulating the functioning of brain and neurons [4]. The model architecture is a function of a sigmoid [4]. For this experiment, the air quality data was divided into training, test, and validation data with split of 60, 20, and 20 with a back propagation network of two hidden layers [4]. To ensure consistency, the air quality data for the training and test sets are derived from the same season [4]. The air quality is forecast by looking at the historic data where the input and output are represented by the air quality data measured at different times [4]. The model turns out to be reliable with a good prediction accuracy with the lowest mean square error of 3.7×10^{-4} [4]. The Artificial Neural Network Model is combined with *Markov Chains* to develop a new improved model with improved prediction accuracy where the ANN computes the primary values and the results are re-computed and improved by the markov transitional probability matrices [4]. Figure 7 shows the Artificial Neural Network Model with two hidden layers.

[Figure 7 about here.]

4.2 Least squares Support Vector Machine Model

Least squares support vector machine is a supervised learning model used for classification and regression analysis which arrives at the solution by solving the data represented in the form of linear equations [4]. For this model, the sample data was collected from 100 sensor points in different intervals of time and at different geographical locations that ranged from urban areas with population, areas near the airport, water surface areas like lakes, and sewage processing areas [4]. The sample data was a good split with 80 percent collected from urban sewage area and the other data collected from air surface areas [4]. The fluorescence content in the air was analyzed by a portable air quality measuring device developed in-house by Zhejiang University [4]. The fluorescence data captured using the device is highly dimensional and non-linear and therefore data pre-processing is essential to bring the dimensions down to a manageable level [4]. This eliminates the ambient noise and the temperature drift from the data [4]. The algorithm predicts the regression model by looking at the training data for each cluster [4]. Finally, the vector consine distance is used to classify the sample into clusters and the performance criterion such as *Root Mean Square Error* and *Mean Absolute Error* are computed which demonstrate the efficiency of the algorithm [4]. Figure 8 shows the pictorial representation of the algorithm.

[Figure 8 about here.]

5 CONCLUSION

While the new age technologies have a big role to play in measuring, tracking, and keeping air pollution in check, each person should have individual environmental responsibility to make the world a better place to live in. *Internet of Things* and *Machine Learning* are augmenting the *Big Data* capabilities like never before. This ensures that we have more data points to work in a given time and continuous data streaming means more accurate real-time analytics with efficient *Machine Learning* algorithms. All these

three technologies will continue to work in tandem to keep a check on air pollution and the imminent threats.

ACKNOWLEDGMENTS

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Figure 1: Green Horizons air quality management for Beijing [3]

AQI	Air Pollution Level
0–50	Excellent
51–100	Good
101–150	Lightly Polluted
151–200	Moderately Polluted
201–300	Heavily Polluted
300+	Severely Polluted

Figure 2: AQI classification [6]

Figure 3: Traffic Congestion[6]

temperature	humility	pressure	wind	visibility	road_length	tfs	poi_number	aqi
Numeric	Numeric	Numeric	Numeric	Numeric	Numeric	Numeric	Numeric	Nominal
5.5	89.0	758.1	2.0	14.0	2185.0	2371.0	63.0	excellent

Figure 4: Structure of RAQ data[6]

Figure 5: Procedure of RAQ [6]

Algorithm 1. RAQ

Input:	A dataset S with features: F_{mt}, F_{mh}, F_{mp}, F_{mw}, F_{mv}, F_{ri}, F_{tcs}, F_{pn} and labeled AQI level; unlabeled dataset U; trees quantity T; features quantity m;
Output:	AQI level
1	for T trees
2	randomly select m features from S;
3	for m features in each node
4	calculate information gain by Equation (3);
5	choose maximum gain to split the dataset in the node;
6	remove used feature from feature candidates;
7	input unlabeled data into trees;
5	get predicted AQI level according to Equations (5) and (6);

Figure 6: RAQ Algorithm [6]

Figure 7: Artificial Neural Network(ANN) Model [4]

Figure 8: Least squares Support Vector Machine Model [4]

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Big Data Analytics in Developing Countries

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ABSTRACT

Developing nations cope with numerous humanitarian challenges. Infrastructures are often inadequate to deal with basic public health, public safety, and environmental concerns. As a result, citizens deal with issues such as poverty, food insecurity, and the unavailability of basic health care. Resource limitations often make it difficult to manage crisis situations such as natural disasters. The use of wireless and Internet related technology is growing globally. Mobile phone and social media usage are becoming common even in remote areas. As a result, Big Data analytics is playing a role in mitigating the impacts of some of these humanitarian concerns.

KEYWORDS

I523, HID332, developing countries, food insecurity, public safety, big data

1 INTRODUCTION

Individuals in developing nations face a long list of humanitarian challenges, including poverty, hunger, health care access, and availability of clean water sources. Other challenges include insufficient resources to deal with public safety and crisis intervention issues.

The statistics are dismal. "Almost 1.3 billion people living in developing countries live on less than 1.50 dollars a day" [2]. "According to the United Nations, approximately twenty two thousand children die each day in these countries due to poverty" [1]. More than eight hundred seventy million people in third world nations have no food to eat or a very precarious food supply. "A third of all childhood deaths in sub-Saharan Africa are caused by hunger related diseases"[1]. That is approximately 2.6 million deaths per year. One child dies every five seconds of starvation [1]. More than two hundred million children under five years of age in developing countries do not reach their developmental potential due to malnutrition [7]. Over 1.2 billion people around the globe do not have regular access to clean drinking water. Many people die from common curable diseases that such as malaria, pneumonia, and diarrhea because they do not have access to health care. Approximately ten million children die each year from treatable diseases. [2]. Fifty percent of pregnant women in developing countries lack proper prenatal care. This results in over three hundred thousand maternal deaths annually from childbirth. [1]. The threat of HIV is also reaching a pandemic level in many of the third world countries [1].

Big Data Analytics is starting to be used to address some of these issues. Digital data is becoming more widely available globally. Internet wireless communications and mobile phone access are starting to become commonplace even in some rural areas. The data collected from these devices is being combined with data collected via traditional data sources such as datasets and surveys. This is providing information and insights that have never before been available. "The diffusion of data science into the realm of international development constitutes an opportunity to bring powerful new tools in the fight against poverty, hunger, and disease" [5]. Furthermore, the real time availability of much this data enables more timely and agile implementations of solutions. This all results in significantly better outcomes.

2 INFRASTRUTURE

In recent years, there has been a huge increase in the availability of digital technology globally, including in developing nations. According to the GSM Association 79 percent of the worlds total inhabited areas had mobile network coverage in 2012 [4]. According to the International Telecommunications Union, there were 2 billion people using the internet in 2015 and there were 91.8 mobile phone subscriptions per 100 inhabitants in developing countries [4]. Social media such as Facebook and twitter is being utilized by more and more people worldwide. Sensor technology is becoming less expensive and more efficient. Better algorithms are being developed to utilize the lower cost sensors for developmental activities. Data information sources include call logs, mobile banking transactions, blog posts, tweets, and Facebook content [5].

The diffusion of mobile phone technology has been especially important. Because mobile phones are often the only interactive technology that low income individuals have access to, they have become the cornerstone of many Big Data projects in the developing world[4].

3 BIG DATA

The amount of data that is being generated in developed countries is increasing rapidly. According to the Cisco Global Cloud index the highest workload growth rates between 2013 and 2018 are expected to be in the Asian Pacific, the Middle East and Africa, and Latin America. Growth rates during these time periods are expected to be 45 percent, 39 percent, and 34 percent respectively. "Data center traffic in the Middle East and Africa is expected to reach 366 exabytes in 2018 compared to 68 exabytes in 2013" [4].

4 HEALTHCARE

"Big Data has enormous potential to address health care challenges in the developing world" [4]. One of the primary problems with healthcare in the developing world is the overall lack of access. This is caused by a combination of geographical accessibility and the lack of basic medical resources. There are shortages trained medical professionals, medical equipment, and drug stocks. People

in rural areas often have to travel long distances in order to obtain care. There are also a lack of resources to implement basic public health regimes such as immunization policies. All of this makes the occurrence of serious disease outbreaks and epidemics common and difficult to manage when they do occur. Another issue is the existence of widespread fake drug distribution networks.

4.1 Public Health

One area in which Big Data can have an enormous impact on the health of vulnerable populations is in public health policy. Proper public health infrastructure is needed to prevent, treat, and manage serious disease outbreaks. Public health policies and related public education can also educate populations and influence attitudes and behaviors concerning important health related matters such as maternal health and immunizations.

Big Data is extremely useful for managing serious disease outbreaks, including pandemics and epidemics. Big Data and data science can be used first to track and monitor the spread of the disease and then to effectively allocate resources and medication so that the disease can be properly treated and contained. In fact, the term for this field is Infodemiology. It is a whole new field of data science [5].

Health related data is mined from social media and sites such as twitter and then combined with data visualization techniques to track the geographic spread of a disease. As the spread of the disease is being tracked in real time, big data is used to ensure that all available resources are allocated effectively. Big data ensures the right distribution of resources, including medical personnel and medication at the right time to the right location [6]. Proper resource allocation is especially important when lifesaving medical supplies are in short supply. According to the US Center for Disease Control and prevention (CDC), online data can help detect disease outbreaks before confirmed diagnosis or lab confirmation [5]. It is estimated that disease outbreaks can be identified up to two weeks sooner than with the use of traditional methods such as physician reporting [4]. When this resource allocation technique was used in Tanzania during a malaria outbreak, it reduced the number of drug facilities that were out of stock of the appropriate medication during the epidemic from 78 percent to 26 percent [4].

Social Media can also be used to track peoples health related beliefs, perceptions and concerns at any a given time and in real time. This methodology is referred to as sentiment analysis. For example, researchers can get an indication of health related attitudes about immunizations, the use of medication or prenatal care programs by reviewing social media posts. These studies can assist with health related education efforts. Social media and big data analytics are also be used to measure the impacts of humanitarian aid and intervention. For example, the United Nations used this technique to evaluate whether the Every Woman Every Child initiative had had an impact. This was a program that was designed to increase awareness of maternal health, breastfeeding, vaccinations. A team of researchers analyzed social media posts for two years for relevant keywords, such as breastfeeding or vaccination to determine if the program has resulted in increased parental awareness [4]. The information collected can be used to identify needs in order to establish and manage public health policies and programs.

Sentiment analysis can also be used to track other public health related issues such housing shortages, employment, and inflated food prices. This methodology is able to identify issues earlier than traditional methods and thus enables more timely deployment of resources and solutions [5].

4.2 Health Care Access

In developing countries, there are often problems with geographical accessibility to health care. People in rural areas often need to travel long distances to visit a health care professional. Also, rural areas do not have enough primary health care providers and specialists are rarely available.

The Internet of Things technology can solve some of these issues. One solution is patient sensors. Relatively low cost sensors can be worn on the person to monitor physiological variables in real time. The data collected can be transmitted to health care providers in a distant locations for diagnosis and treatment. These sensors can be used for routine as well as critical health issues such as heart palpitations. For example, in Africa there is a device called Cardio pad. It is a medical tablet that can be used to perform and collect information from cardiology related tests by individuals who have no cardiac training. The information gathered can then be sent to a cardiac specialist via mobile phone in order to receive diagnosis and treatment instructions[4]. In China the Internet of Things technology Institute is developing a telephone booth sized health capsule. Rural villagers can be receive a diagnosis from a distantly located physician when they step into it. [4].

4.3 Distribution of Fake Drugs

The widespread distribution of fake drugs is a huge health hazard in developing nations. According to the World Health Organization, counterfeit antimalarial and tuberculosis drugs account for seven hundred thousand deaths annually. Big Data technology is playing a huge role in fighting this crime. One nonprofit organization has developed a possible solution. The name of the program is called GoldKeys. All legitimate prescription containers have a twelve digit scratch off code. Customers can verify the authenticity of the medication by texting the scratched off code number to a health hotline. The number is matched to information in a cloud database and the information is sent back to the customer. The project is being maintained and funded primarily by Hewlett Packard [4].

5 ENVIRONMENTAL PROTECTION AND WATER SUPPLY

Almost a billion people in the world to not have a reliable source of clean drinking water [1]. According to World Water Development Report in 2012, inadequate sanitation and poor hygiene result in 3.5 million deaths annually [4]. Much of the water is wasted or leaked due to faulty pipes. Other water is lost due to unidentified or unnecessary pollutants.

The Internet of Things can be used for the purpose of monitoring water supply and quality. Sensors are frequently used to monitor pollutants in a river or water source. Resources are deployed to remedy problems when they are detected. One example is in the city of Da Nang, Vietnam. Da Nang is a major port city on the South China Sea. The Da Nang water company uses Big Data to provide

real time analysis of the citys water supply. The goal is to better manage leaks, monitor pollutants, and accurately forecast future demand. Big Data sensors are installed throughout each stage of the water treatment process. Water quality is tracked in real time. Notifications are sent if there are problems. [4].

In another example, IBM worked with the city of Tshwane in South Africa to develop a crowd source application that users use to report water supply issues such as faulty pipes. The result was the discovery of thirty million dollars of wasted water sources. This application operates without the need of a central inspection authority [3].

6 PUBLIC SAFETY AND CRISIS INTERVENTION

One of the most important areas in which Big Data is being deployed is to enhance public safety and crisis intervention efforts during natural disasters. "The availability of digital data collected and analyzed rapidly and in real time can drastically improve interventions and outcomes in crisis situations for vulnerable populations" [5].

One of the most widely used tools in this effort are crisis maps. Crisis maps use data from numerous sources, including local citizen reports, social network data, and environmental data to aid emergency responders in times of natural disaster. "Crisis maps have been deployed during dozens of events worldwide,including the 2012 Haiti earthquake and the 2010 Pakistan floods" [3]. In Haiti during an earthquake a centralized text message center was set up that allowed cell phone users to report where people were trapped. The United States Geological Survey has developed a system the monitors twitter for spikes about earthquakes globally. This information can be used to evaluate the location, quantify magnitude, identify epicenter, and respond quickly and appropriately [5].

7 AGRICULTURE

"More than half the population in all of the developing nations depend upon agriculture and farming for at least two meals a day. This accounts for almost seventy five percent of the worlds poorest people" [1]. Therefore, one important way to address poverty and food insecurity is to find ways to make farming techniques more effective and productive. Big Data has big potential to dramatically increase production for small scale farmers.

"Studies suggest that ineffective farm operations such a late planting, lack of proper land preparation, improper harvesting techniques and poor housing and feeding of livestock can reduce a smallholders farmers productivity by up to forty percent" [4]. One technique for improving production is Precision agriculture. The objective of Precision agriculture is to provide farmers with informed, personalized information so that they can make better operational decisions in real time. Data is collected on things such as soil conditions, weather, seeding rates, and crop yields using technology such as sensors, drones and satellites[4]. Sensors can be located in fields, inside livestock, or on farm equipment. After the data is collected it is analyzed and returned to the farmers via computers and mobile phones in terms of customized solutions. Instructions may be such things as the optimum type of seeds, pesticides, herbicides, and fertilizer use. The objective is to match inputs with the exact need. When resources are used efficiently production is maximized. Another solution involves collecting data to locate and notify farmers of the spread of crop and livestock plight. The objective is that farmer take safety measures as soon as possible [3].

In Uganda there is a Big Data tools project that uses Precision agriculture techniques that were developed by the Grameen Foundation. Data is collected on farmers, farming practices, and external conditions. It is given back to farmers in the form of a community knowledge database via Android phones. Information about the time and methods of planting crops, caring for farm animals and marketing their products [4].

Another way in which big data can be used for small holder farmers to support financing opportunities. In Nairobi, Africa the company Gro Ventures is building a platform which integrates information about crops and the environmental conditions to give lenders more confidence to lend money to farmers. One of the offerings allows farmers to pool their data to apply for collective loans to buy shared tractors and equipment [3].

8 CHALLENGES

There are many challenges to the successful implementation of many of these projects. Many people in the least developed nations still lack access to internet service or a mobile phone. There are high costs associated with using big data technology. Cost of mobile phones, analytical services and data services often cost prohibitive for individual citizens. There is also a Big Data skill set deficient. Big data technology and the analytics to turn big data into actionable information requires technical skills that are often not available. Furthermore, health care professionals and other related personnel often lack knowledge or training about data science.

In order for initiatives to be successful, financial and technical support will need to come from other sources: academia, public and private sector, and philanthropic. To date, there are numerous non-goverment organizations (NGOs) working throughout the world to fight poverty and reduce disease [6]. The United Nations started an initiative in 2009 called Global Pulse. The objective of Global pulse is to research ways that Big Data can be incorporated into the developing world to improve lives. They are currently conducting several research initiatives in various locations throughout the world. Several private organizations are also playing a role. For example, Google has announced a plan to develop high speed internet solutions in developing countries using high altitude balloons. Their goal is to add an additional 1 billion people to the Internet from Africa, and Southwest Asia [4].

9 CONCLUSION

Although Big Data does not have the ability to solve all of the worlds problems, it does have enormous potential to reduce suffering and save lives for those living in developing countries. Big data is giving smallholder farmers resources to substantially increase their food production. This will play a substantial role in the fight against poverty and food insecurity. Big data analytics is improving health by making health care accessible to even those in the most remote locations. Big data provides the knowledge to identify and monitor water availability issues such as waste and pollution so that problems can be identified dealt with immediately. Big is

also saving lives by providing the real time knowledge needed to respond effectively to health epidemics and natural disasters. As the use of internet related devices continues to increase throughout the developing world, the impact of big data will continue to grow.

ACKNOWLEDGMENTS

The author would like to thank Dr. Gregor von Laszewski and the teaching assistants in the Data Science department at Indiana University for their support and suggestions to write this paper.

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35: The statistics are dismal. "Almost 1.3 billion people living in
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    approximately twenty two thousand children die each day in these
    countries due to poverty" \cite{www-google-top10}.   More than
    eight hundred seventy million people in third world nations have
    no food to eat or a very precarious food supply. "A third of all
    childhood deaths in sub-Saharan Africa are caused by hunger
    related diseases"\cite{www-google-top10}. That is approximately
    2.6 million deaths per year. One child dies every five seconds of
    starvation \cite{www-google-top10}. More than two hundred million
    children under five years of age in developing countries do not
    reach their developmental potential due to malnutrition \cite{www-
    google-WikiDevC}.  Over 1.2 billion people around the globe do not
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    common curable diseases that such as malaria, pneumonia, and
    diarrhea because they do not have access to health care.
    Approximately ten million children die each year from treatable
    diseases. \cite{www-google-top5}.  Fifty percent of pregnant women
    in developing countries lack proper prenatal care. This results in
    over three hundred thousand maternal deaths annually from
    childbirth.  \cite{www-google-top10}. The threat of HIV is also
    reaching a pandemic level in many of the third world countries
    \cite{www-google-top10}.

37: Big Data Analytics is starting to be used to address some of these
    issues. Digital data is becoming more widely available globally.
    Internet wireless communications and mobile phone access are
    starting to become commonplace even in some rural areas. The data
    collected from these devices is being combined with data collected
    via traditional data sources such as datasets and surveys. This is
    providing information and insights that have never before been
    available. "The diffusion of data science into the realm of
    international development constitutes an opportunity to bring
    powerful new tools in the fight against poverty, hunger, and
    disease" \cite{www-google-GloPls}. Furthermore, the real time
    availability of much this data enables more timely and agile
    implementations of solutions. This all results in significantly
    better outcomes.

45: The amount of data that is being generated in developed countries
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expected to be in the Asian Pacific, the Middle East and Africa, and Latin America. Growth rates during these time periods are expected to be 45 percent, 39 percent, and 34 percent respectively. "Data center traffic in the Middle East and Africa is expected to reach 366 exabytes in 2018 compared to 68 exabytes in 2013" \cite{DevEcon}.

49: "Big Data has enormous potential to address health care challenges in the developing world" \cite{DevEcon}. One of the primary problems with healthcare in the developing world is the overall lack of access. This is caused by a combination of geographical accessibility and the lack of basic medical resources. There are shortages trained medical professionals, medical equipment, and drug stocks. People in rural areas often have to travel long distances in order to obtain care. There are also a lack of resources to implement basic public health regimes such as immunization policies. All of this makes the occurrence of serious disease outbreaks and epidemics common and difficult to manage when they do occur. Another issue is the existence of widespread fake drug distribution networks.

80: One of the most important areas in which Big Data is being deployed is to enhance public safety and crisis intervention efforts during natural disasters. "The availability of digital data collected and analyzed rapidly and in real time can drastically improve interventions and outcomes in crisis situations for vulnerable populations" \cite{www-google-GloPls}.

82: One of the most widely used tools in this effort are crisis maps. Crisis maps use data from numerous sources, including local citizen reports, social network data, and environmental data to aid emergency responders in times of natural disaster. "Crisis maps have been deployed during dozens of events worldwide,including the 2012 Haiti earthquake and the 2010 Pakistan floods" \cite{www-google-Hffpst}.

87: "More than half the population in all of the developing nations depend upon agriculture and farming for at least two meals a day. This accounts for almost seventy five percent of the worlds poorest people" \cite{www-google-top10}. Therefore, one important way to address poverty and food insecurity is to find ways to make farming techniques more effective and productive. Big Data has big potential to dramatically increase production for small scale farmers.

89: "Studies suggest that ineffective farm operations such a late

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    planting, lack of proper land preparation, improper harvesting
    techniques and poor housing and feeding of livestock can reduce a
    smallholders farmers productivity by up to forty percent"
    \cite{DevEcon}.

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entries in general should not be empty in bibtex


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Tip: newlines can often be replaced just by an empty line

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Big Data Analysis for Computer Network Defense

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Smith Research Center
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ABSTRACT

Computer security threats and attacks are constantly evolving. Everyday, hackers are creating new techniques to bypass network security for the purpose of malicious attacks. To keep up with the changing intrusion technologies, the technologies that defend these attacks need to constantly evolve also. Modern day technologies use deep learning techniques to monitor network activity, and detect malicious code. We will provide an overview of network security and modern technologies being used to protect computer systems and networks.

KEYWORDS

i523,HID336, Computer Network Security, Big Data Analysis, Deep Learning, Intrusion Detection Systems,

1 INTRODUCTION

Everyday a different computer network is being breached with the intent to cause harm to the system or to steal valuable data. Computer hackers are constantly creating new ways to evade network security and create malicious code that can not be detected by security systems. As malicious technologies continue to advance, the technologies that defend against these technologies need to adapt with these advances. The problem with computer network defence is that the technologies used to breach systems constantly change. Once a solution is created to defend a technology, a new malicious technology could be created the next day. Today many security specialist are using deep learning technologies to monitor network intrusions, and detect malicious code. In order to better understand computer network defense, an overview of modern attacks, network data collection processes, and the technologies used to analyze network data is provided.

2 DATA COLLECTION

2.1 Network Intrusion Data Collection

2.2 Malware Data Collection

3 DEEP LEARNING FOR NETWORK INTRUSIONS

4 DEEP LEARNING ON MALWARE

5 CONCLUSION

ACKNOWLEDGMENTS

The authors would like to thank Dr. Gregor von Laszewski for his support and suggestions to write this paper.

REFERENCES

We include an appendix with common issues that we see when students submit papers. One particular important issue is not to use the underscore in bibtex labels. Sharelatex allows this, but the proceedings script we have does not allow this.

When you submit the paper you need to address each of the items in the issues.tex file and verify that you have done them. Please do this only at the end once you have finished writing the paper. To d this cange TODO with DONE. However if you check something on with DONE, but we find you actually have not executed it correcty, you will receive point deductions. Thus it is important to do this correctly and not just 5 minutes before the deadline. It is better to do a late submission than doing the check in haste.

A ISSUES

DONE:

Example of done item: Once you fix an item, change TODO to DONE

A.1 Assignment Submission Issues

Do not make changes to your paper during grading, when your repository should be frozen.

A.2 Uncaught Bibliography Errors

Missing bibliography file generated by JabRef

Bibtex labels cannot have any spaces, _ or & in it

Citations in text showing as [?]: this means either your report.bib is not up-to-date or there is a spelling error in the label of the item you want to cite, either in report.bib or in report.tex

A.3 Formatting

Incorrect number of keywords or HID and i523 not included in the keywords

Other formatting issues

A.4 Writing Errors

Errors in title, e.g. capitalization

Spelling errors

Are you using *a* and *the* properly?

Do not use phrases such as *shown in the Figure below.* Instead, use *as shown in Figure 3*, when referring to the 3rd figure

Do not use the word *I* instead use *we* even if you are the sole author

Do not use the phrase *In this paper/report we show* instead use *We show.* It is not important if this is a paper or a report and does not need to be mentioned

If you want to say *and* do not use *&* but use the word *and*

Use a space after . , :

When using a section command, the section title is not written in all-caps as format does this for you

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A.5 Citation Issues and Plagiarism

It is your responsibility to make sure no plagiarism occurs. The instructions and resources were given in the class

Claims made without citations provided

Need to paraphrase long quotations (whole sentences or longer)

Need to quote directly cited material

A.6 Character Errors

Erroneous use of quotation marks, i.e. use “quotes” , instead of ” ”

To emphasize a word, use *emphasize* and not “quote”

When using the characters & # % _ put a backslash before them so that they show up correctly

Pasting and copying from the Web often results in non-ASCII characters to be used in your text, please remove them and replace accordingly. This is the case for quotes, dashes and all the other special characters.

If you see a ffigure and not a figure in text you copied from a text that has the fi combined as a single character

A.7 Structural Issues

Acknowledgement section missing

Incorrect README file

In case of a class and if you do a multi-author paper, you need to add an appendix describing who did what in the paper

The paper has less than 2 pages of text, i.e. excluding images, tables and figures

The paper has more than 6 pages of text, i.e. excluding images, tables and figures

Do not artificially inffate your paper if you are below the page limit

A.8 Details about the Figures and Tables

Capitalization errors in referring to captions, e.g. Figure 1, Table 2

Do use *label* and *ref* to automatically create figure numbers

Wrong placement of figure caption. They should be on the bottom of the figure

Wrong placement of table caption. They should be on the top of the table

Images submitted incorrectly. They should be in native format, e.g. .graffle, .pptx, .png, .jpg

Do not submit eps images. Instead, convert them to PDF

The image files must be in a single directory named ”images”

In case there is a powerpoint in the submission, the image must be exported as PDF

Make the figures large enough so we can read the details. If needed make the figure over two columns

Do not worry about the figure placement if they are at a different location than you think. Figures are allowed to ffoat. For this class, you should place all figures at the end of the report.

In case you copied a figure from another paper you need to ask for copyright permission. In case of a class paper, you must include a reference to the original in the caption

Remove any figure that is not referred to explicitly in the text (As shown in Figure ..)

Do not use textwidth as a parameter for includegraphics

Figures should be reasonably sized and often you just need to add columnwidth

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Compliance Report
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name: Jordan Simmons
hid:  336
paper1: Oct 25 17
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paper2: In Progress

yamlcheck
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wordcount
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2
wc 336 paper2 2 457 report.tex
wc 336 paper2 2 1097 report.pdf
wc 336 paper2 2 50 report.bib

find "
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passed: True

find footnote
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find input{format/i523}
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4: \input{format/i523}

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floats
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figures 0
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labels 0
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True : ref check passed: (refs >= figures + tables)
True : label check passed: (refs >= figures + tables)
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Label/ref check
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When using figures use columnwidth
[width=1.0\columnwidth]
do not cahnge the number to a smaller fraction


find textwidth
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bibtex
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label errors


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This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
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I found no \citation commands---while reading file report.aux
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(There was 1 error message)

bibtex_empty_fields
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entries in general should not be empty in bibtex


find ""
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Tip: newlines can often be replaced just by an empty line

find newline
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passed: True
cites should have a space before \cite{} but not before the {

find cite {
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passed: True
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Big Data Analytics and IoT Smart Refridgerators

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ABSTRACT

The intent of this paper is to explore the rapid growth of IoT Smart Appliances, specifically with regard to refrigerators. As more devices are connected to the internet, to each other, and become readily available to consumers, there are many exciting new possibilities that offer both convenience and to make our lives more efficient. The scope of this paper will begin with a brief history of IoT, then move on to describe the current way in which this technology is being applied, and conclude with exploration and outlook on future development possibilities as well as potential risks.

KEYWORDS

i523, HID316, Big Data, IoT, Refrigerators, Smart Appliances, M2M, Samsung, Innit, Instacart, GrubHub

1 INTRODUCTION

The advent of the Internet of Things (IoT) began at the close of the last millennium when the world began connecting ordinary devices - electronics other than traditional computers - to the internet. With virtually unlimited possibilities, the unthinkable became reality when the concept of putting a wireless network card in a refrigerator went mainstream. Initial features were as simple as a large touchscreen with the news, the weather, and a doodle board.

From there, IoT Smart Refrigerators have evolved to become equipped with cameras, cooking recommendations, and even rudimentary food inventory and spoilage management systems. Now that food delivery services such as Instacart and GrubHub have become popular, there are already plans to integrate these services with smart refrigerators. As IoT has continued to expand throughout the marketplace and the concept of machine-to-machine (M2M) IoT has taken hold, there are now even more possibilities, which means a bright future in the kitchen no matter if you're an aspiring chef, a person trying to efficiently manage a family, or someone with specific health needs. However, along with the rapid advance of new features, there are also significant threats and blind spots with security.

2 EARLY HISTORY OF IOT AND NETWORKED APPLIANCES

Although the internet didn't yet exist in the minds of Hollywood producers in 1985, the opening scene from Back to the Future begins with a room full of ticking clocks, one of which is an alarm clock that rings and sets off a Rube Goldberg machine that has been configured by Doc Brown to automate the preparation of his breakfast. It's not unreasonable to believe that, in his many time travel escapades, Doc would've eventually *discovered* the internet and would've upgraded this rudimentary appliance.

That reality wouldn't come until five years later in 1990 when the first IoT device, a toaster, was turned off and on via the internet. At the October 1989 INTEROP Conference, John Ramkey used a Sunbeam Radiant Control toaster connected to a TCP/IP network to demonstrate that the device could be turned off and on[11]. Not only did Ramkey succeed at turning the toaster on and off, he used SNMP code delivered via his computer's parallel port to a larger relay to control power to the toaster. The SNMP code executed commands for a value, 1 through 10, for the toast's doneness as well as a calculation for the type of item being toasted. For example, while the command for wheat bread would tell the toaster to toast at a level of 2, the command for a frozen bagel would tell the toaster to toast at a level of 5. Additional innovations were later added, such as a Lego robotic arm to insert the bread into the toaster; a sight Doc Brown would've been proud to see.

By 1999, the Salt Lake City Tribune/Deseret News was predicting that household appliances like the refrigerator were going to be part of a future in which "everyone lived like the Jetsons" [12]. "The networked home is on the horizon", the Tribune/Deseret News' Michael Stroh wrote, "with a click, you call up your refrigerator on your office PC to see what's inside (a bar-code reader within the fridge keeps a running inventory). The refrigerator suggests lasagna but warns that you'll need to buy ricotta - and a few other items" [12]. Not surprisingly, it would be at least another decade before this concept became a viable reality.

3 IOT IS BORN

The first time the term *Internet of Things* was used wasn't until nine years later by Kevin Ashton, co-founder of the Auto-ID Center at the Massachusetts Institute of Technology (MIT). The Auto-ID Center was founded with the expressed purpose of creating a formal standard for Radio Frequency Identification (RFID) and other types of networked sensors. In 2009, Kevin wrote[5]: "I could be wrong, but I'm fairly sure the phrase *Internet of Things* started life as the title of a presentation I made at Procter & Gamble (P&G) in 1999. Linking the new idea of RFID in P&G's supply chain to the then-red-hot topic of the Internet was more than just a good way to get executive attention. It summed up an important insight which is still often misunderstood."

Even though Kevin briefly captured the momentary attention of the C-Suite at P&G, it wasn't another full decade until the true concept of IoT caught on in the marketplace. In 2011, the market research company Gartner, included IoT on their hype cycle chart for the very first time. By 2016, IoT was past-peak of inflated expectations was doing the usual nosedive into the trough of disillusionment[7].

[Figure 1 about here.]

4 IOT SMART REFRIGERATORS COME OF AGE

Internet refrigerators, on the other hand were a bit slower catching up. After many failed attempts in the mid-2000s at various gimmicky models, it seemed that the once rosy future painted by Mr. Stroh a decade earlier was simply not going to come to fruition. Hardware and network technology had not yet caught up. By 2014, murmurs of a new wave of internet fridges hit the marketplace and excitement began to build, and by 2016, the IoT Refrigerator was ready for primetime. On January 24, 2016, Samsung launched its Smart Hub Refrigerator complete with a massive 21.5 inch 1080P touchscreen and Android operating system. Another exciting new feature of the Smart Hub fridge was the interior cameras that allowed users to get a real-time look at the contents of their fridge from anywhere[9].

A year later, Samsung debuted version 2.0 of the Smart Hub fridge, this time with improvements such as third-party apps such as Spotify and individualized user profiles for family members. Users are also able to serve photos and other content to the screen as well. Interestingly, Samsung has opted to go with the its own proprietary voice control system called S-Voice, while its only current competitor in the IoT fridge marketplace, LG, will integrate with Amazon's Alexa. Only in Europe, with the LidL supermarket chain, will consumers be able to order groceries through the the fridge. It's a start, but there is much, much more on the horizon[8].

5 THE FUTURE OF IOT SMART REFRIGERATORS

The future of IoT Smart Refrigerators - and kitchen appliances working in concert in general - is brighter than perhaps Doc Brown or even John Ramkey could have ever imagined. Hardware, networking, and most importantly, software, have all caught up to be viable in fulfilling consumer demands and there are fresh new ideas already just beginning to hit the marketplace. The next phase of the IoT Smart Refrigerator will be one that is marked by progress in software. Structurally speaking, refrigerators are designed to last between 14-17 years[2], however, the average consumer might upgrade their personal computer 3 to 4 times during this time span. In other words, an IoT Smart Refrigerator made today, might only be 1/4 to 1/3 of the way through its average lifespan before its computer and networking components become obsolete.

One Silicon Valley company that seems to have a viable solution to this problem is Innit[4]. Innit has come up with the idea of having a cloud-based platform for the kitchen that partners with appliance manufacturers such as Jenn Air and Whirlpool to add their components and integrate their application with existing appliance platforms. The idea is that you can equip your entire kitchen, not just the refrigerator, with technology that can make anyone a culinary master with a bit of guidance[10]. Building upon Samsung's successful Smart Hub fridge platform, Innit takes the camera-in-your-fridge concept a step further by introducing image recognition software that can be used to interface with the cloud to generate recipes based on available ingredients, manage spoilage, and inventory - including placing orders for new food. The technology would also enable other kitchen appliances such as an oven or microwave to interact with one another to create a meal.

Aside from personal convenience, one of the most significant values derived from the advance of this sort of technology is that it could prevent an enormous amount of food waste. The United Nations' Food and Agriculture Organization estimates that up to 1.3 billion tons of food are wasted globally every year[3], which equates to roughly 30 percent of all food produced in the same time-frame. Ultimately, software like Innit's because it is connected to the cloud and utilizing big data to allow consumers to make informed decisions about what they eat, people will live and eat healthier and greener.

6 SMART AND DANGEROUS: AN IOT DOUBLE-EDGED SWORD

Yes - it is true - both today and in the future, your IoT Smart Refrigerator will help you live better, but as Swapnil Bhartiya points out in a recent article on InfoWorld[6], it could also kill you. It sounds ominous, but the rapid growth of IoT comes with a steep price: lack of security. Consumers can never really be sure if their software will be patched properly and for how long. It has been well-documented that hackers have been able to successfully commandeer smart devices and utilize them to aggressively launch DDoS that disabled a sizeable portion of the internet. An even bigger threat is that, once compromised, a vulnerable smart device will work as a Trojan Horse allowing nefarious users to access other devices on your local network. Once you throw Alexa into the mix, all bets are off.

One development that is offsetting this risk is the unification of IoT networks in the cloud. Samsung is now creating a SmartThings cloud in which all of its IoT devices will interact. This centraliztion makes security and big data much easier to manage. This unification is also occurring at the macro level with Cisco and Google's cloud[1] which will hopes to achieve the following goals:

(1) Freedom to access any resource while preserving security and compliance
(2) Ability to extend policy to cloud environments to optimize applications
(3) Extend visibility, threat detection and control across hybrid environments without slowing innovation

7 CONCLUSION

IoT has a very bright future ahead and the rapidly evolving IoT Smart Refrigerator will serve as the centerpiece not only to a smart, connected kitchen, but to a smart, connected, and secure home. While it was hardware and networking that delayed progress in the 1990s and software and implementation that led to stagnation in the 2000s, security serves as the next challenge to be overcome as IoT Smart Refrigerators join the burgeoning global network of IoT smart devices.

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List of Figures

1 2016 Gartner Hype-Cycle Chart. 5

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Figure 1: 2016 Gartner Hype-Cycle Chart.

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The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
Database file #1: report.bib
Warning--no key, author in SFGate2017
Warning--no author, editor, organization, or key in SFGate2017
Warning--to sort, need author or key in SFGate2017
Warning--no key, author in Innit2017
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latex report
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This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
bookmark level for unknown  defaults to 0.
The anchor of a bookmark and its parent's must not be the same. Added a new anchor.
Typesetting of "report.tex" completed in 0.8s.

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Compliance Report
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hid:  316
paper1: 100% Oct 25 17
paper2: 99%
project: 10%

yamlcheck
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wordcount
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wc 316 paper2 5 1898 report.tex
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wc 316 paper2 5 408 report.bib

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passed: True
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find footnote
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passed: True

find input{format/i523}
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4: \input{format/i523}

passed: True

floats
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52: \begin{figure}
54: %\includegraphics[width=\linewidth]{gartner2016.png}
56: \label{fig:Gartner2016}

figures 1
tables 0
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labels 1
refs 0
floats 1

True : ref check passed: (refs >= figures + tables)
True : label check passed: (refs >= figures + tables)
True : include graphics passed: (figures >= includegraphics)
False : check if all figures are refered to: (refs >= labels)

Label/ref check
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When using figures use columnwidth
[width=1.0\columnwidth]
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label errors


bibtex errors

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The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
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Warning--no number and no volume in Ashton01
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entries in general should not be empty in bibtex


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Tip: newlines can often be replaced just by an empty line

find newline
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passed: True
cites should have a space before \cite{} but not before the {

find cite {
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passed: True
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Big Data Applications in Virtual Assistants

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3209 E 10 St
Bloomington, IN 47408
jervwang@indiana.edu

ABSTRACT

This paper provides

KEYWORDS

i523, HID233, Big data, Virtual Assistants, Artificial intelligence

1 INTRODUCTION

Put here an introduction about your topic. "We just need one sample refernce so the paper compiles in LaTeX so we put it here" [11] [13] [3] [5] [8] [12] [7] [6] [10] [2] [9] [4] [1].

2 FIGURES

3 LONG EXAMPLE

4 CONCLUSION

Put here an conclusion. Conclusions and abstracts must not have any citations in the section.

ACKNOWLEDGMENTS

The author would like to thank Dr. Gregor von Laszewski for his support and suggestions to write this paper.

REFERENCES

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We include an appendix with common issues that we see when students submit papers.

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paper2: Nov 10 17 50%
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True : label check passed: (refs >= figures + tables)
True : include graphics passed: (figures >= includegraphics)
True : check if all figures are refered to: (refs >= labels)

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Tip: newlines can often be replaced just by an empty line

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find cite {
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Hadoop and MongoDB in support of Big Data Applications and Analytics

Sushant Athaley
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ABSTRACT

Big data processing is beyond the capability of traditional tools. It requires specialized tools to handle the volume, velocity, and variety of big data. We explore Haddop and MongoDB technically as a tool and how they provide support/help in big data analytics.

KEYWORDS

i523, hid302, big data, Hadoop, MongoDB, HDFS, MapReduce

1 INTRODUCTION

The emergence of big data challenges also gave rise to the various technologies which can be used to solve big data problem. Typically to solve big data, we need to consider two types of technologies, data capture and storage, and data analysis. We evaluate capabilities of two popular technologies Hadoop and MongoDB to understand their features and power to solve big data problem. We get started with the section *Big Data* which captures big data definition and characteristics. Section *Hadoop* provides an introduction to the technology and subsections *Hadoop Common, HDFS, YARN, MapReduce* explores technology in detail. Section *Big Data Support* captures how Hadoop supports big data analytics along with the real-life examples. We then explore MongoDB through section *MongoDB* which further drill down to the technology using sections *Architecture, Data Model, Data Management, Data Visualization, and Security*. Section *Big Data Support* captures how MongoDB supports big data analytics along with the real-life examples. Section *Power of Two* captures how both technologies can be used together to solve big problems. Section *Conclusion* concludes the study.

2 BIG DATA

Big Data is defined in lot many different ways but one of the interesting ways it has been defined is in terms of three V's which are Volume, Velocity, and Variety. Big data is generated in great *volume* typically in the gigabyte or more which makes data processing difficult. Data *velocity* has been increased due to the real-time data streaming from various applications like social media or different type of sensors recording data continuously. Big data comes in *variety* of format like structured or unstructured data. Data varies in various format like text, pictures, audio, videos, 3D, social media and so on. These big data characteristics pose challenges in terms of overall data lifecycle management. Some of the examples of big data usage are the recommendation service, predictive analytics, data analytics, pattern identification, and machine learning. Traditional systems are good for small or medium data processing but unable to provide support for the big data. Big data need specialized technologies and tools to handle its characteristics. The technologies which can solve big data problem should have capabilities like distributed computing system, massively parallel processing, NoSQL, and analytical database [1, Ch. 1, p. 4]. Can Hadoop or MongoDB be those technologies who can provide that support?

3 HADOOP

Apache foundation describes Hadoop as "The Apache Hadoop software library is a framework that allows for the distributed processing of large data sets across clusters of computers using simple programming models. It is designed to scale up from single servers to thousands of machines, each offering local computation and storage. Rather than rely on hardware to deliver high-availability, the library itself is designed to detect and handle failures at the application layer, so delivering a highly-available service on top of a cluster of computers, each of which may be prone to failures" [2]. In other words, Hadoop provides a framework to store data in the distributed manner and provides the capability to run data analysis in the distributed way.

"Currently Hadoop project includes following modules:

- **Hadoop Common**: The common utilities that support the other Hadoop modules.
- **Hadoop Distributed File System (HDFS)**: A distributed file system that provides high-throughput access to application data.
- **Hadoop YARN**: A framework for job scheduling and cluster resource management.
- **Hadoop MapReduce**: A YARN-based system for parallel processing of large data sets" [2].

3.1 Hadoop Common

Hadoop Common is the collection of the utilities to support the Hadoop modules. This is the core package which provides essential and basic service of the framework.

3.2 Hadoop Distributed File System (HDFS)

Hadoop Distributed File System (HDFS) is the default distributed file system provided by the Hadoop. HDFS serves as storage mechanism in the Hadoop framework. HDFC specifically designed to process large data set and run on low-cost hardware. It is highly fault-tolerant which contains the mechanism for quick fault detection and auto recovery. HDFS is designed to port across heterogeneous hardware and software platform. It does data computation on the same node instead of moving data to the server which is faster as well as avoid network congestion. It provides scalability by adding or removing nodes in the HDFS cluster and can support hundreds of nodes in single cluster [4]. Figure 1 shows HDFS architecture.

[Figure 1 about here.]

HDFS is based on master/slave architecture where NameNode is the master server and DataNodes are the slave nodes. There can be only one NameNode server which manages file system namespace and all read-write requests. NameNode doesn't store any data but contains all the meta-data about files and DataNodes. DataNode contains actual data and they can be multiple in numbers usually one per node. DataNodes are responsible for the create, delete, replicate of the data blocks on the node as per the instruction by the NameNode. DataNode also sends block-report to NameNode which has a list of all blocks on the DataNode. DataNode sends the heartbeat message to NameNode which helps in identifying the failure nodes. If the heartbeat is not received by NameNode in specified interval then that DataNode is marked as dead and NameNode usage different DataNode. Figure 2 and 3 depicts read and write in HDFS respectively.

[Figure 2 about here.]

[Figure 3 about here.]

3.3 Hadoop YARN

Hadoop YARN (Yet Another Resource Negotiator) provides cluster resource management which helps in running multiple distributed application in Hadoop. YARN consists of 3 components *ResourceManager (RM), NodeManager (NM)* and *ApplicationMaster (AM)*. ResourceManager is the master process which manages resources across the nodes. NodeManager is responsible for the container and provides resource usage to the ResourceManager. ApplicationMaster is responsible for getting resources from ResourceManager and work with NodeManager to execute the task [3]. YARN makes it possible to run different applications on Hadoop platform which makes it scalable and integrable [1, Ch. 3, p. 65]. Figure 4 shows YARN architecture.

[Figure 4 about here.]

3.4 Hadoop MapReduce

Hadoop MapReduce is a framework which provides the capability to process the vast amount of data in a distributed manner. Processing is done in parallel on various nodes utilizing local machine processor and memory which results in high computation power. The framework provides fault tolerance along with supporting large clusters usually thousands of nodes. Typical framework processing is to split input data into independent chunks and then processed by *map* tasks in parallel. Sort the output of the map task and then provide that as input to *reduce* task for aggregate processing. Two important class in this framework are org.apache.hadoop.mapreduce.Mapper and org.apache.hadoop.mapreduce.Reducer. They respectively provide map and reduce method to process the data.

Figure 5 shows MapReduce process using wordcount example. Each line in the input file is passed to individual mapper class. Mapper class parses the line and sets count for the word. Sort and shuffle consolidate the data and sends it to the reducer. Reducer performs the final word count and provides the output.

[Figure 5 about here.]

3.5 Big Data Support

Big data problem solution requires tools which can process the huge amount of data with high computation power. Hadoop provides this capability by processing data in the distributed environment in big clusters using MapReduce and also provides distributed storage system as HDFS. HDFS can be configured in a cluster of hundreds of nodes and can typically store the file in size of gigabytes or terabytes [4]. Using CPU and memory of local nodes delivers great computation power. Hadoop also provides high tolerance to the faults and scalability by adding nodes and integration with various technologies. Being open source and configurable on commodity hardware, Hadoop is cost effective and can be used by small industries as well for their big data solution. Hadoop's capability to process large-scale data in parallel within distributed environment makes it one of the best tool for Big Data processing. Hadoop is supported by various sub-projects which together forms Hadoop Ecosystem. Different applications can be integrated with Hadoop depending on the big data problem need to be solved. Figure 6 illustrates Hadoop ecosystem by various layers.

[Figure 6 about here.]

Yahoo has one of the biggest Hadoop clusters. It has more than 100,000 CPUs in 40,000 computers running Hadoop. Their biggest cluster is of 4500 nodes. Yahoo is using Hadoop in research of Ad systems and web search and also used to do scaling tests to support the development of Apache Hadoop on larger clusters [5].

Facebook uses Apache Hadoop to store copies of internal log and dimension data sources and use it as a source for reporting/analytics and machine learning. They have 2 major Hadoop cluster, a 1100-machine cluster with 8800 cores and about 12 PB raw storage and a 300-machine cluster with 2400 cores and about 3 PB raw storage. Each node has 8 cores and 12 TB of storage [5].

Ebay has 532 nodes Hadoop cluster. They are heavy user of Mapreduce, Apache Pig, Apachae Hive and Apache Hbase. They are using Hadoop for search optimization and research [5].

4 MONGODB

The rise of Big Data started posing challenges on how data can be stored and processed. The inability of the traditional relational database to scale to big data volume and variety gave rose to the NoSQL databases. Based on the concept of one size doesn't fit all, NoSQL implementation comes in 4 different flavors, namely Column/Column Family, document, key-value and graph. MongoDB is one of the popular implementation of the document type NoSQL [6].

4.1 Architecture

MongoDB architecture blends best of relational and NoSQL technologies. It is enriched from relational database learning and incorporated new NoSQL features. Figure 7 shows MongoDB architectural consideration.

[Figure 7 about here.]

MongoDB provides powerful query language, indexing capability, strong read-write consistency, the capability to integrate with other technologies which they borrowed from the relational database. It

also implemented NoSQL features like flexible data model (schema-less), scalability by sharding or partitioning, and provides high availability by running across the nodes and replication mechanism. MongoDB also provides a multi-model architecture which supports four different storage engines and flexibility to mix and match those storage engines to store data in single MongoDB deployment [7].

4.2 Data Model

MongoDB stores data as BSON (Binary JSON) document object which is an extension of JSON and includes additional data type such as int, long, date, floating point, and decimal128. Documents are stored in the collection which is similar to row and table in relational database. The document can vary in structure and usually contains entire object details in the same document. This provides desired structure flexibility in terms of storing data which is not present in the relational database. The document can miss some fields and can be added to the document at any given point time without impacting other documents. Unlike other NoSQL databases, MongoDB provides data validation at the database level. Checks can be enforced at the database level to validate document structure, data types, data ranges and mandatory values [7].

4.3 Data Management

MongoDB has the capability of horizontal scaling which is referred as Auto-Sharding. In case of data increase, MongoDB distributes data across multiple physical partitions called shards automatically without impacting the application.

MongoDB is ACID compliant at the document level, the entire document is updated in one transaction or error is thrown.

MongoDB maintains multiple copies of data replica using native replication method. In case of failure, primary replica takes over giving high availability. This is done without impacting the application and is fully automated.

Ops Manager gives developers, administrators and operations teams monitoring capabilities into the MongoDB service. Featuring charts, custom dashboards, and automated alerting, Ops Manager tracks 100+ key database and systems health metrics including operations counters, memory and CPU utilization, replication status, open connections, queues and any node status.

Disaster recovery is provided using backup and restore mechanism. Backups are taken just a few seconds behind the operational system [7].

4.4 Data Visualization

MongoDB provides visualization capabilities in MongoDB Enterprise Advanced version using MongoDB Connector for BI. The tool provides the capability to analyze unstructured MongoDB data along with structured SQL database data [7].

4.5 Security

Security is a growing concern and MongoDB addresses it by providing extensive security features in MongoDB Enterprise Advanced. *Authentication* provides integration with external security mechanism like LDAP, Windows Active Directory, Kerberos etc. *Authorization* can be provided using the user-defined role to access the data also certain data can be masked by using a view. *Audit* capability provides tracking of any command executed on the database. *Encryption* can be used to encrypt the data on the disk, on the network or in backup [7].

4.6 Big Data Support

MongoDB is a perfect fit for solving big data problem in terms of database storage. It is capable of handling big data volume and velocity using sharding which scales horizontally. It handles big data variety by providing schema-less data storage. Structured or unstructured, any type of data can be stored in MongoDB. It provides cost benefit as it can be installed on low-cost hardware as well as by cutting down on the development time of the application. "Analytics and data visualization, text search, graph processing, geospatial, in-memory performance and global replication allow to deliver a wide variety of real-time applications on one technology, reliably and securely" [7].

The City of Chicago uses MongoDB to create smarter and safer city. In just four months, data from Chicago's 15 most crucial department is integrated into MongoDB which provides real-time data analysis to make better decisions. Dashboard created gives querying capability on various department data simultaneously along with twitter data for sentiment analysis [8].

MongoDB helped online retailer OTTO to improve catalog update time. OTTO now can update catalog within 15 minutes which was earlier could take 12 hours. It helps OTTO to provide a personalized experience to their customer [9].

Expedia built scratchpad app using MongoDB to personalize and help their customer by providing previous searches. It saves users all previous travel searches so that users can refer those before finalizing the travel. MongoDB's flexible data structure and ease of development was the selling point for Expedia to use it as database store [10].

5 POWER OF TWO

Big data solution requires two types of technology to solve the problem, operational where real-time data is captured and stored, and analytical where this data is used for complex analysis. Frequently both of the technologies are deployed together to solve big data problem. MongoDB and Hadoop are the great choices for operational and analytical technology respectively. MongoDB can be used to store structured/unstructured data and then Hadoop MapReduce can be used to process this data for the analytics. Together they provide the complete and cost-effective solution to the big data problems [11].

6 CONCLUSION

Hadoop and MongoDB are the front-runner technologies to solve big data problems. The features provided by both technologies are extremely suitable to solve big data problem which requires handling of huge data and great computing power. Distributed nature of both technologies helps data to break across multiple nodes and distributed processing helps process data in parallel. Cost-effective implementation enables to accept these technologies industry-wide. There are a lot of other technologies emerging in the market but Hadoop and MongoDB will be favorite for some time to come.

ACKNOWLEDGMENTS

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Figure 1: HDFS Architecture [4]

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Figure 2: HDFS Read [1, Ch. 3, p. 38]

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Figure 4: YARN Architecture [3]

Figure 5: MapReduce Example [1, Ch. 3, p. 48]

Figure 6: Hadoop Ecosystem [1, Ch. 2, p. 26]

Figure 7: MongoDB Architecture [7]

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    master server and DataNodes are the slave nodes. There can be only
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    list of all blocks on the DataNode. DataNode sends the heartbeat
    message to NameNode which helps in identifying the failure nodes.
    If the heartbeat is not received by NameNode in specified interval
    then that DataNode is marked as dead and NameNode usage different
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80: Figure \ref{f:mapreduceex} shows MapReduce process using wordcount
    example. Each line in the input file is passed to individual
    mapper class. Mapper class parses the line and sets count for the
    word. Sort and shuffle consolidate the data and sends it to the
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Why Deep Learning matters in IoT Data Analytics?

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ABSTRACT

The Deep Learning is unique in all machine learning algorithms to analyze supervised and unsupervised datasets. Big Data challenges, such as high volumes, multi-dimensionality and feature engineering, are well addressed using Deep Learning algorithms. Deep Leaning, with edge and distributed mesh computing, is best suited to handle IoT Analytics from millions of sensors producing petabytes of time-series data.

KEYWORDS

i523, hid306, IoT, Deep Learning, Big Data Analytics

1 INTRODUCTION

Supervised machine learning algorithms: decision trees, linear regression, support vector machines (SVMs), Naive Bayes, neural networks, etc. are popular for classification and regression problems by analyzing labeled training data. K-means clustering algorithms are good for unsupervised datasets to categorize based on the identified patterns in unlabeled data. While there are so many factors - nature of the domain, sample size of the dataset and number of attributes defining characteristics of the data - decide which machine learning algorithm works better, Deep Learning algorithms are, getting greater traction, addressing complex analytics tasks including high-dimensionality and automatic creation of new features from existing complex hierarchical features, very well.

2 NEURAL NETWORKS

Neural Network is modeled after the human brain, specifically the way it solves complex problems. *Perceptron*, the first generation neural network, created a simple mathematical model or a function, mimicking neuron - the basic unit of the brain, by taking several binary inputs and produced single binary output. *Sigmoid Neuron* improved learning by giving some *weightage* to the input based on importance of the corresponding input to the output so that tiny changes in the output due to the minor adjustments in the input weights (or biases) can be measured effectively. Neural Network is, a *directed graph*, organized by layers and layers are created by number of interconnected neurons (or nodes). Every neuron in a layer is connected with all the neurons from the previous layer; there will be no interaction of neurons within a layer. As shown in Figure (1), a typical Neural Network contains three layers: input (left), hidden (middle) and output (right) [3]. The middle layer is called *hidden* only because the neurons of this layer are neither the input nor the output. However, the actual processing happens in the hidden layer as the data passes through layer by layer, each neuron acts as an *activation function* to process the input. The performance of a Neural Network is measured using *cost or error function* and the dependent input *weight* variables. *Forward-propagation* and *back-propagation* are two techniques, neural network uses repeatedly until all the input variables are adjusted or calibrated to predict accurate output. During, forward-propagation, information moves in forward direction and passes through all the layers by applying certain weights to the input parameters. *Back-propagation* method minimizes the error in the *weights* by applying an algorithm called *gradient descent* at each iteration step.

[Figure 1 about here.]

3 DEEP LEARNING

Deep Learning is an advanced neural network, with multiple hidden layers (thousands or even more deep), that can work well with supervised (labeled) and unsupervised (unlabeled) datasets. Applications, such as speech, image and behavior patterns, having complex relationships in large-set of attributes, are best suited for Deep Learning Neural Networks. Deep Learning vectorizes the input and converts it into output vector space by decomposing complex geometric and polynomial equations into a series of simple transformations. These transformations go through neuron activation functions at each layer parameterized by input weights. For it to be effective, the cost function of the neural network must guarantee two mathematical properties: *continuity* and *differentiability*.

[Figure 2 about here.]

3.1 Feature Engineering

The dataset with too many dimensions, also known as attributes or features, create large sparsity and make it difficult to process. *Curse of dimensionality* is a scenario where the value added by the dimensions is much smaller in comparison to the processing cost. However, in certain applications, such as face recognition and patient electronic medical records, the complexity created by multiple dimensions might add value to the context. *Feature Engineering* is an exploratory analysis to identify the features that collectively contribute to better predictive modeling by removing irrelevant features and creating new features, using the training information to identify the patterns, from existing interrelated features [6]. *Principal component analysis* (PCA) is a technique to analyze the interdependency among the features and keep only the principal, most relevant, features with minimum loss in the model. With enough training, Deep Learning makes neurons learn new features themselves, in an unsupervised manner, from existing features distributed in several hidden layers. *Stacked Autoencoder* (AE) is, a Deep Belief Network algorithm, to create advanced predictive models for large datasets having thousands or even millions

of dimensions, automatically, with complex hierarchical attributes in non-linear fashion for simpler computing. Though AE is sophisticated, it is very difficult to understand the algorithm logic and so unable to reuse the learnings from the modeling to other systems.

3.2 Deep Neural Networks

Convolutional Neural Network (CNN), also called multilayer perceptron (MLP), is a deep feedforward network, consists of (1) convolutional layers - to identify the features using weights and biases, followed by (2) fully connected layers - where each neuron is connected from all the neurons of previous layers - to provide non-linearity, sub-sampling or max-pooling, performance and control data overfitting [2]. CNN is used in image and voice recognition applications by effectively using multiples copies of same neuron and reusing group of neurons in several places to make them *modular*. CNNs are constrained by *fixed-size* vectorized inputs and outputs. *Recursive Neural Network* (RNN) is, another type of Deep Learning, that uses same shared feature weights recursively for processing sequential data, emitted by sensors or the way spoken words are processed in natural language processing (NLP), to produce arbitrary size input and output vectors. RNN uses a technique called *loop*, where several copies of the same chunk of network (module), each instance passing a message to the next, to persist the information. Long Short Term Memory (LSTM) is an advanced RNN to learn and remember *longer* sequences by composing series of repeated modules of neural network and a concept called *cell state*, a memory unit, to memorize the learning by adding and removing information using *input*, *output* and *forget* gates, in a regularized fashion while data flows through the layers [9]. The Convolutional and Recursive Neural Networks can complement each other to produce better and effective models where problem space has both - hierarchical features and temporal data. Deep Learning can also work well with related *Reinforcement Learning* algorithms where the focus is on how to maximize the learning based on rewards and punishments.

[Figure 3 about here.]

[Figure 4 about here.]

4 IOT DATA ANALYTICS

Internet of Things (IoT) is getting lots of traction, due to the massive volumes and variety of the sensor data, qualifying it to be part of *Big Data*; however, business needs to convert this data into *information* whether to monitor and control the things (devices) or to analyze the sensor data for betterment. Time-series data has non-stationary time aspects collected at certain intervals over a short period of time and correlate this sequence of data with past or future sequences. Stock prices and IoT sensor data are examples of time-series data. *InfluxDB*, an open source time-series database, is offering high write performance, data compaction through down-sampling and automatic deletion of expired old time-series data, to address IoT data storage challenges [5].

4.1 Complexity

Unique traits of IoT data, such as noise, high dimensionality and high streaming of time-series data in real-time, make it challenging to process using traditional machine learning algorithms [10]. Autoregressive Moving Average Model (ARIMA), converts time-series from non-stationary into stationary, but only for short-time predictions. Deep Learning, using LSTM, can detect anomalies in the sensor data and train time-series patterns very well. Deep Learning algorithms involve complex mathematics - geometry, matrix algebra, differential calculus, statistics and probability, and intensive distributed computing to train the massive amounts of sensor data.

4.2 Scalability

Deep Learning, by design, allows parallel programming, as each module - with all the dependencies among neurons - can run independently and parallelly from other modules within the network. Using Graphics Process Unit (GPU), module networks can achieve parallel programming without needing much of Central Processing Unit (CPU) allocation of a computer. Though GPU is intended for graphical processing, it works efficiently to run thousands of small mathematical functions, such as matrix multiplications, in parallel. Cloud computing and edge analytics offer flexible scale out distributed processing options using virtualization and containerization. Sophisticated algorithms and distributed computing make Deep Learning scale and perform well to process huge datasets.

4.3 Case Study

Hewlett Packard (HP) Labs has given a presentation of their research to measure the effectiveness Deep Learning algorithms on IoT Sensor Data Analytics. Sample data - vision, speech, text and sensor signals, has been collected from scripted video and the accelerometer from 52 subjects gathered 20 minutes of activity recognition per subject averaging 12,000 measurements per minute per person with 16 classifications, such as walk to bed, enter bed, lie down, roll left, roll right and speak. They have analyzed and trained the sample time-series data using various supervised learning algorithms including SVMs, decision trees and traditional neural networks; compared the results with recurrent, Deep Learning, neural network. Deep Learning showed 95% or more accuracy in various scenarios, performed much better than all the other algorithms, without sophisticated feature engineering. However, Deep Learning algorithms were predictively slow and expensive for results to converge as the sample dataset is huge with lots of instances (10^6-10^9) and very large number of features ($>10^6$). They have concluded the presentation with scale-out hardware options using CPU/GPU clusters, edge analytics and futuristic distributed mesh computing alternatives for better scalability and performance [11].

5 CONCLUSION

In contrast to traditional machine learning solutions, Deep Learning not only scales well with high volumes of input data but also facilitates in automatic decomposition of complex data representations of unsupervised and uncategorized data. Automatic discovery of new features, from convolutional or recurrent neural networks, makes Deep Learning predominant among all machine learning algorithms. It is very difficult to understand fuzzy and complex logic of Deep Learning; perhaps, more adoption helps getting better handle at them. Deep Learning algorithms need deep research in

validating the process of advanced Big Data Analytics tasks, such as IoT sensor time-series data, semantic learning, scalability, data tagging and reliability of the predictive models without extreme generalization.

ACKNOWLEDGMENTS

The author would like to thank Dr. Gregor von Laszewski and the Teaching Assistants for their support and valuable suggestions.

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Figure 2: Deep Neural Network with three hidden layers [3].

Figure 3: Sample Convolutional Neural Network [1].

Figure 4: Recursive Neural Network Loop and LSTM Cell State [7, 8].

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Tip: newlines can often be replaced just by an empty line

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Big Data Analytics and Insurance Fraud Detection

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ABSTRACT

This paper is to analysis how people using big data to detect Insurance Frad in real life.

KEYWORDS

i423, hid106, Data Science, Big Data Analytics, Cloud Computing,frad detection

1 INTRODUCTION

Digitization set apart by an increasing number social media and mobile devices is shifting the business landscape in every sector insurance included. The opportunity presented by this aspect for insurance companies are immense. Communities and social networks enable insurers to interface with their clients better, which to their advantage improves branding, customer retention, and acquisition [?]. Insurance companies additionally get a plenty of contributions from computerized data as feedbacks, which likewise can be utilized to develop unique products and aggressive valuing. Digitization of big data analytics offers numerous opportunities that Insurances Company can harness to detect fraud among their customers. Dealing with fraud manually has dependably been expensive for insurance firms regardless of the possibility that maybe a couple of minor fraud went undetected [?]. What's more, the trends in big data (the evolution in unstructured information) are prone to numerous fraud, which can go without notice is analysis is performed correctly. In the proceeding section, the article will examine important of big data in insurance fraud detection and its relevancy.

2 IMPORTANCE BIG DATA AND INSURANCE FRAUD DETECTION

Conventionally, insurance firms utilize statistical models to recognize fraudulent cases. These models have their limitation [?]. To start with, they employ sampling techniques to assess information, which prompts at least one fraud going unnoticed. There is a punishment for not performing a proper assessment of the data provided. Subsequently, this strategy depends on the cases analyzed before. Therefore, every time different fraud takes place, insurance firms need to manage the impact for the first time. Lastly, the conventional strategy works in silos and is not correctly equipped for taking care of the natural developing wellsprings of data from various diverts and diverse capacities in an integrated way. Analytics tends to be difficult and assumes an exceptionally pivotal part in fraudulent recognition for insurance firms. In the proceeding section, the significant benefits of utilizing big analytics in fraud detection assessed.

2.1 Identification of low incidence events:

Utilizing sampling methods accompanies its particular arrangement of acknowledged mistakes. By using analytics, insurance can manufacture frameworks that go through every fundamental datum. This like this distinguishes events with low frequency (0.001%) [?]. Methods such as predictive modeling can be utilized to altogether break down processes of fraud, channel clear cases, and allude low-rate fraud cases for facilitating analytics.

2.2 Enterprise-wide solution:

Analytics help in building a global point of view of the anti-fraud endeavors all through the undertaking. Such a point of view regularly prompts dominant fraud location by connecting related data inside the association. Fraud can happen at various source focuses premium, claims or surrender, application, employee-related or outsider fraud. In the meantime, insurance channel broadening is adding to the breakdown of identifiable information. Insurance-related exercises should be possible using cell phones separated from the conventional face-to-face and online Insurance [? ?]. This can be seen as an expansion to data storehouses in the Insurance business. Given more prominent channel enhancement and the development of ranges where fraud can happen, it is vital for insurers to have reachable enterprise-level data about their business and clients.

2.3 Data Integration:

Analytics assumes a vital part in incorporating information. Viable fraud recognition abilities can be worked by joining information from different sources. Analytics additionally help in integrating inside information with outsider information that may have predictive significance, for example, public records. Information sources with derogatory properties are on the whole public documents that can be incorporated into a model. Cases include liquidations, liens, criminal records, judgment, abandonment, or even deliver change speed to show transient conduct. Different sorts of outsider information can be useful in upgrading effectiveness, for example, audit evaluating data to decide whether harms coordinate portrayal or misfortune or injury being guaranteed [?]. A standout amongst the most under-used information sources is doctor's visit expense audit information. This information, if utilized as a part of a model legitimately, is a gold dig for organizations researching medical fraud. Revealing peculiarities, in charging and adding these to the next scoring motors or interpersonal organization analytics will diminish the measure of time an agent or expert spends endeavoring to pull the majority of the pieces together to recognize deceitful action.

2.4 Harnessing Unstructured Data:

Analytics is useful for getting the best incentive from unstructured information. Fraud can be delicate or hard. This depends on whether it comprises of a policyholder's misrepresented cases, or on the off chance that it contains of a policyholder arranging or creating a misfortune. At an abnormal state, fraud can happen amid commission discounting, because of false documentation, an arrangement between parties or from is offering [?]. Albeit bunches of organized data is put away in an information distribution center as a component of numerous applications, a significant portion of the vital data about a fraud is in unstructured information, for example, outsider reports, which are not assessed. In most insurance firms, data accessible in online networking is not suitably stored. An uncommon investigative-unit specialist will concur that unstructured information is vital for fraud examination. Since textual information is not straightforwardly utilized for reporting, it does not discover a place in most information stockrooms [?]. This is the place content examination can assume a crucial part in checking on this unstructured information and giving some valuable experiences in fraud discovery.

3 RELEVANCE OF BIG DATA IN INSURANCE FRAUD DETECTION

Big data analytics is a reality for the insurance company because of its capability to enhance various conventional technologies and be used to detect fraudulent acts. In the proceeding section, the relevance of big data and insurance fraud detection will be examined.

3.1 Text analysis

In numerous Insurance fraud recognition ventures, from 33% to one-portion of factors utilized as a part of the fraud location model originate from unstructured content data. This is particularly helpful for long-tail claims, for example, damage claims, because the best information frequently is found in claim notes [?] . Content mining is something beyond keyword sorting. Excellent content analytics apparatuses translate the importance of the words to establish context. Innovation that is adroit at preparing common dialect can help remove factors from the unstructured content that can be utilized for assist fraud modeling.

3.2 Data Management

Regardless of where your information is stored fi!? from legacy frameworks to the valid information stockpiling structure, Hadoop fi!? an information administration framework can enable insurers to make reusable information rules. They give a standard, repeatable strategy for enhancing and incorporating information [?]. Preferably, you need a framework that interfaces with different information sources. It ought to have streamlined information league, relocation, synchronization, organization, and visual assessment.

3.3 Event Stream Processing

This enables insurers to investigate and processes in movement (i.e., process streams). Rather than putting away information and running questions against data, you store the inquiries and stream the data through them [?]. This is foundational to both ongoing fraud identification (invigorating fraud scoring) and successful utilization of great high-speed information sources similar to vehicle telematics.

3.4 Hadoop

A free programming structure that assesses and prepares of tremendous collected information in a distributed environment of computing. It offers gigantic details stockpiling and super-quick processing at around 5 percent of the cost of convection less-adaptable databases. Hadoop's mark quality is the capacity to deal with organized and unstructured information (counting sound, text, and visual), and in expansive volumes. Insurers either can employ Hadoop specialists to exploit the structure or purchase items that scaffold to existing databases and information distribution centers[? ?]. This foundational innovation for making predictive analytics models stays one-step in front of fraudsters and spillage of paid-out cases cash. The exchange observing advancement innovation used to battle regularly complicated illegal tax avoidance utilizes Hadoop as a center stockpiling and sorting out innovation. Complex organized crack rings and therapeutic factories, for instance, are conveying progressively modern techniques for laundering cash stolen from auto insurers.

3.5 In memory

In-memory analytics is a processing style in which all information utilized by an application is put away inside the principal memory of the computing condition. Instead of being available on a disc, the data stays suspended in the mind of useful sets of PCs. Different clients can share this information with numerous applications in a quick, secure, and simultaneous way. In-memory analytics likewise exploits multi-threading and distributed registry [? ?]. This implies clients can disseminate the information (and complex workloads that process the data) over different machines in a group or inside a single server condition. In-memory analytics manages questions and information analytics, yet also is utilized with more-complex procedures, for example, predictive analytics, machine learning, and analytics. The sorts of neural-network analytics that assist insurer in discovering association among suspects sustaining claim and premium fraud depending on the kind of processes

3.6 Software as a Service (SaaS)

Predictive modeling and different analytics were accessible to large insurance net providers willing to introduce the innovation on location as of not long ago. Software as a service has advanced to even where genuinely little insurers can exploit Big Data analytics [?]. Insurance providers subscribe to a service keeps running by a seller as opposed to paying for the vast buy, establishment, and support of in-house frameworks. SaaS likewise is named "on-demand software."

4 CONCLUSION

Big data analytics is efficient means that insurance organization can use to structure their data in a manner to detect insurance fraud analyze events. More importantly, big data analytics offers implies that insurance companies can use to develop predictive analytics to identify unknown and suspicious events taking place within

databases systems. More importantly, big data analytics provides means for management of large insurance data efficiently. Additionally, big data analysis can be integrated with another source of information such as public records to determine individual profiles and chances of committing an offense. Notably, big data analytics as SaaS can be used with a different level of insurance firms to detect fraudulent activities in a cost-effective manner.

ACKNOWLEDGMENTS

The authors would like to thank Dr. Gregor von Laszewski for his support and formatting in writing this paper.

REFERENCES

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Warning--I didn't find a database entry for "5"
(There were 2 error messages)

bibtex_empty_fields
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entries in general should not be empty in bibtex


find ""
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passed: True

ascii
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non ascii found 8212
non ascii found 8212

================================================================================
The following tests are optional
================================================================================

Tip: newlines can often be replaced just by an empty line

find newline
--------------------------------------------------------------------------------

passed: True
```

```
cites should have a space before \cite{} but not before the {

find cite {
--------------------------------------------------------------------------------

passed: True
```

Big Data Application in Amazon

Shiqi Shen
Indiana University Bloomington
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ABSTRACT

This case study evaluates being data application in Amazon, with specific focus on how the company has employed big data to enhance its performance. Amazon has created robust applications from big data that has enabled it to give customers more targeted product recommendations and enhance the quality of care for them. The all-rounded customer profiles created using big data resources has enabled the firm to send customized and personalized marketing messages for its customers. Other firms have also adopted the big data tools offered by Amazon to enhance their performance and revenue flows. The other parts of the paper evaluate how amazon used big data to enhance operations and improve its performance.

KEYWORDS

i423, hid109, Big Data; Amazon; Customers; Pricing; Dynamic, Internet, application

1 INTRODUCTION

The ability to generate and exchange information has increased tremendously over the recent past. This growth is driven by the easy availability and affordability of the computing as well as the ubiquity of the internet [3]. In the current businesses world, almost everything is conducted electronically. There is a lot of information exchange and engagement over the internet, as well as selling and buying of products. Amazon is one of the leading giants in the application of big data. The firm is one of the pioneers of e-commerce, and one of its most outstanding innovations in this domain is the personalized recommendation system. The foundation of the system is big data, which is usually collected from the customers. The firm has received various coveted awards due to its excellent innovations and application of big data [3]. The firm has leveraged big data in the recent past to enhance its performance as well as service delivery to the customers. Together with other major firms in the internet services industry, Amazon acknowledged the significance of big data in the initial years of 2000, and then immediately focused on adequately using the big database of clients shopping on its online platforms.

Big data operates on the concept of the power of suggestion, as fronted by psychologists. They claim that by putting something that an individual may like in front of them, then they may have strong desire to purchase it. Amazon employed this philosophy by leveraging their customer data and transforming its system into a high powered one that is focused on the customer. The firmfis systems have been getting better by the day and expected to be even more superior in the near future.

2 PRODUCT RECOMMENDER SYSTEM

In the recent past, Amazon has moved from operating as a pure e-commerce firm to a major player in the internet services industry, with focus on offering a wide variety of services to both individuals as well as companies. The firm started to shift its focus on big data and started the journey to transition from a typical online retailer into one a major force in the realm of big data. Around 2000, the company, along with other internet firms such as Google, Yahoo, and Twitter realized that they had voluminous data about their customers, which could be put used to improve their performance. Although the other firms did not initially concentrate majorly on big data, Amazon swiftly moved to take advantage of the invaluable database of individuals who used its e-commerce platforms around the world to shop. The team charged with the responsibility of recommending the products to the customers came up with innovative strategies that the firm could make use of the data collected by the firm about their customers. The end result of the move was a huge success in big data, which revolutionized how the company did business.

As a major player in the e-commerce domain, the success of Amazon was always pegged on availing the right products to the customers. The efficacy of providing the right products for the customers in turn largely depended on a proper understanding of the needs of the consumers. A proper market research was necessary in order to understand the customerfis needs and tastes. Since it was founded, Amazon has created a name for itself because of its superior product recommender system, which suggests products to consumers on the basis of their last purchase. The major driving force behind the recommender system is the data gathered from the customers.

The product recommender system is essential for the personalization of each customerfis experience when they are shopping in the firmfis online store [6]. The firm employs collaborative filtering and clustering algorithms to classify clients on the basis of preferences. Customers are grouped on the basis of same search as well as collaborative filtering between items. Content-based search employs the shopping history of customers and item ratings to establish a search query capable of finding other items that match the tastes of consumers. For instance, if a customer purchases a book, the product recommender systems will suggest books from the same author, publisher, or subject area. The product recommendations are not only used by the company in the online stores, but it also doubles up as a marketing tool useful in conducting email campaigns. There is a recommendation link that enables shoppers to filter products by several criteria depending on the items that they have in their shopping carts.

3 BIG DATA FOR DYNAMIC PRICING

Dynamic pricing entails the use of big data such as clickstreams, purchase history, cookies, etc. to offer customized discounts to customers or to alter the prices of items being sold dynamically. The technology enables the real-time price customization for an item to suit a specific customer. This explains why it is sometimes possible for two different sets of customers to buy the same item at different prices from the same online store [5]. Despite the immense benefits of this technology, some customers may always feel discriminated against due to the price differences. Amazon has successfully used the power of big data to implement a price discrimination system. For example, there was an incident in which some Amazon customers were aggravated about price variations of a certain DVD. One of the customers noted that there was a difference of nearly two points five dollars in the price if the cookers were deleted from the computer. Price discrimination was also experienced in the sale of a product known as Diamond Rio MP3 Player.

Big data also enables price optimization. This enables the firm to manage the prices of commodities and grow its profits by twenty-five percent annually. Several factors are used to set the prices of commodities. Some of them are: activity of the customer on the firmfis shopping portal, availability of the product, competitorfis prices, order history, item preferences, and the anticipated profit margin [5]. The prices are normally refreshed every ten minutes as big data become updated. Due to this, Amazon provides customers with discounts on best-selling commodities and accrue large profit margins on the items that are less popular with customers.

4 BIG DATA AND CUSTOMER SERVICE

Big data is also extensively being used for customer service at Amazon. The acquisition of Zappos has often been viewed as a major element in the same. Since it was founded, Zappos has enjoyed a good reputation for the excellence in customer service and was usually viewed as a world leader in this domain. Much of the success can be attributed to their advanced relationship management systems which extensively employed their own customer data. After the acquisition of the form in 2009, the procedures were integrated together with those of Amazon. Todayfis business environment is changing at a rapid rate, and consumers are also using their voices faster. Within a few moments after undergoing a bad experience, customers can swiftly move into social media and spread the news about their negative experience [4]. The only strategy for an organization to survive under such conditions is to employ the power of analytic to streamline and shorten the response time, as well as fix the customer support issues. The customers of the present day are not only looking for a product that works, but also one that is personalized and able to recognize their interests and save them time.

5 ONE CLICK ORDERING

Amazon used big data to create one-click ordering. This feature is activated automatically when the customer places his first order, enters a shipping address as well as a method of payment. When using the one-click feature, the customer is given thirty minutes to change his mind about the particular purchase. This system was created on the premise that a simplified path to purchase would increase conversion rates. Since the introduction of the technology, the firmfis revenues have increased year after year. The significance of this application pushed the company to patent it to prevent other companies from using it without authorization. Reorganizing the purchase process is currently one of the most significant differentiates in the current marketplace. The service enables users to make payments without having to exchange cards or money physically. Amazon has also greatly benefited from impulse buying, which is accelerated by one-click buying. Research has shown that the largest percentage of people normally purchase things they donfit require or did not plan to purchase in the first place [2].

6 USING BIG DATA TO SUPPORT OTHER COMPANIES

Amazon also uses its big data platform to support and help other companies improve their operations. Organizations can employ AWS toolkit provided by Amazon to create scalable big data applications that have the capacity to improve business performance [6]. Besides, they would be able to secure these applications easily without the need to spend on expensive infrastructure and hardware. The big data applications including data warehousing, clickstream analytic, fraud detection, internet of things, and several others are delivered via cloud computing. Hence, there is no need for an organization to incur additional costs in setting up a data center. The Amazon web services can enable companies to analyze spending habits, customer demographics, and other related information to enable them effectively cross-sell some of the firmfis products in patterns similar to Amazon. That is to say that the retailers will also be able to stalk their customers, recommend products to them, and improve their customer experience.

7 BIG DATA TECHNOLOGIES

Amazon EMR: This technology offers a managed Hadoop framework that simplifies and hastens the processing of huge amounts of data across scalable Amazon EC2 instances. Amazon EMR also supports other common distributed frameworks including HBase, Apache Spark, Flink, and Presto [1]. Besides, it reliably and safely handles a wide range of big data use cases, such as web indexing, log analysis, financial analysis, machine learning, and bioinformatics.

Amazon Athena: It denotes an interactive query service that simplifies data analysis in Amazon S3 via standard SQL. Since it is service less, one only pays for the queries they run and there is no infrastructure to be managed [1]. The technology is quite straightforward and delivers results within the shortest time possible. Moreover, it does not require complex ETL jobs to prepare data for analysis.

Amazon Kinesis Firehouse: This is one of the simplest methods to import streaming data into Amazon Web Services. The technology can be used to gather, transform, and import streaming data into Amazon S3, Amazon Kinesis analytic, and Amazon Redshift, to permit instant analytic with the current BI tools and dashboards currently being used. It is a comprehensively managed service that can expand automatically with the increase in data throughput.

8 CONCLUSION

Big data has grown tremendously in the recent past. The growth has been accelerated majorly by the increased accessibility of computing devices as well as the ubiquity of the internet. Being one of the pioneers of e-commerce, Amazon has extensively employed big data to improve its performance. Big data has been used to create recommender systems, implement dynamic pricing, streamline and improve the customer experience, and support other companies. The system recommends products to customers based on their purchase history and enables them to filter the products list based on certain criteria. The company continues to enhance its big data applications with a view to creating a loyal customer base.

ACKNOWLEDGMENTS

The authors would like to thank Dr. Gregor von Laszewski for his support to write this paper as well as TAs' helpful suggestions on this paper.

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[2] Roy F Baumeister. 2002. Yielding to temptation: Self-control failure, impulsive purchasing, and consumer behavior. *Journal of consumer Research* 52, 4 (2002), 670–676.
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[6] Hsinchun Chen & Roger H L Chiang & Veda C. Storey. 2012. Business intelligence and analytics: From big data to big impact. *MIS Quarterly: Management Information Systems* 36, 4 (2012), 1165–1188.

```
bibtext report
===========================================

This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
Database file #1: report.bib

bibtext _ label error
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bibtext space label error
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bibtext comma label error
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latex report
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        [2017-11-05 20.48.45] pdflatex report.tex
This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
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Typesetting of "report.tex" completed in 0.9s.

================================================================================
Compliance Report
================================================================================


name: Shiqi Shen
hid:  109
paper1: complete 100% Oct 27th
paper2: complete 100% Oct 4th
project: 0%

yamlcheck
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wordcount
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3
wc 109 paper2 3 2060 report.tex
wc 109 paper2 3 2105 report.pdf
wc 109 paper2 3 199 report.bib

find "
--------------------------------------------------------------------------------

passed: True

find footnote
--------------------------------------------------------------------------------

passed: True

find input{format/i523}
--------------------------------------------------------------------------------

4: \input{format/i523}

passed: True

floats
--------------------------------------------------------------------------------
```

```
figures 0
tables 0
includegraphics 0
labels 0
refs 0
floats 0

True : ref check passed: (refs >= figures + tables)
True : label check passed: (refs >= figures + tables)
True : include graphics passed: (figures >= includegraphics)
True : check if all figures are refered to: (refs >= labels)

Label/ref check
passed: True

When using figures use columnwidth
[width=1.0\columnwidth]
do not cahnge the number to a smaller fraction


find textwidth
--------------------------------------------------------------------------------

passed: True

below_check
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bibtex
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label errors


bibtex errors

This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
Database file #1: report.bib

bibtex_empty_fields
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entries in general should not be empty in bibtex


find ""
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passed: True

ascii
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================================================================================
The following tests are optional
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Tip: newlines can often be replaced just by an empty line

find newline
--------------------------------------------------------------------------------

passed: True
cites should have a space before \cite{} but not before the {

find cite {
--------------------------------------------------------------------------------

passed: True
```

Big Data for Edge Computing

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ABSTRACT

This paper provides a sample of a LaTeX document which conforms, somewhat loosely, to the formatting guidelines for ACM SIG Proceedings.

KEYWORDS

Big Data, Edge Computing i523

1 INTRODUCTION

Put here an introduction about your topic. We just need one sample refernce so the paper compiles in LaTeX so we put it here [**?**].

2 FIGURES

In Figure 1 we show a fly. Please note that because we use just columwidth that the size of the figure will change to the columnwidth of the paper once we change the layout to final. CHnaging the layout to final should not be done by you. All figures will be listed at the end.

[Figure 1 about here.]

When copying the example, please do not check in the images from the examples into your images directory as you will not need them for your paper. Instead use images that you like to include. If you do not have any images, do not dreate the images folder.

3 TABLES

In case you need to create tables, you can do this with online tools (if you do not mind sharing your data) such as https://www.tablesgenerator.com/ or other such tools (please google for them). They even allow you to manage tables as CSV.

or generate them by hand while using the provided template in Table**??**. Not ethat the caption is before the tabular environment.

[Table 1 about here.]

4 LONG EXAMPLE

If you like to see a more elaborate example, please look at report-long.tex.

5 CONCLUSION

Put here an conclusion. Conlcusions and abstracts must not have any citations in the section.

ACKNOWLEDGMENTS

The authors would like to thank Dr. Gregor von Laszewski for his support and suggestions to write this paper.

REFERENCES

We include an appendix with common issues that we see when students submit papers. One particular important issue is not to use the underscore in bibtex labels. Sharelatex allows this, but the proceedings script we have does not allow this.

When you submit the paper you need to address each of the items in the issues.tex file and verify that you have done them. Please do this only at the end once you have finished writing the paper. To d this cange TODO with DONE. However if you check something on with DONE, but we find you actually have not executed it correcty, you will receive point deductions. Thus it is important to do this correctly and not just 5 minutes before the deadline. It is better to do a late submission than doing the check in haste.

A ISSUES

DONE:

Example of done item: Once you fix an item, change TODO to DONE

A.1 Assignment Submission Issues

Do not make changes to your paper during grading, when your repository should be frozen.

A.2 Uncaught Bibliography Errors

Missing bibliography file generated by JabRef

Bibtex labels cannot have any spaces, _ or & in it

Citations in text showing as [?]: this means either your report.bib is not up-to-date or there is a spelling error in the label of the item you want to cite, either in report.bib or in report.tex

A.3 Formatting

Incorrect number of keywords or HID and i523 not included in the keywords

Other formatting issues

A.4 Writing Errors

Errors in title, e.g. capitalization

Spelling errors

Are you using *a* and *the* properly?

Do not use phrases such as *shown in the Figure below.* Instead, use *as shown in Figure 3*, when referring to the 3rd figure

Do not use the word *I* instead use *we* even if you are the sole author

Do not use the phrase *In this paper/report we show* instead use *We show.* It is not important if this is a paper or a report and does not need to be mentioned

If you want to say *and* do not use *&* but use the word *and*

Use a space after . , :

When using a section command, the section title is not written in all-caps as format does this for you

`\section{Introduction}` and NOT `\section{INTRODUCTION}`

A.5 Citation Issues and Plagiarism

It is your responsibility to make sure no plagiarism occurs. The instructions and resources were given in the class

Claims made without citations provided

Need to paraphrase long quotations (whole sentences or longer)

Need to quote directly cited material

A.6 Character Errors

Erroneous use of quotation marks, i.e. use “quotes” , instead of ” ”

To emphasize a word, use *emphasize* and not “quote”

When using the characters & # % _ put a backslash before them so that they show up correctly

Pasting and copying from the Web often results in non-ASCII characters to be used in your text, please remove them and replace accordingly. This is the case for quotes, dashes and all the other special characters.

If you see a ffigure and not a figure in text you copied from a text that has the fi combined as a single character

A.7 Structural Issues

Acknowledgement section missing

Incorrect README file

In case of a class and if you do a multi-author paper, you need to add an appendix describing who did what in the paper

The paper has less than 2 pages of text, i.e. excluding images, tables and figures

The paper has more than 6 pages of text, i.e. excluding images, tables and figures

Do not artificially inffate your paper if you are below the page limit

A.8 Details about the Figures and Tables

Capitalization errors in referring to captions, e.g. Figure 1, Table 2

Do use *label* and *ref* to automatically create figure numbers

Wrong placement of figure caption. They should be on the bottom of the figure

Wrong placement of table caption. They should be on the top of the table

Images submitted incorrectly. They should be in native format, e.g. .graffle, .pptx, .png, .jpg

Do not submit eps images. Instead, convert them to PDF

The image files must be in a single directory named ”images”

In case there is a powerpoint in the submission, the image must be exported as PDF

Make the figures large enough so we can read the details. If needed make the figure over two columns

Do not worry about the figure placement if they are at a different location than you think. Figures are allowed to ffoat. For this class, you should place all figures at the end of the report.

In case you copied a figure from another paper you need to ask for copyright permission. In case of a class paper, you must include a reference to the original in the caption

Remove any figure that is not referred to explicitly in the text (As shown in Figure ..)

Do not use textwidth as a parameter for includegraphics

Figures should be reasonably sized and often you just need to add columnwidth

e.g.

```
/includegraphics[width=\columnwidth]{images/myimage.pdf}
```

re

2

List of Figures

1 Example caption 4

Figure 1: Example caption

List of Tables

1 My caption 6

Table 1: My caption

1	2	3
4	5	6
7	8	9

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bibtext report
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This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
Database file #1: report.bib
Warning--I didn't find a database entry for "editor00"
(There was 1 warning)

bibtext _ label error
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bibtext space label error
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bibtext comma label error
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latex report
===========================================

        [2017-11-05 20.48.51] pdflatex report.tex
This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
p.1   L62   : [editor00] undefined
p.1   L89   : 't:mytable' undefined
Empty `thebibliography' environment.
Missing character: ""
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Missing character: ""
There were undefined citations.
bookmark level for unknown  defaults to 0.
The anchor of a bookmark and its parent's must not be the same. Added a new anchor.
The anchor of a bookmark and its parent's must not be the same. Added a new anchor.
There were undefined references.
Typesetting of "report.tex" completed in 1.2s.
../README.yml
  9:81      error    line too long (83 > 80 characters)  (line-length)
  10:81     error    line too long (81 > 80 characters)  (line-length)
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  11:81     error    line too long (82 > 80 characters)  (line-length)
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  13:81     error    line too long (81 > 80 characters)  (line-length)


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Compliance Report
================================================================================



name: Arnav, Arnav
hid:  201
paper1: 20th Oct 2017 100%
paper2: not started
project: not started

yamlcheck
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wordcount
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wc 201 paper2 (null) 1163 report.pdf
wc 201 paper2 (null) 50 report.bib

find "
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passed: True

find footnote
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passed: True

find input{format/i523}
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4: \input{format/i523}

passed: True

floats
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67: In Figure \ref{f:fly} we show a fly. Please note that because we
    use
73: \begin{figure}[!ht]
74: \centering\includegraphics[width=\columnwidth]{images/fly.pdf}
75: \caption{Example caption}\label{f:fly}
90: or generate them by hand while using the provided template in
    Table\ref{t:mytable}. Not ethat
93: \begin{table}[htb]
96: \label{t:mytabble}

figures 1
tables 1
includegraphics 1
labels 2
refs 2
floats 2

True : ref check passed: (refs >= figures + tables)
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15: note            = "",

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If you see a ffigure and not a figure in text you copied from a text that has the fi combined as a single character

A.7 Structural Issues

Acknowledgement section missing

Incorrect README file

In case of a class and if you do a multi-author paper, you need to add an appendix describing who did what in the paper

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The paper has more than 6 pages of text, i.e. excluding images, tables and figures

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Do not use textwidth as a parameter for includegraphics

Figures should be reasonably sized and often you just need to add columnwidth

e.g.

`/includegraphics[width=\columnwidth]{images/myimage.pdf}`

re

2

List of Figures

1 Example caption 4

Figure 1: Example caption

List of Tables

1 My caption 6

Table 1: My caption

1	2	3
4	5	6
7	8	9

```
bibtext report
===========================================

This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
Database file #1: report.bib
Warning--I didn't find a database entry for "editor00"
(There was 1 warning)

bibtext _ label error
===========================================


bibtext space label error
===========================================


bibtext comma label error
===========================================


latex report
===========================================

        [2017-11-05 20.49.08] pdflatex report.tex
This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
p.1   L62   : [editor00] undefined
p.1   L89   : 't:mytable' undefined
Empty `thebibliography' environment.
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
There were undefined citations.
bookmark level for unknown  defaults to 0.
The anchor of a bookmark and its parent's must not be the same. Added a new anchor.
The anchor of a bookmark and its parent's must not be the same. Added a new anchor.
There were undefined references.
Typesetting of "report.tex" completed in 1.2s.

================================================================================
Compliance Report
```

```
==============================================================================


name: Lu, Junjie
hid:  214
paper1: 100% Oct 29th
paper2: 0%
project: 0%

yamlcheck
------------------------------------------------------------------------------



wordcount
------------------------------------------------------------------------------

6
wc 214 paper2 6 518 report.tex
wc 214 paper2 6 1163 report.pdf
wc 214 paper2 6 50 report.bib

find "
------------------------------------------------------------------------------

passed: True

find footnote
------------------------------------------------------------------------------

passed: True

find input{format/i523}
------------------------------------------------------------------------------

4: \input{format/i523}

passed: True

floats
------------------------------------------------------------------------------

67: In Figure \ref{f:fly} we show a fly. Please note that because we
    use
73: \begin{figure}[!ht]
74: \centering\includegraphics[width=\columnwidth]{images/fly.pdf}
75: \caption{Example caption}\label{f:fly}
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90: or generate them by hand while using the provided template in
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figures 1
tables 1
includegraphics 1
labels 2
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[width=1.0\columnwidth]
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find textwidth
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below_check
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bibtex
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Big Data for Edge Computing

Ben Trovato
Institute for Clarity in Documentation
P.O. Box 1212
Dublin, Ohio 43017-6221
trovato@corporation.com

G.K.M. Tobin
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webmaster@marysville-ohio.com

Gregor von Laszewski
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laszewski@gmail.com

ABSTRACT

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KEYWORDS

Big Data, Edge Computing i523

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ACKNOWLEDGMENTS

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re

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Figure 1: Example caption

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Database file #1: report.bib
Warning--I didn't find a database entry for "editor00"
(There was 1 warning)

bibtext _ label error
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latex report
===========================================

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p.1   L62   : [editor00] undefined
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There were undefined references.
Typesetting of "report.tex" completed in 1.2s.
../README.yml
  9:81      error    line too long (82 > 80 characters)  (line-length)
  10:81     error    line too long (81 > 80 characters)  (line-length)
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```
  11:81     error    line too long (81 > 80 characters)  (line-length)


================================================================================
Compliance Report
================================================================================


name: Niu, Geng
hid:  218
paper1: 100%
paper2: in progress

yamlcheck
--------------------------------------------------------------------------------



wordcount
--------------------------------------------------------------------------------

6
wc 218 paper2 6 518 report.tex
wc 218 paper2 6 1163 report.pdf
wc 218 paper2 6 50 report.bib

find "
--------------------------------------------------------------------------------

passed: True

find footnote
--------------------------------------------------------------------------------

passed: True

find input{format/i523}
--------------------------------------------------------------------------------

4: \input{format/i523}

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floats
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```

```
    use
73: \begin{figure}[!ht]
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Big Data Applications in Aviation Industry

Swargam, Prashanth
Indiana University Bloomington
107 S Indiana Ave
Bloomington, Indiana 47408
pswargam@iu.edu

ABSTRACT

Data generated by aviation industry is being increased enormously. The data generated by all the components of aviation industry can be analysed for reducing the operational costs, predict customer behaviour, analyse customer satisfaction. These applications of big data in aviation industry makes it a prominent player. Hence, collecting this data, storing and processing them for desired results can help the aviation industry in boosting their profits and improve customer satisfaction.Various applications of Big data, their challenges and models are discussed here.

KEYWORDS

HID228, I523, Big Data, Aviation Industry,Analytics ,

1 INTRODUCTION

Big Data has transformed the businesses were being conducted. Every sector is integrated with data and generating huge amounts of data every day. All the companies are following data driven approach to crunch their competition. With the advent of concepts like Internet of things, the generation of data is increasing by many folds. This brings scope for a new business which handles the storage and analysis of data.

The solutions offered by Big Data in many industrial sections have revolutionised the respective businesses. In aviation industry, where data as big as 20tb is generated from an aircraft flying for an hour, Big Data can offer influential solutions in terms of dealing with the massive data. This data ,if is processed in an efficient way would increase the customer satisfaction at a reduced running and operational costs which in turn increases the profits.

2 APPLICATIONS

2.1 Baggage Handling

All the customer check-in their bag and have a doubt if their bags are being transported with them. There are several cases where customers raise some complaints about their bag being missed are bag transported to another destination. Traditional barcode system was used to handle this task. As the number of airline users increased, this solution was not profitable for customers and airline operators. However, this is being replaced by the new technology which uses radio frequencies to track real-time location of the bag. Bags which are checked in at the kiosk are assigned with a microchip. These chips will send the data related to the location of the bag frequently. The data generated by these chips is processed and stored. The processed data is available to the customers through mobile application or a web interface.

2.2 Flight Safety

All the flights have many sensors which generates a lot of data related to flight status and incidents. According to, a Being 737 generates nearly 20tb of data for one hour and an average cross international plane travelling for 6 hours generates 240 tb of data. Most of these data is related to safety and status of various equipment on the flights. A lot of this data should be filtered and mined to generate a meaningful and usable data. Southwest Airlines partnered with NASA for crunching this data and generating a meaningful data. NASA uses machine learning algorithms to mine this data.

This collected data from the flight can be analysed to decide a desired value for variables like altitude, wind speed, thrust, weight of the aircraft are proposed to the pilot for increased fuel economy. This data can also be helpful in deciding the nature of services according to the nature of the location and fuel costs.

2.3 Personalized promotion

In the advent of smart devices, all the industries including airline industry have come closer to the customer. Variables which are considered as characteristics are studied from the customer data available through their interaction with customers. These details range from preferences to behaviour of the customer. This data is analysed to study the behaviour of the customer and improve his experience with the airline industry.

2.4 Pricing strategies

Pricing is an important strategy to generate profits. It is quite often to see a price bump of the airfare during the payment or checkout process. This is because of increase in demand for the journey. This demand data is analysed in the servers and shown on the customers screen in less than minute. This calculations and analysis requires high computing power and efficient algorithms.

3 DATA SOURCES

3.1 In-Flight Data

QAR Data: Quick Access Recorder records the statistics of the flight like speed, height, speed, altitude, at any instance during flight. This data is stored in servers and processed

ACARS Data: Aircraft Communications Addressing and Reporting System is a online data transmission system which transmits data to ground through the aircraftfis satellite communication system. ACARS records values of different parameters during a event. An event is an action performed by the aircraft. The sensors mounted on the flightsfi brakes, wings, doors, send data to the ground staff using ACARS. Aircraft connection sensors and equipment monitoring system also uses this ACARS to transmit the data to ground.

3.2 Data from mobile and web applications

Now-a-days all the customer interactions with airline industry is through web. All the web applications and mobile applications which are developed for interacting with customer are smart enough to store the variables which are used to study the customer behaviour. This portion of data sources generates the data at increasing rates due to the evolution of customerfis interaction with internet.

3.3 Historical Data

Data available from the previous analytics and recordings constitutes a major portion. These are generally excel sheets or other forms of data stored in servers or files. These can be used for predictive analysis of the flight.

3.4 Other Sources

Other sources like weather sensors, internet, analysis from third party vendors which help airline industry in scheduling and predicting flight delays .

3.5 Service Oriented Model

4 DATA STORAGE AND PROCESSING

4.1 Apache Spark for Realtime data

5 CHALLENGES IN IMPLEMENTING BIG DATA

5.1 Information Security

6 CONCLUSION

```
bibtext report
===========================================

This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
I found no \citation commands---while reading file report.aux
I found no \bibstyle command---while reading file report.aux
(There were 2 error messages)
make[2]: *** [bibtex] Error 2

latex report
===========================================

        [2017-11-05 20.49.24] pdflatex report.tex
This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
Typesetting of "report.tex" completed in 0.9s.

================================================================================
Compliance Report
================================================================================



name: Swargam, Prashanth
hid:  228
paper1: Oct 20 17  100%
paper2: in progress

yamlcheck
--------------------------------------------------------------------------------



wordcount
--------------------------------------------------------------------------------

2
wc 228 paper2 2 1003 report.tex
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```

```
find "
--------------------------------------------------------------------------------

passed: True

find footnote
--------------------------------------------------------------------------------

13: \renewcommand\footnotetextcopyrightpermission[1]{} % removes
    footnote with conference information in first column

passed: False

find input{format/i523}
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figures 0
tables 0
includegraphics 0
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find textwidth
--------------------------------------------------------------------------------
```

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find ""
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ascii
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non ascii found 8217
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Big Data for Edge Computing

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Dublin, Ohio 43017-6221
trovato@corporation.com

G.K.M. Tobin
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Capitalization errors in referring to captions, e.g. Figure 1, Table 2

Do use *label* and *ref* to automatically create figure numbers

Wrong placement of figure caption. They should be on the bottom of the figure

Wrong placement of table caption. They should be on the top of the table

Images submitted incorrectly. They should be in native format, e.g. .graffle, .pptx, .png, .jpg

Do not submit eps images. Instead, convert them to PDF

The image files must be in a single directory named ”images”

In case there is a powerpoint in the submission, the image must be exported as PDF

Make the figures large enough so we can read the details. If needed make the figure over two columns

Do not worry about the figure placement if they are at a different location than you think. Figures are allowed to ffoat. For this class, you should place all figures at the end of the report.

In case you copied a figure from another paper you need to ask for copyright permission. In case of a class paper, you must include a reference to the original in the caption

Remove any figure that is not referred to explicitly in the text (As shown in Figure ..)

Do not use textwidth as a parameter for includegraphics

Figures should be reasonably sized and often you just need to add columnwidth

e.g.

```
/includegraphics[width=\columnwidth]{images/myimage.pdf}
```

re

2

List of Figures

1 Example caption 4

Figure 1: Example caption

List of Tables

1 My caption 6

Table 1: My caption

1	2	3
4	5	6
7	8	9

```
bibtext report
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This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
Database file #1: report.bib
Warning--I didn't find a database entry for "editor00"
(There was 1 warning)

bibtext _ label error
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bibtext space label error
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bibtext comma label error
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latex report
===========================================

        [2017-11-05 20.49.43] pdflatex report.tex
This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
p.1   L62   : [editor00] undefined
p.1   L89   : 't:mytable' undefined
Empty `thebibliography' environment.
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
There were undefined citations.
bookmark level for unknown  defaults to 0.
The anchor of a bookmark and its parent's must not be the same. Added a new anchor.
The anchor of a bookmark and its parent's must not be the same. Added a new anchor.
There were undefined references.
Typesetting of "report.tex" completed in 1.2s.
../README.yml
  9:81      error    line too long (86 > 80 characters)  (line-length)
  19:1      error    trailing spaces  (trailing-spaces)
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  25:106    error    trailing spaces  (trailing-spaces)
  26:81     error    line too long (109 > 80 characters)  (line-length)
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  39:81     error    line too long (87 > 80 characters)  (line-length)
  39:87     error    trailing spaces  (trailing-spaces)
  40:49     error    trailing spaces  (trailing-spaces)
  47:9      error    trailing spaces  (trailing-spaces)


================================================================================
Compliance Report
================================================================================


name: Wu, Yujie
hid:  235
paper1: 100%, 10/27/2017
paper2: in progress

yamlcheck
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wordcount
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6
wc 235 paper2 6 518 report.tex
wc 235 paper2 6 1163 report.pdf
wc 235 paper2 6 50 report.bib

find "
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passed: True

find footnote
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passed: True

find input{format/i523}
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4: \input{format/i523}

passed: True

floats
--------------------------------------------------------------------------------

67: In Figure \ref{f:fly} we show a fly. Please note that because we
    use
73: \begin{figure}[!ht]
74: \centering\includegraphics[width=\columnwidth]{images/fly.pdf}
75: \caption{Example caption}\label{f:fly}
90: or generate them by hand while using the provided template in
    Table\ref{t:mytable}. Not ethat
93: \begin{table}[htb]
96: \label{t:mytabble}

figures 1
tables 1
includegraphics 1
labels 2
refs 2
floats 2

True : ref check passed: (refs >= figures + tables)
True : label check passed: (refs >= figures + tables)
True : include graphics passed: (figures >= includegraphics)
True : check if all figures are refered to: (refs >= labels)

Label/ref check
passed: True

When using figures use columnwidth
[width=1.0\columnwidth]
do not cahnge the number to a smaller fraction


find textwidth
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passed: True

below_check
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bibtex
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label errors


bibtex errors

This is BibTeX, Version 0.99d (TeX Live 2016)
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Database file #1: report.bib
Warning--I didn't find a database entry for "editor00"
(There was 1 warning)

bibtex_empty_fields
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entries in general should not be empty in bibtex


find ""
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15: note            = "",

passed: False

ascii
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================================================================================
The following tests are optional
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Tip: newlines can often be replaced just by an empty line
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find newline
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passed: True
cites should have a space before \cite{} but not before the {

find cite {
--------------------------------------------------------------------------------

passed: True
```

Big Data Analytics for Social Media Threat Intelligence

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Smith Research Center
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ABSTRACT

This paper provides a sample of a LaTeX document which conforms, somewhat loosely, to the formatting guidelines for ACM SIG Proceedings.

KEYWORDS

Big Data, Edge Computing i523

1 INTRODUCTION

Put here an introduction about your topic. We just need one sample refernce so the paper compiles in LaTeX so we put it here [**?**].

2 FIGURES

In Figure 1 we show a fly. Please note that because we use just columwidth that the size of the figure will change to the columnwidth of the paper once we change the layout to final. CHnaging the layout to final should not be done by you. All figures will be listed at the end.

[Figure 1 about here.]

When copying the example, please do not check in the images from the examples into your images directory as you will not need them for your paper. Instead use images that you like to include. If you do not have any images, do not dreate the images folder.

3 TABLES

In case you need to create tables, you can do this with online tools (if you do not mind sharing your data) such as https://www.tablesgenerator.com/ or other such tools (please google for them). They even allow you to manage tables as CSV.

or generate them by hand while using the provided template in Table**??**. Not ethat the caption is before the tabular environment.

[Table 1 about here.]

4 LONG EXAMPLE

If you like to see a more elaborate example, please look at report-long.tex.

5 CONCLUSION

Put here an conclusion. Conlcusions and abstracts must not have any citations in the section.

ACKNOWLEDGMENTS

The authors would like to thank Dr. Gregor von Laszewski for his support and suggestions to write this paper.

REFERENCES

We include an appendix with common issues that we see when students submit papers. One particular important issue is not to use the underscore in bibtex labels. Sharelatex allows this, but the proceedings script we have does not allow this.

When you submit the paper you need to address each of the items in the issues.tex file and verify that you have done them. Please do this only at the end once you have finished writing the paper. To d this cange TODO with DONE. However if you check something on with DONE, but we find you actually have not executed it correcty, you will receive point deductions. Thus it is important to do this correctly and not just 5 minutes before the deadline. It is better to do a late submission than doing the check in haste.

A ISSUES

DONE:

Example of done item: Once you fix an item, change TODO to DONE

A.1 Assignment Submission Issues

Do not make changes to your paper during grading, when your repository should be frozen.

A.2 Uncaught Bibliography Errors

Missing bibliography file generated by JabRef

Bibtex labels cannot have any spaces, _ or & in it

Citations in text showing as [?]: this means either your report.bib is not up-to-date or there is a spelling error in the label of the item you want to cite, either in report.bib or in report.tex

A.3 Formatting

Incorrect number of keywords or HID and i523 not included in the keywords

Other formatting issues

A.4 Writing Errors

Errors in title, e.g. capitalization

Spelling errors

Are you using *a* and *the* properly?

Do not use phrases such as *shown in the Figure below.* Instead, use *as shown in Figure 3*, when referring to the 3rd figure

Do not use the word *I* instead use *we* even if you are the sole author

Do not use the phrase *In this paper/report we show* instead use *We show.* It is not important if this is a paper or a report and does not need to be mentioned

If you want to say *and* do not use *&* but use the word *and*

Use a space after . , :

When using a section command, the section title is not written in all-caps as format does this for you

`\section{Introduction}` and NOT `\section{INTRODUCTION}`

A.5 Citation Issues and Plagiarism

It is your responsibility to make sure no plagiarism occurs. The instructions and resources were given in the class

Claims made without citations provided

Need to paraphrase long quotations (whole sentences or longer)

Need to quote directly cited material

A.6 Character Errors

Erroneous use of quotation marks, i.e. use “quotes” , instead of ” ”

To emphasize a word, use *emphasize* and not “quote”

When using the characters & # % _ put a backslash before them so that they show up correctly

Pasting and copying from the Web often results in non-ASCII characters to be used in your text, please remove them and replace accordingly. This is the case for quotes, dashes and all the other special characters.

If you see a ffigure and not a figure in text you copied from a text that has the fi combined as a single character

A.7 Structural Issues

Acknowledgement section missing

Incorrect README file

In case of a class and if you do a multi-author paper, you need to add an appendix describing who did what in the paper

The paper has less than 2 pages of text, i.e. excluding images, tables and figures

The paper has more than 6 pages of text, i.e. excluding images, tables and figures

Do not artificially inffate your paper if you are below the page limit

A.8 Details about the Figures and Tables

Capitalization errors in referring to captions, e.g. Figure 1, Table 2

Do use *label* and *ref* to automatically create figure numbers

Wrong placement of figure caption. They should be on the bottom of the figure

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Remove any figure that is not referred to explicitly in the text (As shown in Figure ..)

Do not use textwidth as a parameter for includegraphics

Figures should be reasonably sized and often you just need to add columnwidth

e.g.

```
/includegraphics[width=\columnwidth]{images/myimage.pdf}
```

re

2

List of Figures

1 Example caption 4

Figure 1: Example caption

List of Tables

1 My caption 6

Table 1: My caption

1	2	3
4	5	6
7	8	9

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bibtext report
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This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
Database file #1: report.bib
Warning--I didn't find a database entry for "editor00"
(There was 1 warning)

bibtext _ label error
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bibtext space label error
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bibtext comma label error
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latex report
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        [2017-11-05 20.49.49] pdflatex report.tex
This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
p.1   L62   : [editor00] undefined
p.1   L89   : 't:mytable' undefined
Empty `thebibliography' environment.
Missing character: ""
Missing character: ""
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Missing character: ""
There were undefined citations.
bookmark level for unknown  defaults to 0.
The anchor of a bookmark and its parent's must not be the same. Added a new anchor.
The anchor of a bookmark and its parent's must not be the same. Added a new anchor.
There were undefined references.
Typesetting of "report.tex" completed in 1.2s.
../README.yml
  8:81      error    line too long (85 > 80 characters)  (line-length)
  9:81      error    line too long (84 > 80 characters)  (line-length)
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  10:81     error    line too long (84 > 80 characters)  (line-length)
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  38:1      error    trailing spaces  (trailing-spaces)
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  40:17     error    trailing spaces  (trailing-spaces)
  42:4      error    wrong indentation: expected 7 but found 3  (indentation)
  44:4      error    wrong indentation: expected 7 but found 3  (indentation)
  48:81     error    line too long (117 > 80 characters)  (line-length)
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  50:81     error    line too long (123 > 80 characters)  (line-length)
  51:75     error    trailing spaces  (trailing-spaces)


================================================================================
Compliance Report
================================================================================



name: Ahmed, Tousif
hid:  237
paper1: 100%, October 27, 2017
paper2: 0%, In Progress
project: in progress

yamlcheck
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wordcount
--------------------------------------------------------------------------------

6
wc 237 paper2 6 521 report.tex
wc 237 paper2 6 1166 report.pdf
wc 237 paper2 6 50 report.bib

find "
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passed: True
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find footnote
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passed: True

find input{format/i523}
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4: \input{format/i523}

passed: True

floats
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67: In Figure \ref{f:fly} we show a fly. Please note that because we
    use
73: \begin{figure}[!ht]
74: \centering\includegraphics[width=\columnwidth]{images/fly.pdf}
75: \caption{Example caption}\label{f:fly}
90: or generate them by hand while using the provided template in
    Table\ref{t:mytable}. Not ethat
93: \begin{table}[htb]
96: \label{t:mytabble}

figures 1
tables 1
includegraphics 1
labels 2
refs 2
floats 2

True : ref check passed: (refs >= figures + tables)
True : label check passed: (refs >= figures + tables)
True : include graphics passed: (figures >= includegraphics)
True : check if all figures are refered to: (refs >= labels)

Label/ref check
passed: True

When using figures use columnwidth
[width=1.0\columnwidth]
do not cahnge the number to a smaller fraction
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find textwidth
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passed: True

below_check
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bibtex
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label errors


bibtex errors

This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
Database file #1: report.bib
Warning--I didn't find a database entry for "editor00"
(There was 1 warning)

bibtex_empty_fields
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entries in general should not be empty in bibtex


find ""
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15: note            = "",

passed: False

ascii
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================================================================================
The following tests are optional
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Tip: newlines can often be replaced just by an empty line

find newline
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passed: True
cites should have a space before \cite{} but not before the {

find cite {
--------------------------------------------------------------------------------

passed: True
```

Prediction of psychological traits based on Big Data classification of associated social media footprints

Gagan Arora
Indiana University
2709 E 10th St
Bloomington, Indiana 47401
gkarora@iu.edu

ABSTRACT

Discusses the importance of digital footprints in evaluating person's psychological traits. We also reviewed few researches and articles which conducted studies in this field. We presented an algorithm at very high level of abstraction to understand how digital qualitative data can be translated to quantitative data to arrive at psychological traits. We concluded by providing few real life examples such as how Facebook likes can be used to evaluate psychological traits, how this research was used in last year elections and etc.

KEYWORDS

Big Data, Edge Computing i523, psychological traits, Big Data, Facebook Data, Social media, digital foot prints, five factor model, personality traits, elections, Facebook likes, Facebook comments, Instagram

1 INTRODUCTION

With the advancement of digital media and social media networks, there has been enormous amount of human activities, which is recorded as the digital footprints. According to IBM, in 2012 on an average 500 MB of personal data is uploaded to the online digital database daily. This data is either in the form of social media activities such as Facebook likes, Facebook comments, profile picture upload, tweets or in the form offline transactions where person goes to grocery shopping and pays using credit card. According to [6] China is investing heavy technological resources to mine this data along with person's financial transactions to build social credit system. This project is expected to be implemented by 2020. There has been studies [1] — [12], which analyzed the behavior outcomes of the digital profile with the actual characteristics of an individual. Interesting thing about these studies is that human behavior can be mapped statistically to define similarities and differences between individuals. This can further be used to build recommendation based system to enrich social medial networks such as Facebook, LinkedIn, and Twitter etc. These studies [1] to [12] further contributes in radically improving our behavior understanding of humans. [8] discusses about the predictability of individualfis psychological traits using statistical approach to arrive at the personality traits with certain confidence level. Psychological traits automation can further be used to enrich the quality of recommendation based systems and online search engines. [3] suggest how these studies [1] and [12] can be used to improve online marketing systems. With so many advantages on one side, on other side it possesses biggest challenge to the Data privacy [2] and [10]. Reason why these studies [1] and [12] provide better estimate of human psychological traits as compared to results of psychometric test because these study results [1] and [12] takes the data of prolonged history. However, psychometric tests on the other hands is for few minutes or hours where human can manipulate response in order to achieve desire results. Thus, these studies [1] and [12] can also be leveraged in employee hiring process where many companies still relies on psychometric tests.

2 DATA SOURCE OF BIG DATA IN DIGITAL WORLD

This section discusses how we can import, store and preprocess digital big data. This data can be fetched online via REST api or its direct available to download from website such as mypersonality.org. This site stores the social media data of close to six million participants. There are other sites like Stanford network analysis project, which contains enormous amount of data in the form of product reviews, Tweets, and social media data. Social medial sites like Instagram and Twitter provides public rest APIs through which we can access data, which is public. Other example is Amazon.com, which provides elegant web services to access product reviews. For preprocessing of this data, Python provides excellent libraries to access [via web service call] and preprocess data.

3 HUMAN BEHAVIOR AND PERSONALITY

[11] talks about various models, which can be used to describe human personality. Among all, five factor model [FFM] is proved to be the best model to describe human behavior, psychological traits and preferences: Openness, Conscientiousness, Extroversion, Agreeableness and Emotional stability. We have data, we have psychological traits, and biggest challenge lies in extracting value out of big data and mapping the result to psychological traits. To accomplish this challenge we can perform singular value decomposition to map the qualitative data to quantitative data. To elaborate this further let us take an example: we have a Facebook likes of 10 million people and we filter down top 100 Facebook pages, which are of relevance. Top 100 relevant pages are those, which can predict factors mentioned in FFM. Now we will prepare Boolean matrix with Facebook user profile on vertical axis and Facebook page as horizontal axis. In simple words row represents Facebook user and column represents Facebook page. We will mark the coordinate as one if corresponding Facebook user [on vertical axis] likes a page [on horizontal axis] otherwise zero. Therefore, matrix will look like this:

$$
\begin{array}{c}
 \\ user_1 \\ user_2 \\ user_3 \\ user_n
\end{array}
\begin{array}{c}
\begin{array}{cccc} fbPage_1 & fbPage_2 & \dots & fbPage_n \end{array} \\
\begin{pmatrix} 1 & 0 & \dots & 1 \\ 0 & 1 & \dots & 1 \\ \vdots & \vdots & \ddots & \vdots \\ 1 & 1 & \dots & 1 \end{pmatrix}
\end{array}
$$

These 100 Facebook pages is clustered, based on the five factors mentioned in FFM. First twenty pages will represent first factor, second twenty pages will represent second factor and so on. Next step would be to build correlation matrix that represents how each person is correlated with each other based on the five factors. This matrix will be N by N where is N is number of Facebook users in this experiment. This matrix will help to determine how similar Facebook users are. Which will help us to build the recommendation based systems because similar peoples tends to like same pages and share same psychological traits. This correlation matrix will look like this:

$$
\begin{array}{c}
 \\ user_1 \\ user_2 \\ user_3 \\ user_n
\end{array}
\begin{array}{c}
\begin{array}{cccc} user_1 & user_2 & \dots & user_n \end{array} \\
\begin{pmatrix} 1 & .75 & \dots & .85 \\ .75 & 1 & \dots & .91 \\ \vdots & \vdots & \ddots & \vdots \\ .85 & .91 & \dots & 1 \end{pmatrix}
\end{array}
$$

Step 1: Build binary matrix with Facebook user profile on vertical axis and Facebook page as horizontal axis.
Step 2: Populate the binary matrix with one and zero depending on if person has liked the page or not.
Step 3: Sort Facebook page columns depending on the factors mentioned in FFM.
Step 4: Use this matrix to build correlational matrix represents how each person is correlated with each other based on the five factors.
Step 5: Apply k mean algorithm to group Facebook users of similar factors mentioned in FFM.

4 COMPUTER BASED PERSONALITY JUDGMENT AND HUMAN BASED PERSONALITY JUDGMENT

Research [14] has shown computer based personality judgments are more accurate than those made by humans. According to [14] perceiving and judging peoplefis personality is an important component of living society. Many cognitive decision made by humans are based on the judgment they have in their mind. This research [14] has shown how advance machine learning algorithms and statistical tools can be used to predict the personality traits and compared the results with the human judgments. This research also addresses the issue of substantiating the qualitative aspects of behavior with the quantitative parameters. Computer based personality judgment is not only based on machine learning or statistics but computer vision algorithms can also be used to distinguish facial emotions and concluding psychological traits.

5 SOCIAL NETWORK AS A PERSONALITY TRAIT PREDICTOR

[9] studies suggest how valuable social network is in predicting the psychological traits. According to [9], It is considered as one of the valuable digital footprints to predict intimate personal traits. For instance, number of friends and their location can be used to grade first factor of FFM, which is openness. Person romantic partner can be detected depending on the social network overlap of each friend, which can further be analyzed to predict one's sexual preference. These predictions can further be statistically analyzed to [14] to know how accurate predictions are. We can use social network data on the algorithm discussed in the "Human Behavior and Personality" and conclude a very strong predictions on the psychological traits of a person. It has been in the news that 2016 elections were strategized with the help of the social media big data which will be discussed in the next section.

6 SOCIAL MEDIA BIG DATA AND ITS IMPACT ON POLITICAL ELECTIONS

[13] suggests how last year elections were revolutionized by the impact of big data of social media. Using statistical and machine learning algorithms on social media big data, political parties filtered down the data to identify their likely supporters and then channelized their strategy to win their votes. These strategies were less expensive than conducting campaigns at various places. Traditional analysis is generally based on the survey which is in the sense is limited [7] but now with the ease of big social media data, analysis is more accurate and conclusive. There has been sophisticated tools available that can predict the personfis race depending on his or her name and location. In recent election, political parties also combined social media data and public data [from census Bureau] to run sophisticated machine learning algorithm to pinpoint their supports. All these mentioned ways helped the political parties to micro target their supporters and gained their votes.

7 SOCIAL ACTIVITY, THE PREDICTOR OF PERSONALITY

[9] suggests Facebook profile of a user is not static rather it also contains enriched records of digital footprints such as likes, comments, reactions to other posts. Such activities materializes the connections between user and content. This information along with the other activities such as playlist, browsing logs, online shopping activities and google queries can be used to develop sophisticated highly predictive FFM set for a user and with a very high confidence level can predict userfis age, gender, intelligence religious view and sexual orientation [9]. Very interesting example from the [9] suggests "Users who liked Hello Kitty brand tended to have high openness, low conscientiousness, and low agreeableness" - strange but very interesting! [9] research further elaborate the importance of comments. Semantic analysis on comment can be analyzed to infer one's personality as shown by the research: [5] and [4].

8 CONCLUSION

We discussed various ways in which social medial data can be utilized to build five factor personality model for a user. Main

purpose here is to review the literature work done in this field and also presented the algorithm which can be used to translate qualitative data to quantitative data and how value can be extracted to build FFM for a user. We discussed computer based personality judgments are better than the human based personality judgments. We also touched based where social network can be used to predict userfis personality. As discussed earlier, these researches [1] - [12] have proved to impact the general election last year in United states. Finally we concluded by showing evidences how social activity can be used to build the FFM for a user.

ACKNOWLEDGMENTS

The authors would like to thank Dr. Gregor von Laszewski and all the TA's for their support and suggestions to write this paper.

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[2] Declan Butler. 2007. Data sharing threatens privacy. *NCBI* 449 (11 2007), 644–5.

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We include an appendix with common issues that we see when students submit papers. One particular important issue is not to use the underscore in bibtex labels. Sharelatex allows this, but the proceedings script we have does not allow this.

When you submit the paper you need to address each of the items in the issues.tex file and verify that you have done them. Please do this only at the end once you have finished writing the paper. To d this cange TODO with DONE. However if you check something on with DONE, but we find you actually have not executed it correcty, you will receive point deductions. Thus it is important to do this correctly and not just 5 minutes before the deadline. It is better to do a late submission than doing the check in haste.

A ISSUES

DONE:

Example of done item: Once you fix an item, change TODO to DONE

A.1 Assignment Submission Issues

Do not make changes to your paper during grading, when your repository should be frozen.

A.2 Uncaught Bibliography Errors

Missing bibliography file generated by JabRef

Bibtex labels cannot have any spaces, _ or & in it

Citations in text showing as [?]: this means either your report.bib is not up-to-date or there is a spelling error in the label of the item you want to cite, either in report.bib or in report.tex

A.3 Formatting

Incorrect number of keywords or HID and i523 not included in the keywords

Other formatting issues

A.4 Writing Errors

Errors in title, e.g. capitalization

Spelling errors

Are you using *a* and *the* properly?

Do not use phrases such as *shown in the Figure below*. Instead, use *as shown in Figure 3*, when referring to the 3rd figure

Do not use the word *I* instead use *we* even if you are the sole author

Do not use the phrase *In this paper/report we show* instead use *We show*. It is not important if this is a paper or a report and does not need to be mentioned

If you want to say *and* do not use *&* but use the word *and*

Use a space after . , :

When using a section command, the section title is not written in all-caps as format does this for you

`\section{Introduction}` and NOT `\section{INTRODUCTION}`

A.5 Citation Issues and Plagiarism

It is your responsibility to make sure no plagiarism occurs. The instructions and resources were given in the class

Claims made without citations provided

Need to paraphrase long quotations (whole sentences or longer)

Need to quote directly cited material

A.6 Character Errors

Erroneous use of quotation marks, i.e. use “quotes” , instead of ” ”

To emphasize a word, use *emphasize* and not “quote”

When using the characters & # % _ put a backslash before them so that they show up correctly

Pasting and copying from the Web often results in non-ASCII characters to be used in your text, please remove them and replace accordingly. This is the case for quotes, dashes and all the other special characters.

If you see a ffigure and not a figure in text you copied from a text that has the fi combined as a single character

A.7 Structural Issues

Acknowledgement section missing

Incorrect README file

In case of a class and if you do a multi-author paper, you need to add an appendix describing who did what in the paper

The paper has less than 2 pages of text, i.e. excluding images, tables and figures

The paper has more than 6 pages of text, i.e. excluding images, tables and figures

Do not artificially inffate your paper if you are below the page limit

A.8 Details about the Figures and Tables

Capitalization errors in referring to captions, e.g. Figure 1, Table 2

Do use *label* and *ref* to automatically create figure numbers

Wrong placement of figure caption. They should be on the bottom of the figure

Wrong placement of table caption. They should be on the top of the table

Images submitted incorrectly. They should be in native format, e.g. .graffle, .pptx, .png, .jpg

Do not submit eps images. Instead, convert them to PDF

The image files must be in a single directory named ”images”

In case there is a powerpoint in the submission, the image must be exported as PDF

Make the figures large enough so we can read the details. If needed make the figure over two columns

Do not worry about the figure placement if they are at a different location than you think. Figures are allowed to ffoat. For this class, you should place all figures at the end of the report.

In case you copied a figure from another paper you need to ask for copyright permission. In case of a class paper, you must include a reference to the original in the caption

Remove any figure that is not referred to explicitly in the text (As shown in Figure ..)

Do not use textwidth as a parameter for includegraphics

Figures should be reasonably sized and often you just need to add columnwidth

e.g.

`/includegraphics[width=\columnwidth]{images/myimage.pdf}`

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bibtext report
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================================================================================
Compliance Report
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95: \cite{ref13} studies suggest how valuable social network is in
    predicting the psychological traits.  According to \cite{ref13},
    It is considered as one of the valuable digital footprints to
    predict intimate personal traits. For instance, number of friends
    and their location can be used to grade first factor of FFM, which
    is openness. Person romantic partner can be detected depending on
    the social network overlap of each friend, which can further be
    analyzed to predict one\textquotesingle s sexual preference. These
    predictions can further be statistically analyzed to \cite{ref12}
    to know how accurate predictions are. We can use social network
    data on the algorithm discussed in the "Human Behavior and
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    Personality" and conclude a very strong predictions on the
    psychological traits of a person. It has been in the news that
    2016 elections were strategized with the help of the social media
    big data which will be discussed in the next section.

103: \cite{ref13} suggests Facebook profile of a user is not static
     rather it also contains enriched records of digital footprints
     such as likes, comments, reactions to other posts. Such
     activities materializes the connections between user and content.
     This information along with the other activities such as
     playlist, browsing logs, online shopping activities and google
     queries can be used to develop sophisticated highly predictive
     FFM set for a user and with a very high confidence level can
     predict users age, gender, intelligence religious view and
     sexual orientation \cite{ref13}. Very interesting example from
     the \cite{ref13} suggests "Users who liked Hello Kitty brand
     tended to have high openness, low conscientiousness, and low
     agreeableness" - strange but very interesting! \cite{ref13}
     research further elaborate the importance of comments. Semantic
     analysis on comment can be analyzed to infer one's personality as
     shown by the research: \cite{ref16} and \cite{ref17}.

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True : ref check passed: (refs >= figures + tables)
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label errors


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    axis.\newline

84: \textbf{\textit{Step 2}}: Populate the binary matrix with one and
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85: \textbf{\textit{Step 3}}: Sort Facebook page columns depending on
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86: \textbf{\textit{Step 4}}: Use this matrix to build correlational
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Big Data Applications in Historical Studies

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Indiana Unversity
Anderson, Indiana

ABSTRACT

As big data analytics progress in other fields, historians have began to consider how they can apply these techniques to their studies. Various studies demonstrate potential benefits of big data approaches. However, care must be taken to keep big data results in the overall context of traditional scholarship and to utilize appropriate historical and technical expertise to avoid introducing inaccuracy and bias into findings.

KEYWORDS

i523, HID 312, Big Data, History, Visualization

1 INTRODUCTION

1.1 Big Data

Big data to date can claim numerous victories in a variety of fields, and promises more. Businesses such as Facebook and Netflix have built corporate empires off of the insights gathered from their big data, and physicists and biologists are learning what makes up the universe and ourselves via big data [1].

Despite all this, the concept itself is rather nebulously defined. A rough description is data with quantitative factors that require specialized techniques to utilize. The most commonly referenced big data factors are volume (amount of data), variety (number of data source types), and velocity (rate of data collection or input) known as the three vs. As these data factors become more extreme to the point that traditional methods of data analysis fail, it becomes big data. While this definition is generally accepted, its application varies based upon the industry or field of study and often changes with developments in information technology [5].

The focus on big data arises partially from the phenomenon of data storage capabilities growing at a faster rate than data processing. This creates a situation where data can be economically stored, but not as economically processed, requiring specialized analytic techniques. As big data progresses through the storage, cleaning, analysis, and interpretation stages of the data life cycle, specialized approaches are required [1].

1.2 History of History

The historian's labor has involved interacting with voluminous and varied data for centuries. Before computers, this process involved searching physical archives for relevant data, and manually copying and organizing it into useful information to be analyzed. Though this method can deliver deep insights, some data sets are too big to be studied in a manual fashion [7].

Around the mid-twentieth century, computers had become sufficiently powerful and usable for historians to begin using them to process larger amounts of information. This facilitated a change towards a more quantitative approach and a focus by some from tracing the rise and fall of political or ideological forces, to developing a more complete understanding of mundane topics, such as the family or economics.

Now as archives become digitized and accessible via the internet, the quantity of data available leads to an appeal to big data analytic methods [4]. The potential of unlocking significant connections and developing big picture historical insights at the scale of the growing digital archives of the world is alluring. This hope has driven the labor of many researchers towards developing more big data informed research methods and has directed funds of many institutions towards investments in data infrastructure. However, many are also concerned that the promises of big data are at best optimistic, and at worst hiding potential pitfalls to the historical process [7].

1.3 Thesis

Big Data Analytics have the potential to provide new insights to the field of historical studies. However, their application will differ due to the nature of historical data, and they will serve as an additional tool for the historian, rather than the only tool.

2 BIG DATA IN HISTORICAL STUDIES

2.1 Data Sources

It could be argued that the seeds of big data history have long laid dormant in archives and libraries, waiting to be germinated by sufficient computational capabilities to process them. As big data analytics mature, pressure develops to increase the data available for analysis by digitizing more archival material. This is evidenced not only by the familiar repositories of e-books, but also by archives of a variety of types, such as newspapers articles [7] or letters [4].

Sources for big data research consist not only of the content of documents in an archive, but also the bibliographical records.While originally designed to allow individual works to be located in an archive, historians have began to study the bibliographical data themselves, an approach called distant reading. By looking at the data about a document, rather than the document's content, societal or intellectual trends can be identified across large scale factors such as time or geography in a more comprehensive way. This approach has elicited some criticism that collections of bibliographical data are not complete enough to derive such large-scale conclusions. Still, considerable interest exists in targeting these data sets for historical analysis [10].

However, the data from these sources differs from that of other fields which utilize big data analytics. Historical data is not streaming the way that social media or smartphone sensors are. It is data which has already been collected, organized, and often times analyzed for a purpose defined by people from a different time and different needs/constraints from ourselves. This creates data

sets which are difficult to compare and often require considerable cleaning and reworking to be used in a larger framework. [4].

2.2 Analytics for Big Historical Data

Due to the natural reliance on documents in historical studies, text analytic techniques are the primary set of big data approach utilized by historians. Text analytics are a broad category of related algorithms and statistical techniques, such as artificial intelligence, machine learning, and natural language processing that attempt to extract specific information from the text and identify patterns and relationships within the body of data [7].

Artificial intelligence is "the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings" [2]. In the context of historical research, this would include tasks such as extracting relevant content from sources or identifying relationships within the data. A specific type of artificial intelligence is machine learning, which consists of programs which change their actions autonomously in response to external input. Their ability to adapt allows them to do decision-making tasks, and thus can search through data sources in a more intelligent way to find relevant data [1]. Natural language processing is another artificial intelligence technique, which aims to create programs that can take human language, and make it machine readable [9]. Historians can use such programs to extract meaningful information from archival documents and prepare it for more further analysis and interpretation.

In order to interpret the results of big data analysis, visualization is critical. This is a challenge, as the large scale of the data makes striking a balance between a sufficiently big picture perspective without losing relevant details difficult. Many approaches attempt to utilize high resolution approaches to avoid losing important information [1]. This process is especially challenging in historical studies, as the data is often incomplete and may have inconsistencies which prevent assuming a uniform set of data. For this reason, historians often use visualizations to identify qualitative, rather than quantitative relationships in the data, to inform further inquiry [4].

2.3 Software Packages and Resources for Big Data History

A variety of software packages have been utilized to assist the process of translating raw data into historical insights, such as Tableau, Gephi, R, and ArcGIS. However, a limitation of these tools is their quantitative focus, which tends to exclude more qualitative approaches [4]. Some general qualitative analysis software has been applied to big data historical analysis, such as Google Fusion Tables and OpenHeatMap [10].

Some software has been developed to provide a more qualitative visualization tool set for researchers.For example Stanford University developed a software package called Palladio, designed to visualize connections in large scale historical data. Their approach focused on visualizations that encouraged exploring data, rather than creating statistical statements about it. Examples of this would be mapping connections between historical actors over geography or creating a visualization of the social network of a particular figure in history. They do not create statistical arguments, rather they give a framework for understanding how the data are connected [6].

Another tool with a qualitative visualization focus is WAHSP. Its specific purpose is to conduct text analysis on the National Library of the Netherlands digitized newspaper collection, which contains around 100 million articles published in 1618 to 1995. It provides a number of useful analyses, such as word frequency cloud visualizations, detecting positive or negative sentiment related to certain terms, and Named Entity Recognition, which can identify people, places, events, etc. and then connect them into a relational or geographical framework. It also provides an interactive histogram where the resolution of the data can be adjusted to quickly move between a big picture and detailed data perspective. A derivative project is BILAND, which is a program developed by Utrecht University, that builds off of WAHSP's analytical capabilities, but adapts them across Dutch and German for comparative cultural studies [7].

Along with these data intensive tools specifically designed for historical studies, there are also resources to help the historian learn some of these methods. For example, The Programming Historian website provides a wide range of tutorials and lessons on how to use digital tools in historical studies. At the time of this writing there were 67 lessons available organized by their target stage of research, including lessons on using R, Python, Java, and GitHub for historical studies[8].

2.4 Insights from Big Historical Data

A number of studies have used these techniques to approach historical research from a big data perspective. Stanford's Mapping of the Republic of Letters project sought to map the social network of Enlightenment thinkers who actively corresponded with each other. This was accomplished by utilizing big data analytics on the meta-data of these letters to see how these thinkers related temporally, geographically, and socially. Through the research process, the need for more qualitative approaches to visualization was recognized, and eventually led to the development of the Palladio tool set.

Their analysis revealed a number of interesting points. By mapping the social network of John Locke, they supported previous scholarly contentions that the Enlightenment culture was not homogeneously connected, but was made up of a number of subcultures which had thin social connections. Also, by analyzing Benjamin Franklin's letters, they noted that despite his reputation as cross cultural traveler, the main hub of his correspondence was between the familiar British cultural hubs in Philadelphia and London [4].

Another study used the WAHSP tool to research attitudes found towards drugs in early 20th century newspapers. It found by using the word cloud analysis tool, that before 1924 drugs such as heroin and opium were discussed in the context of health, but after 1924 they were more associated with crime. Their analyses also noted that as Dutch negative associations with opium influenced their perception of China and the Dutch East Indies Colonies.

The related tool BILAND was used by to study how the perceptions of eugenics differed in the Netherlands and Germany, requiring an application which could compare data across languages. The aim was to study not only the direct conversations about this

topic in both regions, but also to study implicit use of terminology which was influenced by the eugenics debate. Through word cloud analysis, the study found that in the mid 19th century, eugenics and concepts of genetic inheritance were used in a primarily medical or biological context. By the 1930s, the terms were utilized more in reference to race and law [7].

One study analyzed music bibliographical data from the British Library and the Repertoire International des Sources Musicales to explore how music was transmitted in Europe over time and geography. Their analytic methods were actually closer to traditional techniques, using a large amount of research assistants to perform repetitive tasks, and wrestling with the information in Excel spreadsheets, but used visualization approaches more congruent with big data. They had surprising results related to who were prominently published composers during different time periods. For example, during the 1800s, relatively unknown composers are high in the frequency list, and famous composers such as Bach do not make the top 50 [10].

3 POTENTIAL ISSUES

While big data can provide some powerful and at times novel solutions to problems, there are also potential issues with its implementation. For example as digital algorithms make search and selection decisions, bias can be introduced into the research inadvertently by the program. This danger is aggravated by the level of transparency of the algorithm, and how well the researcher understands it. For example, when researchers utilize commercial search engines, such as Google scholar, the algorithms are not available, and thus the researcher does not know why data is being included or excluded. If recommender systems are utilized, the potential for bias increases, as the search engine is actively attempting to provide results which are based on its user profile. This could exclude opportunities for data which may challenge the researcher's perspective. The danger of biased analysis through ignorant execution of an automated search or analysis is present in any big data tool, such as those previously described. [3].

In the context of historical studies, it is acknowledged that to use digital methods without expert knowledge of both the subject matter and the big data methodologies can lead to inaccurate conclusions [4]. However, this can be addressed using a number of strategies. For example, there are resources to help historians expand their technical abilities, giving them greater understanding and control over big data analytic methods [8].Creating inter-disciplinary teams are also an effective way to address biased analysis. By allowing information technology and historical research experts to meet together to create research methods, they can address can avoid unintentional bias from misuse of algorithms and from a lack of knowledge of historical context. However, equally important is for the research team to keep a balanced perspective on big data analytics applied to history. These new methods cannot be done in a vacuum or be used to replace traditional human reading of the sources [4]. Though big data techniques have powerful possibilities, they cannot replace the role of the historian, who combines their historical knowledge and narrative creation, to provide context and meaning to the enormous bits of information from the past [7].

There are also a number of technical difficulties associated with using big data for historical analysis. The big data available to historical researchers has no guarantee of completeness or uniformity from which to make generalized claims. Large archives of records can only provide information about what people in the past chose to record or which records survived to our time. Thus, traditional methods are critical, and big data methods serve the purpose of confirming or challenging previous theories, or inspiring new veins of inquiry. History is an interpretative task, and big data analytics serve to better inform interpretation, not replace it. In addition, data often comes from different sources formatted for a variety of purposes. Thus for the historian, rather than dealing with large masses of unstructured data, the challenge is to reconfigure data which has already been organized, and often at cross-purposes to a researchers objectives [4].

4 CONCLUSION

Big data analytics have attracted both interest and criticism from historians. Large digitized databases, effective text analytic techniques, and innovative qualitative visualizations provide fertile ground for a big data approach to historical analysis, which would allow for a more comprehensive analysis of large datasets, which would not be possible for the researcher. These techniques have already been applied to a variety of topics, yielding useful, if not incredibly surprising results.

As historians continue to explore new methods of big data research, it is important to do so from a position of historical and technical expertise, to prevent inaccurate and biased findings. The researchers' perspectives on big data analysis also needs to remain balanced, not ignoring the possibilities of the new techniques, but also not neglecting traditional research. Without traditional scholarship, big data has not external validation or historical context, and thus making it's results inaccurate or meaningless.

ACKNOWLEDGMENTS

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5 ISSUES

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Example of done item: Once you fix an item, change TODO to DONE

5.1 Assignment Submission Issues

Do not make changes to your paper during grading, when your repository should be frozen.

5.2 Uncaught Bibliography Errors

Missing bibliography file generated by JabRef

Bibtex labels cannot have any spaces, _ or & in it

Citations in text showing as [?]: this means either your report.bib is not up-to-date or there is a spelling error in the label of the item you want to cite, either in report.bib or in report.tex

5.3 Formatting

Incorrect number of keywords or HID and i523 not included in the keywords

Other formatting issues

5.4 Writing Errors

Errors in title, e.g. capitalization

Spelling errors

Are you using *a* and *the* properly?

Do not use phrases such as *shown in the Figure below.* Instead, use *as shown in Figure 3*, when referring to the 3rd figure

Do not use the word *I* instead use *we* even if you are the sole author

Do not use the phrase *In this paper/report we show* instead use *We show.* It is not important if this is a paper or a report and does not need to be mentioned

If you want to say *and* do not use *&* but use the word *and*

Use a space after . , :

When using a section command, the section title is not written in all-caps as format does this for you

`\section{Introduction} and NOT \section{INTRODUCTION}`

5.5 Citation Issues and Plagiarism

It is your responsibility to make sure no plagiarism occurs. The instructions and resources were given in the class

Claims made without citations provided

Need to paraphrase long quotations (whole sentences or longer)

Need to quote directly cited material

5.6 Character Errors

Erroneous use of quotation marks, i.e. use "quotes" , instead of " "

To emphasize a word, use *emphasize* and not "quote"

When using the characters & # % _ put a backslash before them so that they show up correctly

Pasting and copying from the Web often results in non-ASCII characters to be used in your text, please remove them and replace accordingly. This is the case for quotes, dashes and all the other special characters.

If you see a ffigure and not a figure in text you copied from a text that has the fi combined as a single character

5.7 Structural Issues

Acknowledgement section missing

Incorrect README file

In case of a class and if you do a multi-author paper, you need to add an appendix describing who did what in the paper

The paper has less than 2 pages of text, i.e. excluding images, tables and figures

The paper has more than 6 pages of text, i.e. excluding images, tables and figures

Do not artificially inffate your paper if you are below the page limit

5.8 Details about the Figures and Tables

Capitalization errors in referring to captions, e.g. Figure 1, Table 2

Do use *label* and *ref* to automatically create figure numbers

Wrong placement of figure caption. They should be on the bottom of the figure

Wrong placement of table caption. They should be on the top of the table

Images submitted incorrectly. They should be in native format, e.g. .graffle, .pptx, .png, .jpg

Do not submit eps images. Instead, convert them to PDF

The image files must be in a single directory named "images"

In case there is a powerpoint in the submission, the image must be exported as PDF

Make the figures large enough so we can read the details. If needed make the figure over two columns

Do not worry about the figure placement if they are at a different location than you think. Figures are allowed to ffoat. For this class, you should place all figures at the end of the report.

In case you copied a figure from another paper you need to ask for copyright permission. In case of a class paper, you must include a reference to the original in the caption

Remove any figure that is not referred to explicitly in the text (As shown in Figure ..)

Do not use textwidth as a parameter for includegraphics

Figures should be reasonably sized and often you just need to add columnwidth

e.g.

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/includegraphics[width=\columnwidth]{images/myimage.pdf}
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bibtext report
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Compliance Report
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label errors


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Tip: newlines can often be replaced just by an empty line

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find cite {
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Big Data Applications in Using Neural Networks for Medical Image Analysis

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ABSTRACT

Medical image analysis is proving to be a promising domain for disruption by machine learning. The analysis of medical imagery has long been within the purview of radiologists, a specialization in medicine that reviews medical imaging to form diagnoses and advise on treatment options. Historically, radiologists have relied on their training, senses and years of experience to evaluate images for medical issues, such as the presence of tumors, lung nodules, and hip osteoarthritis. The presence of technology, generally referred to as computer-aided diagnosis (CAD) tools, has been growing over the last several decades, but modern computing power and sizable datasets have accelerated the effectiveness of these tools. Machine learning algorithms, especially artifical neural networks (ANN), are being leveraged to help identify abnormalities present in medical images at a high level of accuracy. Several research studies conclude that ANN techniques can match, and occassionally outperform, the abilities of radiologists. Big data and the application of advanced algorithms show promise for evolving our ability to successfully evaluate medical images and save lives in the process.

KEYWORDS

i523, hid331, Big Data, Medical Image Analysis, Artificial Neural Networks, Medicine

1 INTRODUCTION

The analysis of medical imagery is primarily the responsibility of radiologists. These individuals are medical doctors who specialize in diagnosing diseases through review of images produced by various imaging modalities, such as x-ray, ultrasound, computerized tomography (CT), magnetic resonance imaging (MRI) and positron emission tomography (PET) [5]. Radiologists serve as an expert to other physicians by analyzing the medical images of patients suspected of having certain medical issues, and by making recommendations on subsequent care based on the observations [5]. The images reviewed by radiologists are generally stored digitially, and images are increasingly being stored in picture archiving and communications systems (PACS). These systems are required to keep up with the rapid accumulation of medical image data. Between 2005 and 2011, the medical image data in US hospitals increased from only 8,900 terabytes to 27,000 terabytes [6]. That number is expected to grow by 20 percent every year due to increasing image size and resolution, the adoption of 3D imaging, and an aging population who will likely bring an increasing demand for medical imaging studies [6].

It is estimated that one billion medical images are created worldwide each year, and most of these are assessed by radiologists [1]. Given that radiologists are human, their judgment is fallible. It is estimated that the lowest average error rate in analyzing medical imagery is 4 percent, which means collectively radiologists are estimated to make 40 million errors in judgement every year [1]. A particularly striking example of fallibility comes from a study that analyzed the first and second interpretations of radiologists from Massachusetts General Hospital. They reviewed abdominal CTs and re-reviewed studies that had either been interpreted by themselves or a colleague. The study found that the radiologists disagreed with their peers 30 percent of the time and even disagreed with themselves 25 percent of the time [1].

There are two major types of radiologic analysis error: perceptual error and interpretive errors [1]. Most errors, up to 80 percent, are perceptual errors, which occur when an abnormality is not perceived by the reviewer during the initial review, but is identified in a subsequent analysis [1]. Interpretive errors occur when the radiologist successfully identifies the abnormality, but incorrectly diagnosis the problem, which may lead to a less appropriate course of careaction [1]. There are several reasons why errors occur, including fatigue, excessive pace of analysis, distractions and insufficient knowledge of the practitioner. It is also asserted that the extreme complexity of a radiologist's job contributes to the errors. Errors occur in the practice of radiologists all across the world, at varying levels of training, in all imaging modalities and all clinical settings [1].

Over the last several decades, there has been an effort to develop computer-based tools to aid radiologists in the detection of abnormalities. Computer-aided diagnosis (CAD) tools are primarily intended to increase the rate at which problems are identified while also reducing the false negatives resulting from human error [8] . These systems are intended to supplement, not replace, the radiologist by reporting a second opinion to be considered alongside the radiologist's assessment. The earliest initiatives to develop these tools occurred in the 1960s, and concerted efforts began in the 1980s [2]. Despite the research being nearly 60 years old, widespread adoption is a relatively recent occurrence [3]. Clinical studies reported early CAD implementations as being minimally effective. Specifically, CAD decisions included more false positives than human assessments, which created more work for radiologists and often led to additional, unnecessary medical tests and biopsies [4].

Several improvements in the field of computing have increased the accuracy of CAD tools and subsequently encouraged wider adoption of these tools into clinical workflows. The advancements

includes increased access to digital imaging datasets, larger imaging data sets, increased used of imaging in healthcare and increased computing power [3][4]. These factors combine to create an ideal state for research related to advanced machine learning techniques, namely artifical neural networks, and the implementation of tools that can rival, and even outperform, the assessment of highly trained radiologists.

2 MACHINE LEARNING AND ARTIFICIAL NEURAL NETWORKS

Broadly speaking, machine learning is a way of applying artificial intelligence to a problem through the analysis of data. Machine learning techniques assess the features, or attributes, of samples in a dataset to identify patterns in the data, and the resulting algorithm can be used to render conclusions about new inputs without human intervention [4]. Medical image analysis presents what is referred to as a classification problem. The typical example of a classifcation problem is handwritten numerical digit recognition. In this example, a handwritten digit between 0 and 9 is fed into the algorithm, and the algorithm decides which of the ten digits, or classes, that handwritten digit is most likely to belong. Specific to medical image analysis, the classifier detects abnormalities in images otherwise not present in images of the same area in healthy individuals, and renders a conclusion as to what that abnormality is.

There are several different machine learning techniques that have traditionally been used in classification problems, such as support vector machines (SVM). SVMs are an example of a supervised machine learning model, meaning this method uses labeled data. Every sample in the dataset includes the label, or correct answer, along with a value for each of the attributes. The SVM identifies patterns in the labeled samples to create an algorithm, and new, unlabeled samples can be processed by the algorithm and given a prediction. In the task of medical image analysis, attributes have historically been identified and designed by human experts [8]. For example, an expert would identify abnormalities by explicitly describing shape, texture, position and orientation of the abnormal biological structure [7]. In addition to this being labor intensive, the image features are specific to the immediate problem being explored and cannot be expected to work well for other image types [8].

Artifical neural networks (ANN) are another class of machine learning techniques that are increasingly being leveraged to tackle problems related to image analysis. ANNs, just like SVMs, are often utilized in a supervised manner, but do not require the painstaking process of expert-defined key attributes. Instead, ANNs learn the important features from the images themselves [7]. This is an obvious advantage when compared to traditional machine learning methods, but the complexity of these algorithms has prevented the achievment of mainstream use until recently. The theory of ANNs was introduced in the 1950s, and research in this field has begun to flourish recently due to the increase in computing power and availability of high quality datasets [4].

3 HOW ANNS WORK

The inspiration for the design of ANNs is drawn from the way a brain works.

4 APPLICATIONS IN MEDICAL IMAGE ANALYSIS

There are several specialities in which medical image analysis has been studied and applied for the purpose of computer-aided detection and diagnosis. ANNs have been used in studies to compare performance of radiologists to computerized approches. A study

Diabetic retinopathy is the third leading cause of blindness worldwide, contributing to

5 INFRASTRUCTURE

6 CHALLENGES

There are several challenges that may inhibit the success of widespread use of CAD tools built upon a neural network algorithm. First, overfitting occurs when an algorithm is trained based on a dataset that does not generalize well to examples outside of the data used to train the algorithm. Many studies demonstrating the value of ANNs were trained using relatively small datasets, and because the significant features present in a small dataset may not be the exact same features present in a large dataset, the algorithm derived from the small dataset may not perform well when analyzing images from the large dataset [9] [4]. This issue can be addressed by training algorithms on larger datasets, but of course requires access to larger datasets, longer training periods and more computing power.

Second, algorithms derived from ANNs are frequently considered to be black boxes, meaning that the results are uninterpretable. This contrasts with several other types of machine learning techniques that produce equations that much more easily lend themselves to understanding which features are significant and why [4]. Instill belief and trust in a sytem that is difficult, if not impossible, to explain is a barrier, even if that system produces accurate responses the vast majority of time.

Third, ethical and legal considerations must be made. Adopters of this technology must grapple with questions pertaining to the liability if and when the system makes a prediction that harms a patient [4]. If a radiologist is led to a conclusion by an algorithm, and the algorithm presents a false positive, a false negative or presents one conclusion while missing another, who is responsible for the error?

Fourth, the ANNs are dependent on the quality and nature of the imaging data used to train algorithms. There is variability around the world in regards to the type and quality of imaging machines and the imaging protocols that dictate why and how images are taken [4]. It's conceivable that two different imaging machines or two different techniques capturing two images of similar abnormalities could appear different to an algorith such that the conclusion is not the same. This issue could at least partially be addressed by sufficiently large datasets containing labeled images of abnormalities that were taken using machines of varying quality and executed using differing methods.

7 CONCLUSION

math used - sigmoid function - why what does this do

back propagation

what is deep learning, how does it compare with human brains

difference between types on neural networks, which are best suited to the tast

ACKNOWLEDGMENTS

These are my acknowledgements

REFERENCES

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A ISSUES

DONE:

Example of done item: Once you fix an item, change TODO to DONE

A.1 Assignment Submission Issues

Do not make changes to your paper during grading, when your repository should be frozen.

A.2 Uncaught Bibliography Errors

Missing bibliography file generated by JabRef

Bibtex labels cannot have any spaces, _ or & in it

Citations in text showing as [?]: this means either your report.bib is not up-to-date or there is a spelling error in the label of the item you want to cite, either in report.bib or in report.tex

A.3 Formatting

Incorrect number of keywords or HID and i523 not included in the keywords

Other formatting issues

A.4 Writing Errors

Errors in title, e.g. capitalization

Spelling errors

Are you using *a* and *the* properly?

Do not use phrases such as *shown in the Figure below*. Instead, use *as shown in Figure 3*, when referring to the 3rd figure

Do not use the word *I* instead use *we* even if you are the sole author

Do not use the phrase *In this paper/report we show* instead use *We show*. It is not important if this is a paper or a report and does not need to be mentioned

If you want to say *and* do not use *&* but use the word *and*

Use a space after . , :

When using a section command, the section title is not written in all-caps as format does this for you

`\section{Introduction}` and NOT `\section{INTRODUCTION}`

A.5 Citation Issues and Plagiarism

It is your responsibility to make sure no plagiarism occurs. The instructions and resources were given in the class

Claims made without citations provided

Need to paraphrase long quotations (whole sentences or longer)

Need to quote directly cited material

A.6 Character Errors

Erroneous use of quotation marks, i.e. use “quotes” , instead of ” ”

To emphasize a word, use *emphasize* and not “quote”

When using the characters & # % _ put a backslash before them so that they show up correctly

Pasting and copying from the Web often results in non-ASCII characters to be used in your text, please remove them and replace accordingly. This is the case for quotes, dashes and all the other special characters.

If you see a ffigure and not a figure in text you copied from a text that has the fi combined as a single character

A.7 Structural Issues

Acknowledgement section missing

Incorrect README file

In case of a class and if you do a multi-author paper, you need to add an appendix describing who did what in the paper

The paper has less than 2 pages of text, i.e. excluding images, tables and figures

The paper has more than 6 pages of text, i.e. excluding images, tables and figures

Do not artificially inffate your paper if you are below the page limit

A.8 Details about the Figures and Tables

Capitalization errors in referring to captions, e.g. Figure 1, Table 2

Do use *label* and *ref* to automatically create figure numbers

Wrong placement of figure caption. They should be on the bottom of the figure

Wrong placement of table caption. They should be on the top of the table

Images submitted incorrectly. They should be in native format, e.g. .graffle, .pptx, .png, .jpg

Do not submit eps images. Instead, convert them to PDF

The image files must be in a single directory named "images"

In case there is a powerpoint in the submission, the image must be exported as PDF

Make the figures large enough so we can read the details. If needed make the figure over two columns

Do not worry about the figure placement if they are at a different location than you think. Figures are allowed to ffoat. For this class, you should place all figures at the end of the report.

In case you copied a figure from another paper you need to ask for copyright permission. In case of a class paper, you must include a reference to the original in the caption

Remove any figure that is not referred to explicitly in the text (As shown in Figure ..)

Do not use textwidth as a parameter for includegraphics

Figures should be reasonably sized and often you just need to add columnwidth

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True : ref check passed: (refs >= figures + tables)
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True : check if all figures are refered to: (refs >= labels)

Label/ref check
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When using figures use columnwidth
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Tip: newlines can often be replaced just by an empty line

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Advancements in Drone Technology for the U.S. Military

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Indiana University
petrusse@iu.edu

ABSTRACT

Technological breakthroughs in military technology have put the U.S. in a new a chapter of warfare. These advancements have become realizations of what was at one time only deemed possible in science fiction, such as autonomous decision making and weaponization of drones. These innovations provide unique advantages to the leaders of the technology and are too lucrative to ignore. However, in coming years as these technologies push the boundaries, decisions will need to be made in how much control military leaders are willing to give to their new mechanic allies and whether they should be passive, as they have been in the past, or active participants on the battlefield.

KEYWORDS

i523, HID 334, Drone Technology, Big Data, Military Technology

1 INTRODUCTION

Among the many industries being transformed by the Big Data movement, few carry more consequences than the changes being experienced in the U.S. military due to the direct impact on human life. It has been argued that the current changes could affect warfare and diplomatic landscape on the same scale that nuclear weapons did [1].

Traditionally, drones can be categorized as a re-usable, autonomous vehicle either in the air or on the ground. In the air, these are known as "Unmanned Aerial Vehicles", or UAVs, and on the ground, "Unmanned Ground Vehicles", or UGVs. More recently, this has expanded to USVs for "Unmanned Surface Vehicles" and UUVs for "Unmanned Underwater Vehicles." Our focus will remain primarily on the former two types, UAVs and UGVs since these have been the most long-standing types.

For most citizens, UAVs remain the more well known of the two and have garnered more attention recently for their proposed commercial and consumer uses. Unsurprisingly, this has created rapid growth in the industry. In 2017 alone, the $6 billion industry for these uses is expected to grow by 35%, roughly matching its 2016 growth [9]. While these market segments are growing quickly, they remain in their nascent stages and dwarfed by drone spending in the Department of Defense (DoD). To put the difference of size in perspective, for the FY2018 budget, the DoD requested nearly $7 billion *for the year* in drone spending, which is the highest since FY2013 and $3.3 billion than previously estimated four years ago [10]. This annual spending is no anomaly. Currently, the DoD is responsible for nearly 90% of the spending in the UAV market [7].

This continued investment in the drone program demonstrates a clear vote of confidence in the advancement of this technology and its impact on military operations.

2 STRATEGIC ADVANTAGE WITH DRONES

One facet in the complexity of military planning is finding the path that gives the highest probability of success with the lowest possible risk of casualties. In this light, the stakes of the problem that technology is trying to solve with Big Data could not be higher. Leaders are constantly trying to solve a constrained optimization problem and when it comes to this overarching problem of mission success, Big Data can be utilized to help the decision maker solve the smaller sub-problems that comprise it, such as where to set up surveillance, where and when to pursue the enemy, how to carry out reconnaissance and how to disarm hazardous obstacles along the way.

2.1 Surveillance

The RQ-4 Global Hawk is currently America's most expensive surveillance drone, projected to cost nearly $428 million in 2018 [10]. Having flown missions for nearly 15 years now, the total cost of this drone is over $14 billion [6]. This drone provides a great case study in the evolution of military drone capabilities for its long track record, which stands at over 200,000 flight hours [11].

Initially, the RQ-4 provided imagery through its equipped sensors, which were for landscape topography (synthetic aperature radar), navigation (electro-optical sensors) and heat signatures (infrared sensors). Later models have been equipped with features that allow the antennae to move on its own for an improved signal and a radar tracking system that allows its operators to zero in a target from its surroundings (moving target indication).

The advancement of sensors provides leaders with high resolution photos for strategic planning. In its current capability, images can be obtained with up to a 1 foot resolution and targeting precision within a 60 foot radius from its maximum height of 65,000 feet [21]. However, it should be noted, the revolutionary aspect in drones does not necessarily come entirely from its sensors. The U-2, which was first introduced in 1955 and famously downed over the Russian border during the Cold War, can be retrofitted with these sensors. The stark difference modern aerial surveillance has with its predecessors like the U-2 is that the current technology allows the device to be unmanned. As a result, if a situation were to occur like with the U-2 where the plane is downed, there is no pilot to capture and a diplomatic crisis around hostage negotiation is avoided. Along these lines, a similar situation played out in late 2016 when China captured an underwater U.S. drone with no major diplomatic ramifications. Additionally, unmanned drones allow for flight times that would likely push beyond the boundaries of human focus and endurance since the RQ-4 can sustain flights in excess of 30 hours [19].

2.2 Swarms

One of the most exciting applications of drone technology revolves around drone swarms. Spending in this category, broadly defined as "Autonomy, Teaming and Swarms" has doubled in the last four years [10]. With UGV spending stagnant over this period, this program is now receiving twice as much funding, but is still only a small fraction of the largest program, unmanned aircrafts, at 10% of that spending. The rapid growth in this program will undoubtedly continue given the revolutionary nature of these swarms as it relates to warfare.

The public has been aware of this new technology since early 2016, but its development has been underway since at least 2014 [13]. The program, however, did not gain mass attention until a 60 Minutes special aired in early 2017 introducing the Perdix drone and demonstrating a mock swarm mission comprised of 103 Perdix drones acting as a single unit [15].

The Perdix drone looks similar to a toy airplane, weighing only a pound and with a wingspan of 6.5 inches. This simple design reflects the expendability of each drone, which is one of the swarms major advantages. In the swarm, there is no lead drone in the swarm and therefore, no single vulnerability to attack if one of the drones was taken down by the enemy [5]. As a result, each drone is designed to work with other drones of the same type as a single unit to achieve a given mission objective and fill in any gaps if drones are no longer functional. These drone swarms are intended to be able to scan large areas very quickly, provide electronic jamming against the enemy, create a wide communication area for ground troops or confuse enemy radar [16].

In the 60 Minutes demonstration, these Perdix drones were dropped from F-18 jets at the speed of sound, aggregated together and collectively scanned an area, entirely on their own. The innovation in computing and Big Data allows the swarm to exist since no human either individually or as part of a team could make the calculations that these drones are making collectively to achieve their mission.

At the moment, while also being a means of surveillance like the RQ-4, these swarms are not a replacement for these traditional drones, nor does that seem to be the end goal. These Perdix drones have a flight time of only 20 minutes currently and are flown at a relatively low-altitude. This compares with with the RQ-4, which is considered a HALE, or High Altitude Long Endurance drone. Additionally, the RQ-4 requires a team of nearly a dozen while the swarm is given a directive by an operator on its objective and requires no human intervention [8]. Lastly, with a unit cost of $235 million per unit, the RQ-4 holds an economic liability with any enemy attack that the Perdix does not at only $30,000 per unit.

Eventually, these swarm drones are expected to have the capability to be aggregated together by the thousands and carry out overwhelming and confusing attacks on enemies. It has been properly described as the "difference between a wolf pack and just little wolves[8]."

2.3 Disarmament and Detection

Of these two drone segments, UAVs remain by far the larger of the two with spending on UAVs nearly 20x that of UGVs[10]. To date, UGVs have been responsible for aiding ground troops in their mission. While this could come in the form of reconnaissance or in helping carry heavy loads, explosive detection has arguably been the most important impact for their ability to screen areas for improvised explosive devices (IEDs) along paths that ground troops must travel to complete their mission.

In comparison to aerial innovations, UGV development has developed at a slower pace when it comes to full autonomy. This is largely due to the nature of challenges a ground drone faces in navigation versus flying. Namely, how to deal with uneven terrain and unpredictable obstacles [14]. Nonetheless, user operated UGVs have proven to be a tremendous advantage as it relates to disarmament and detection.

To circumvent the endless and unique possible situations a UGV could be faced with, the military been innovative in the way these UGVs are deployed instead to avoid these hurdles. For example, soldiers can now throw a five pound UGV from a height of up to 15 feet to begin a reconnaissance or bomb detection mission [18]. This allows them to be thrown on top of a roof or into openings that humans might not be able to fit. These robots are equipped with video cameras and various sensors to relay information about the landscape back to the operator.

3 RECENT DEVELOPMENTS

In the field of surveillance, one of the newest drones being pursued is the Zephyr 8, a solar powered drone that can fly for 45 *days* continuously. This flight time allows the drone to be launched in the U.S. and reach destinations like Afghanistan on its own, but perhaps even more incredible is the amount of data this drone can produce. Specifically, it flies at a height of nearly 12.5 miles in the sky, far exceeding the height needed to see the curvature of the Earth, but can still take pictures at the precision of 6-inch resolution. This height allows surveillance of 386 square miles and coupled with this resolution, this becomes a large data set very quickly [3]. One of the newest developments in drone technology by the U.S. military does not categorize as a UAV or UGV, but instead as a USV, for Unmanned Surface Vehicle. These are autonomous boats with the most famous example to date being the Sea Hunter, which was introduced in 2016. This massive vessel, with the length of 132 feet and 135 tons, was built to track diesel submarines and detect mines [17]. It is a major innovation for the U.S. military for its range, which is 12,000 miles on a single tank of gas, and its economic savings, which is 2% of what a traditional ship costs to operate daily. [20] [4]. Or, framed differently, the U.S. military can operate 50 of these Sea Hunter ships for the same cost as one traditional ship. This has proven to be a Big Data and computational marvel as the ship operates autonomously through 36 computers running 50 million lines of code [15].

4 FUTURE DEVELOPMENTS

One of the aspirational areas of future drone development for the military is in the field of Micro Air Vehicles (MAVs), which as the name implies, are extremely small UAVs, such as the size of a small bird. Even within that area, there is a growing interest in Nano Air Vehicles, which could be the size of an insect. The future of this technology is for troops to gain intelligence on areas that would be either too dangerous or physically impossible to enter.

One of the more well-known MAVs is the Black Hornet Nano. The drone measures 4 inches in length and is an inch wide with the weight of just a half an ounce, or the weight of 3 pieces of paper. This drone has three cameras and can fly for 20 minutes non-stop. Interestingly, the drone is designed to stream video back to its operators to avoid the risk of footage being compromised if it were stored locally. While this is all extremely impressive, future developments are pushing to make these MAVs even smaller. However, the smaller and lighter these MAVs become, the harder they become for a user to control. The reason being is that the smaller they are, the more sensitive they become to cross winds, the more difficult they are to equip with navigation sensors and the smaller field of vision the camera has. However, the inability to be detected by enemies is a tremendous advantage and to circumvent these piloting issues, work is being done to make them fully autonomous, potentially even as a swarm.

5 INTEGRATION OF DRONE TECHNOLOGIES

One of the beautiful aspects of technological innovation are the synergies created. For the U.S. military, these synergies in the context of the Big Data movement are opening new possibilities with difficult questions that will eventually have to be answered. An example of this is how or if drones should be weaponized, even if their decision making is superior to humans.

Without Big Data this debate could never take place. For example, one of the highest resolution drone surveillance cameras in 2014, ARGUS-IS, disclosed some, but not all, of its features as some parts remained classified. It was equipped with a 1.8 billion megapixel camera that could monitor 10 square miles and store all of this information, which works out to be 6 petabytes of data daily [2].

This information accumulation allows greater monitoring of potential targets. Namely, if a known target is tagged and tracked, pictures can be taken at different angles and stored in a database. This ability to accumulate a massive amount of data improves the accuracy of facial recognition. One demonstration showed how a low-altitude drone could be coupled with a UGV and USV against an enemy. The low-altitude and UGV would work in conjunction with each other to carry out a reconnaissance and scan an area and once a match of the target has been found, communicate this to the USV in a different location to fire the weapon systems on the target [15].

While this chain of events is currently possible, which is to attack an enemy with no human interaction, there is a difficult ethical choice to be made in how, or if, these drones will be integrated with respect to weaponization. Even if computers are able to make better decisions on facial recognition, which recent evidence suggests that they can, there remains a large reluctance to open this potential Pandora's box as a new type of warfare [12].

6 CONCLUSION

Adoption of drone and autonomous technology has become the modern arms race and the U.S. has shown itself willing to push to the forefront of these new technologies. This new arms race is unlike the nuclear arms race in that there is no clear first mover, or innovator, advantage. Instead, in the era of Big Data, as shown in the use example of these technologies, the operator that is best able to use the vast amount of information available to them simultaneously will hold the advantage. The U.S. is making promising steps towards this end and will face new, difficult choices in how to integrate these innovations.

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    the ground, ``Unmanned Ground Vehicles", or UGVs. More recently,
    this has expanded to USVs for ``Unmanned Surface Vehicles" and
    UUVs for ``Unmanned Underwater Vehicles." Our focus will remain
    primarily on the former two types, UAVs and UGVs since these have
    been the most long-standing types.

59: Eventually, these swarm drones are expected to have the capability
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Big Health Data from Wearable Electronic Sensors (WES) and the Treatment of Opioid Addiction

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ABSTRACT

Wearable electronic sensors (WES) and mobile health applications can be used to collect vital health data to supplement traditional forms of treatment for opioid addiction and may be used to predict risk factors related to overdose death.

KEYWORDS

Health Informatics, Wearable Sensors, Addiction Treatment, i535, HID335

1 INTRODUCTION

In the increasingly connected digital age, personal electronic devices are generating huge volumes of data with important applications for health informatics. Wearable electronic sensors (i.e., *wearables*) and fitness monitors (e.g, FitBit, iWatch) can record our movements and vital physiological measures such as heart rate, temperature, and blood pressure [7]. Consumers are using wearables to self-monitor stress and hypertension, and wearable sensors can be used to help track recovery following medical procedures such as surgery [2]. The development of personalized health care models are also enabling individuals to self-monitor and manage their own health in partnership with care providers. This paper explores approaches to using personal electronic devices and wearable sensors for the treatment of addiction disorders and the prevention of drug overdose. Past research has shown that *Mobile Health* platforms have been used to address prescription medication abuse in several ways: (a) monitor patient health conditions at any time and remotely, (b) monitor medication consumption, and (c) connect patients with health care providers and treatment services [19]. The following review of the literature shows that wireless digital technologies and smartphone applications are effective at providing health data in real time and can assist patients in recovery to resist physical cravings, prevent relapse, and access treatment support. Mobile applications can play an important role in addressing the opioid epidemic by supplementing traditional approaches to addiction treatment and recovery.

1.1 The Opioid Epidemic: Medication Abuse and Addiction

The abuse of prescription opioid medication in the U.S. has become a major health crisis that the Department of Health and Human Services (HHS) has described as an epidemic [20]. Approximately 2 million Americans were dependent on or abused prescription opioids (e.g., oxycodone, hydrocodone) in 2014 [9]. Overdose deaths from prescription opioids has quadrupled since 1999, resulting in more than 180,000 deaths between 1999 to 2015. Figure 1 shows that the dramatic increase in overdose deaths in the U.S. between 2000 and 2016 are from synthetic opioids (other than methadone), natural and semi-synthetic opioids, and heroin [14]. Of the estimated 64,000 drug overdose deaths in 2015, over 20,000 were from fentanyl and other synthetic opioid analogs. Public health agencies are implementing comprehensive efforts to address four major risk areas of prescription opioid abuse, overdoses, and deaths: (i) Increasing knowledge of opioid abuse and improving decisions among medication prescribers, (ii) Reducing inappropriate access to opioids, (iii) Increasing effective overdose treatment, (iv) Providing substance-abuse treatment to persons addicted to opioids. The opioid epidemic is complex, with multiple and interacting causal factors. To understand how technological interventions can play a role in mitigating the crisis, it is necessary to consider the nature of addiction itself and various approaches to treatment.

[Figure 1 about here.]

1.1.1 Drug Addiction and Treatment. For millions of people struggling with substance abuse and dependency in the U.S., addiction and relapse are chronic health conditions [4]. Drug addiction has many similar characteristics to other chronic medical illnesses; however, there are unique challenges to the treatment of addiction illnesses. For example, drug addicted patients undergo intense detoxification in rehabilitation treatment programs, which reduces their drug tolerance, and then are released back into the same environment associated with their drug use, putting them at greater risk for relapse and potential drug overdose. The lack of continuity in the treatment of addiction disorders leaves persons in recovery at high risk of relapse for substance use and abuse. Second, individuals with severe addiction disorders end up at emergency rooms for care following acute intoxication, often following law enforcement interventions. Emergency personal are very competent at crisis interventions for drug overdose, but lack resources to evaluate severe addiction disorders or provide follow-up. Furthermore, addicted individuals seeking treatment often relapse at night or on weekends when treatment centers are not open. Various theories of addiction and relapse have been proposed. According to the classical conditioning model, situational cues or events can elicit a motivational state underlying relapse to drug use. A slightly more complex model suggests that addictive behavior can be reinstated after extinction of dependency by exposure to drugs, drug-related cues, or environmental stressors [15]. Understanding that a user's affective (i.e., motivational) response to cues in the environment can lead to relapse and drug use are key to developing strategies for prevention and treatment.

1.2 Technology-Based Interventions for Addiction Treatment

Technology-based interventions have been used for drug addiction assessment, treatment, prevention, and recovery [12]. In terms of assessment, data about substance use can be obtained from mobile cell phone reporting outside of treatment settings. Web-based approaches to treatment have been implemented online to improve behavioral and psychosocial functioning for addicted individuals in recovery [13]. For example, the *Therapeutic Education System* (TES) is a self-directed, web-based interactive treatment program consisted of 65 training modules that focused on cognitive-behavioral skills and psychosocial functioning (family/social relations). This online approach helped to increase access to treatment for individuals in rural areas, and included an optional contingency management module. A computer based *Training in Cognitive Behavioral Therapy* (CBT) program was found to enhance treatment outcomes when provided in conjunction with traditional substance abuse treatment, and helped improve coping skills and decision-making skills [6]. In evaluating the effectiveness of mobile applications for addiction treatment, several questions remain to be answered: First, if mobile applications are regarded primarily as supplements to traditional therapeutic treatment, can their effectiveness be evaluated independently from the approach used in treatment? Second, over what time period period can the benefits of mobile applications be observed? Research evidence suggests that the benefits of mobile interventions may be limited to 12 or 15 weeks [16]. It is unclear whether individuals struggling from addiction would continue to use mobile treatment applications in the long term, beyond a limited course of treatment.

1.2.1 Mobile-Based Applications. Mobile applications have been used for monitoring and treatment of substance abuse and addiction disorders for several decades [4]. Early applications included the use of electronic pagers (i.e., beepers) for experience sampling with paper-based assessments that generated data about daily life behavior and experiences [16]. In the 1990s, programmable personal digital assistants (e.g., palm-pilot) enabled collection of data electronically, and subsequent mobile research tools facilitated the collection of information about psychological factors (e.g., daily stressors, emotional states, thoughts) and other variables related to addiction (e.g., craving, contextual cues, actual substance use). Assessments performed several times throughout the day (commonly, every 2 to 4 hours) allowed for analysis of the daily fluctuations of these symptoms and features. Historically, addiction research has faced some unique challenges that the use of mobile technologies may help to overcome. Methodological aspects of traditional research using retrospective, cross-sectional, or longitudinal assessments (over periods of weeks, months, or years) have been problematic for investigating risk factors including behaviors and symptoms (severe physiological cravings, withdrawal, and substance use) that can span a relatively short time. An additional factor is the co-morbidity, or co-occurence, of substance use disorders (SUDs) with other psychological disorders, such as anxiety and mood disorders. For example, the *self-medication* model has commonly been used to explain the association between alcohol abuse as an effort by an individual to reduce or cope with a high degree of anxiety (or depression). It has also been challenging for researchers to capture the role of environmental or contextual cues (e.g., people, places, things) associated with substance abuse, which can act as triggers of relapse for individuals in recovery.

Smartphone Applications. Continued care is an important ingredient for recovery from addiction that involves monitoring, outreach, planning, case management, and social support [11]. Smartphone applications can help individuals in recovery to monitor cravings at critical points in daily life, track contextual cues associated with substance use, and provide outreach to support services. A team of researchers at the University of Wisconsin evaluated the effectiveness of a smartphone application called *Addiction Comprehensive Health Enhancement Support System* (A-CHESS), designed to provide recovery support for patients leaving a residential alcohol treatment center [10]. A-CHESS provided anytime, anywhere access to support services in audio-visual format, GPS monitoring and warnings for risky locations related to past substance use, and communication with counselors. Over an 8-month period (and 4 month follow-up), patients who used the A-CHESS intervention reported fewer risky drinking days, on average, per month than patients in a comparable control group. The findings provide evidence that the smartphone intervention was effective at treating a critical behavioral measure for treatment of alcohol use disorder (AUD). The methods described in this study could be extended by re-purposing built-in smartphone sensors to record physiological measures related to opioid usage, and communicate data to health care providers or treatment specialists to initiate interventions for opioid addiction [11].

[Figure 2 about here.]

1.3 Medication Adherence and Abuse Monitoring System

Mobile health applications can be used to monitor medication adherence and as an advanced warning system for potential abuse of prescription medication [18]. Medication abuse can consist of higher medication dosages or rapid escalation of a prescribed dosage, and the general goal of a prediction model is to analyze patient data for sudden changes in medication consumption. Figure 2 illustrates several steps in a process and decision support structure for a medication monitoring system, with adjustable parameters, such as the threshold for abuse (e.g., greater than N doses in X hours) [19]. A major challenge for measuring medication abuse is obtaining reliable information from potentially addicted individuals based on self report data. Ideally, information on medication consumption and adherence can be obtained from multiple sources. Addiction is a complex behavior that involves a variety of factors, including: demographics (e.g., age, gender), past history, comorbidity with other disorders, family support, social influence, employment status, and patient motivation. Figure 3 shows a model architecture of a system for monitoring potential abuse where dose information is provided via a smartphone application, relayed via wireless cellular network to analytic models that measure changes in medication consumption, relays reports to support treatment services for possible interventions, and to a smart medication box that dispenses medication. In order to function successfully a medication abuse monitoring system depends on the collection of reliable information, including data from wearable sensors that can directly

measure physiological changes (e.g., heartrate, blood pressure, respiration, temperature) related to changes in medication usage. In the context of prescription opioid abuse, a medication monitoring system could be very beneficial in anticipating opioid dependency and preventing accidental death from medication overdose.

[Figure 3 about here.]

1.4 Mobile Detection with Wearable Biosensors

Portable biosensors can provide a continuous stream of data on the timing, location, context, and duration of drug use by individuals in treatment. In a small pilot study, researchers used an Affectiva Q sensor to measure electrodermal activity (EDA), skin temperature, and acceleration (8 recordings per second), in a sample of N = 4 patients during the administration of opioid medication in an emergency room setting [5]. Table 1 provides a summary of the participant characteristics. The biosensor was worn on the wrist and was similar in size and dimensions to a wristwatch or fitbit health monitor. The results showed an increase in EDA associated with intravenous opioid injection that was detected by the biosensors. In addition, there was some indication that the physiological response to opioids varied according to individual drug tolerance; patients with higher opioid tolerance showed less EDA response than patients with low tolerance. The findings provide evidence to support the use of wearable sensors to detect drug use in real time, in a controlled environment. An important limitation of the study is the small sample size, which reduces the generalizability of the findings to a broader population. The authors also acknowledged that psychological or physiological stress can produce alterations in EDA, skin temperature, and acceleration, and therefore this could not be ruled out as an alternative explanation for the findings. The results are promising, however, and encourage efforts to explore the effectiveness of wearable biosensors in the context of environments associated with substance use.

[Table 1 about here.]

1.5 Emerging Sensor Technologies

Wearable wireless sensors have been used to study physiological responses, activity, and social behavior in non-human primates in the form of a fitted vest and using a mobile phone with blue tooth protocol to collect data in real time. Figure 4 shows sample ambulatory data from a rhesus macaque recorded from a wearable wireless sensor for 11 hours inside a large group primate cage [8]. Data was recorded on a custom Android software application, which captured measures of EDA, heart rate (HR), temperature, and acceleration. The goals of this study were to measure associations between physiological measures and social behavior in primates; however, this practical application of sensor technology demonstrated a system that was relatively low-cost, highly portable, scalable, and simple to use. Future research could explore the development of a similar system modified for use with humans to collect data on physiological measures from addicted individuals in naturalistic settings.

[Figure 4 about here.]

1.5.1 LoRa Backscatter: Enabling Ubiquitous Connectivity. Emerging technologies, such as longe range (LoRa) backscatter, have the potential to extend the boundaries of wireless connectivity. Existing radio technologies (e.g., WIFI, ZigBee, SigFox, LTE-M) provide reliable long range coverage, but consume energy and would be costly to expand to large scale implementation; however, LoRa backscatter is a smaller, low-cost, low-power alternative with extended range between an RF source and receiver of approximately 475 meters (i.e., yards) [17]. Table 1 shows the sensitivity and supported data rates for different communication technologies and feasibility of different power sources. LoRa backscatter performed best overall, in terms of sensitivity (-149 dBm), supporting bit rates of 18 pbs to 37.5 kbps, providing whole home coverage, and capable of being powered by button cell, tiny solar cell, or printed battery. LoRa backscatter uses chirp spread activation (CSS) that can synthesize continuous frequency modulated chirps; a limitation is that backscatter is drowned out by noise and the RF source. The LoRa backscatter system was tested in various deployments: across three floors of a 4800 square- foot house, a single floor of 13,000 square foot office building, and on a one-acre farm. Figure 5 shows the layout of the house with the RF source (TX) on the second floor and receiver in the basement (RX); the plot shows the system achieved RSSI values greater than -144 dBm, with reliable wireless coverage throughout the house, and rates sufficient for temperature sensors that transmit small packages. The system was also implemented in the form flexible epidermal patch sensor shown in Figure 6, that provided reliable connectivity across a 3,300 square foot atrium with RSSI greater than -132 dBm. LoRa backscatter provides a compact, energy-efficient, and affordable wireless transmission system that can be extended to scale at reasonable cost. This system could possibly transmission of biometric data from wearable sensors to capture health information from addicted individuals in treatment.

[Table 2 about here.]

[Figure 5 about here.]

[Figure 6 about here.]

1.5.2 Graphene Electronic Tattoo sensors. Wearable, tattoo-like epidermal sensors allow for continuous, ambulatory monitoring of biometric signals from the heart, muscles, and brain, outside of hospitals and clinical lab settings [3]. A team of researchers at the University of Texas at Austin designed the graphene electronic tattoo (GET) as a long term wearable sensor that can be directly laminated on human skin, and can remain functional for several days with a liquid bandage cover [1]. Graphene is the thinnest electrically conductive material that is biocompatible, stable, and mechanically robust. The "GET is fabricated through a simple 'wet transfer, dry patterning' process directly on tattoo paper, allowing it to be transferred on human skin exactly like a temporary tattoo, except the sensor is transparent"(p.8)[1]. As depicted in Figure 7, the GET sensor is is flexible, stretchable, and transparent, and less than a sub-micrometer in thickness (463 +/- 30 nm). GET has been used successfully to measure electrocardiograph (ECK), electromyogram (EMG), electrocephalograph (EEG) signals, as well as skin temperature and skin hydration. After use, the GET can be easily removed by peeling it from the skin. A future step in the development of GET is to include an antenna to the design so that signals can be beamed off the device to a smartphone application or computer. The thin, flexible, resilient tattoo biosensor provides a durable, unobtrusive tool for collecting physiological data, and

could be used to detect physical changes due to drug withdrawal in addicted individuals.

[Figure 7 about here.]

2 CONCLUSION

Can Technological Applications Reduce Opioid Addiction? The abuse of prescription medication in the U.S. has led to opioid addiction at levels of epidemic proportion. Technological interventions can play a role in addressing this crisis as a supplement to conventional forms of addiction treatment. Mobile health applications can help monitor potential medication abuse and connect individuals with treatment services. An important limitation of data based addiction interventions is the difficulty of obtaining reliable information about medication consumption based on self-reports from potentially addicted individuals. The literature reviewed indicates that wearable sensors are an effective way to measure vital health data in real time and remotely. Providing individuals in recovery with vital health data may help them to resist physical cravings and prevent relapse. Another limitation of treatment approaches is that, after detoxification, individuals in recovery are released back into the environmental settings associated with their drug use, putting them at risk for potential relapse and possible overdose. Recent advances in signal technologies such as LoRa Backscatter and Graphene tattoo sensors can lead to the more efficient collection of biometric information and cost effective transmission of health data for subsequent analysis. The opioid addiction epidemic is a complex phenomenon, with both physical and sociological contributing factors. Technological interventions will increase the amount of data about addicted individuals and relevant risk factors that may be used to predict opioid overdose death; however, it will not address the environmental factors that lead to addiction. Despite increased awareness of the potential for prescription medication abuse, Table 1 shows the rate of overdose deaths is growing more rapidly for heroin and synthetic opioids such as fentanyl compared to conventional prescription opioid medication. The implication of this is that individuals who may become addicted to prescribed medication may go on to abuse illicit or synthetic opioids, in non-clinical, unsupervised, and unregulated settings. Big data offers potential for transforming health care and addition treatment. Increasing levels of data about opioid addiction ultimately may not be sufficient to prevent or decrease rates of overdose death if the availability of illicit and synthetic opioids remains high.

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3 ISSUES

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Example of done item: Once you fix an item, change TODO to DONE

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If you want to say *and* do not use *&* but use the word *and*

DONE:

Use a space after . , :

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When using a section command, the section title is not written in all-caps as format does this for you

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It is your responsibility to make sure no plagiarism occurs. The instructions and resources were given in the class

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Need to quote directly cited material

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Acknowledgement section missing

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Incorrect README file

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In case of a class and if you do a multi-author paper, you need to add an appendix describing who did what in the paper

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The paper has less than 2 pages of text, i.e. excluding images, tables and figures

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The paper has more than 6 pages of text, i.e. excluding images, tables and figures

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Do not artificially inffate your paper if you are below the page limit

3.8 Details about the Figures and Tables

DONE:

Capitalization errors in referring to captions, e.g. Figure 1, Table 2

DONE:

Do use *label* and *ref* to automatically create figure numbers

DONE:

Wrong placement of figure caption. They should be on the bottom of the figure

DONE:

Wrong placement of table caption. They should be on the top of the table

DONE:

Images submitted incorrectly. They should be in native format, e.g. .graffle, .pptx, .png, .jpg

DONE:

Do not submit eps images. Instead, convert them to PDF

DONE:

The image files must be in a single directory named "images"

DONE:

In case there is a powerpoint in the submission, the image must be exported as PDF

DONE:

Make the figures large enough so we can read the details. If needed make the figure over two columns

DONE:

Do not worry about the figure placement if they are at a different location than you think. Figures are allowed to ffoat. For this class, you should place all figures at the end of the report.

DONE:

In case you copied a figure from another paper you need to ask for copyright permission. In case of a class paper, you must include a reference to the original in the caption

DONE:

Remove any figure that is not referred to explicitly in the text (As shown in Figure ..)

DONE:

Do not use textwidth as a parameter for includegraphics

DONE:

Figures should be reasonably sized and often you just need to add columnwidth

e.g.

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/includegraphics[width=\columnwidth]{images/myimage.pdf}
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List of Figures

1 Drugs Involved in U.S. Overdose Deaths from 2000 to 2016, National Institute on Drug Addiction (NIDS) [14] 8
2 Process and Decision Support for Abuse Monitoring System [19] 9
3 Architecture for Abuse Monitoring System [19] 10
4 Sample Ambulatory Data from Rhesus Macaque Recorded on Wearable Sensor for 11+ hours Inside Large Primate Cage Facility [8] 11
5 Home Deployment of LoRa backscatter pakcets across 4,800 sq. ft. House Apread Across Three Floors [17] 12
6 LoRa Backscatter Epidermal Patch [17] 13
7 Graphene Electronic Tatoo Biosensor [1] 13

Figure 1: Drugs Involved in U.S. Overdose Deaths from 2000 to 2016, National Institute on Drug Addiction (NIDS) [14]

9

Figure 2: Process and Decision Support for Abuse Monitoring System [19]

(a) Architecture of the Abuse Monitoring System

10

Figure 3: Architecture for Abuse Monitoring System [19]

11

Figure 4: Sample Ambulatory Data from Rhesus Macaque Recorded on Wearable Sensor for 11+ hours Inside Large Primate Cage Facility [8]

Figure 5: Home Deployment of LoRa backscatter pakcets across 4,800 sq. ft. House Apread Across Three Floors [17]

Figure 6: LoRa Backscatter Epidermal Patch [17]

Figure 7: Graphene Electronic Tatoo Biosensor [1]

List of Tables

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2 Comparison of Wireless Communication Technologies [17] 15

Table 1: Summary of Participant Characteristics in Pilot study [5]

Patient	Age	Gender	History of Use	Intervention	Pre-EDA	Post-EDA
1	82	Male	Opioid naive	4 mg morphine	4.5	60.0
2	47	Male	Recent short-term	1 mg hydromorphone	3.4	12.2
3	43	Female	Chronic opioid use	1 mg hydromorphone	0.2	0.2
4	72	Male	Chronic opioid use	4 mg morphine	0.9	1.6

Table 2: Comparison of Wireless Communication Technologies [17]

Technology	Sensitivity	Data Rate	Home Coverage	Button Cell	Tiny Solar Cell	Printed Battery
Wi-Fi (802.11 b/g)	-95 dBm	1-54 Mbps	yes	no	no	no
LoRa	-149 dBm	18 bps-37.5 kbps	yes	no	no	no
Bluetooth	-97 dBm	1-2 Mbps	no	no	no	no
SigFox	-126 dBm	100 bps	yes	no	no	no
Zigbee	-100 dBm	250 kpbs	yes	no	no	no
Passive Wi-Fi	-95 dBm	1-11 Mbps	no	yes	yes	yes
RFID	-85 dBm	40-640 kbps	no	yes	yes	yes
LoRA Backscatter	-149 dBm	18 bps-37.5 kpbs	yes	yes	yes	yes

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bibtext report
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The style file: ACM-Reference-Format.bst
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latex report
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Compliance Report
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62: more than 180,000 deaths between 1999 to 2015. Figure 1 shows that
    the dramatic
210: Figure 2 illustrates several steps in a process and decision
     support structure
219: status, and patient motivation. Figure 3 shows a model
     architecture of a system
246: medication in an emergency room setting \cite{carreiro15}. Table
     1 provides a
285: in real time. Figure 4 shows sample ambulatory data from a rhesus
     macaque
314: (i.e., yards) \cite{talla17}. Table 1 shows the sensitivity and
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     supported data
324: one-acre farm. Figure 5 shows the layout of the house with the RF
     source (TX)
329: epidermal patch sensor shown in Figure 6, that provided reliable
     connectivity
382: As depicted in Figure 7, the GET sensor is is flexible,
     stretchable, and
427: for prescription medication abuse, Table 1 shows the rate of
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Natural Language Processing (NLP) to analyze human speech data

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ABSTRACT

Extracting meaningful information from large volumes of unstructured human language is a challenging big data problem. Automatic speech recognition (ASR) and natural language processing (NLP) based intelligent system can be used in several human machine interface applications both in consumer and industrial sector. Here describing the architecture, building blocks, performance and applications for such system that would use pre-developed ASR and NLP APIs.

KEYWORDS

i523, HID333, HID337, Natural Language Processing, Automatic Speech Recognition, Voic Recognition

1 INTRODUCTION

The advancements of digital signal processing, large data processing and natural language processing technologies made speech/voice recognition applications more sophisticated to help solving social and industrial problems. For example, having an intelligent automatic voice recognition system in home to recognize and differentiate between the family members and outsiders would add great value to modern society in terms of assisting in their busy life as well provide necessary help/guidance in offering day-to-day problem solutions, personalized entertainment, and safety/security. In another example, these systems can provide personalized customer care experience through voice and face recognition by engaging them based on their interests/hobbies. Google home, Alexa, and Siri have become part of the main stream human life activities to seek information and get entertainment by directly speaking with these devices.

The hypothetical intelligent voice system would need the following technologies to work together:

- Highly efficient voice sensors and high speed digital signal processors
- Automatic Voice Recognition (AVR) hardware and software algorithms
- Machine Learning (ML) algorithms to classify and learn the voice patterns
- Machine learning algorithms to understand family members habits and behaviors
- Natural Language Processing (NLP) algorithms to precisely recognize and process the voice data

Open Source and/or Other tools:

Figure 1: Conceptual Model of Speech Production

- Google Cloud Speech API or Alexa Voice Service (AVS)
- Audio processing hardware and software algorithms
- Natural language processing (NLP) to analyze the speech of family members, friends and strangers
- Interfacing with email servers, phone, text message servers

The following sections are organized to review some of the technologies available in the industry and universities and discuss the potential application concepts for home and industry.

The sections are broadly discussed on speech recognition and speaker recognition. In the speech recognition the focus is on detecting the words irrespective of the personal differences whereas speaker recognition is focused on detecting the physical speaker by discarding the words and their meanings. In other words, Speech recognition represents speech content and disregards speaker identity whereas speaker recognition represents speaker identity but disregards speech content.

A simple conceptual model of human speech production and recognition is shown in Figure 1. The human speech waveform creation process from the speaker intention is referred as Speaker Model which reflects speakerfis accent and choice of words. The Speech Recognizer consists of acoustic processor which analyzes the speech signal and converts it into a set of acoustic (spectral, temporal) features followed by linguistic decoder to estimate the words of spoken sentence.

2 SPEAKER RECOGNITION THEORY

The speaker recognition technology is multidisciplinary, which requires hardware based sensors to convert voice in to electrical signals, speech processing module that converters the electrical signals in to digitized data using advanced digital signal processors (DSP). The basic recognition process involves modeling the acoustic data and the natural language to search for patterns. Figure 2 shows the basic concept of voice recognition.

As speech is a sound pressure wave, its conversion in to electrical signal and then in to digital signal introduces distortion. As shown

Figure 2: Speaker Recognition Concept

in the figure, acoustic front-end requires several signal processing components such as spectral shaping, spectral analysis, spectral modeling, and parametric transformation. These components will condition the signal and establish the spectral measurements and parameters for acoustic modeling.

Once robust parameterization of speech signal is established, then spectral dynamics or changes of the spectrum with respect to time will be captured. Typically, speaker recognition can be achieved by using differentiation of spectral features, which requires temporal derivatives of the voice spectrum. These temporal derivatives are commonly approximated by differentiating cepstral features using a linear regression.

2.1 Feature Analysis

There is no "standard" set of features for speech recognition. Instead, various combinations of acoustic, articulatory, and auditory features have been utilized in a range of speech recognition systems [2]. The input human speech signal, s[n], is converted to the series of feature vectors, X = x1, x2, fi, xT, by the feature analysis or spectral analysis module. These feature vectors represent the temporal spectral characteristics of the speech signal in the form of mel frequency cepstrum coefficients.

2.2 Pattern Classification

[3]The pattern classification is the process of grouping the patterns, which are sharing the same set of properties. The pattern classification involves in computing a match score in speaker recognition system. The term match score refers the similarity of the input feature vectors to some model. Speaker models are built from the feature vectors extracted from the speech signals. Based on the feature extraction a model of the voice is generated and stored in the speaker recognition system. There three major techniques Dynamic Time Warping (DTW), Gaussian Mixture Model (GMM) and Support Vector Machine (SVM) typically used in pattern classification process.

2.3 Speaker Acoustic Models

In the process of recognizing speaker voice, the speaker model will be created and trained with acoustic characteristics of the voice. The typical speaker recognition process involves two specific tasks: verification and identification. In the verification, the goal is to determine from a voice sample if a person is who he or she claims. In the identification, the goal is to determine which one of a group of known voices best matches the input voice sample. In either task the speech can be constrained to be a known phrase (text-dependent) or totally unconstrained (text-independent). The success in both tasks depends on extracting and modeling the speaker-dependent characteristics of the speech signal which can effectively distinguish one talk from another.

A brief description of some of the speaker modeling methods typically used is given below.

Nearest Neighbor: In this technique, feature vectors from enrollment (training) speech are retained to represent the speaker. During the verification, the match score is computed as the accumulated distance of each test feature vector to its k nearest neighbors in the speaker's training vectors.

Neural Networks: These models are trained to discriminate between the speaker being modeled and some alternate speakers.

Hidden Markov Models (HMM): The temporal evolution of speech signal features/characteristics and model statistical variations of the features are encoded to provide statistical representation of speaker.

Template Matching: In this method, the model contains a template with sequence of feature vectors. During the verification a match score is produced by using dynamic time warping (DTW) to align and measure the similarity between test phrase and speaker template.

2.4 Natural Language Processing (NLP)

Speech recognition is the process of analyzing the acoustic data to extract the speech content. In this process speech will be converted in to text as first step. Then, the converted text will be fed to Natural Language Processing (NLP) algorithms for extracting the words and meaning. NLP is the processing of the text to understand the meaning of the text. Machine learning algorithms are used in conjunction with language models to recognize text in natural language processing systems, which may also employ speech models and hardware/software specialized to process and recognize speech.

Analyzing language for its meaning is a complex task. Modern speech recognition research began in the late 1950s with the advent of the digital computer. The 1960s saw advances in the automatic segmentation of speech into units of linguistic relevance like phonemes, syllables. And now with advancements in the field of Artificial Intelligence, neural networks have been used in many aspects of speech recognition such as phoneme classification, isolated word recognition, audiovisual speech recognition, and audiovisual speaker recognition and speaker adaptation. In the context of Speech Recognition, NLP involves 4 basic steps.

Morphological Analysis: Morphological analysis is the identification, analysis, and description of the structure of a given language's root words,word boundaries, affixes, parts of speech, etc. The term Morpheme means the "minimal unit of meaning". For ex: if you take word "unhappiness" it has three morphemes each carrying its own meaning.

Syntactic Analysis: Syntactic analysis is the process of analyzing a string of symbols in natural language conforming to the rules of a formal grammar.

Semantic Analysis: Semantic analysis is the process of relating syntactic structures, from the levels of phrases, clauses, sentences and paragraphs to the level of the writing as a whole, to their language-independent meanings.

Pragmatic Analysis: Pragmatic Analysis is how sentences are used in different situations and how use affects the interpretation of the sentence. Means what was said is reinterpreted as what it actually means.

NLP techniques are broadly categorized into *Rule based (human driven)* and *Statistical based (data driven)*:

Rule based: Rule based (human driven) approach requires huge human effort.Grammars and semantic components are prepared by many carefully hand crafted rules. Rule based approaches takes time, money and trained personnel to make and test the rules. Also rule engineering may not scale very well. Systems based on hand-written rules can only be made more accurate by increasing the complexity of the rules, which is a much more difficult task. In particular, there is a limit to the complexity of systems based on hand-crafted rules, beyond which the systems become more and more unmanageable.Once there are hundreds of rules, they start interacting in complex ways and becomes difficult while updating or adding any new rules. Rule based approaches have very poor generalization, but for the languages with fewest speakers, rules-based is the best approach since there exist not enough large corpora to go for Statistical approach. The best known parser with a rule base backbone is the RASP(Robust Accurate Statistical Parsing) system that combines rule-based grammar with a probabilistic parse selection model [12, 13].

Statistical based: Statistical (data driven) approaches treats natural language processing as a *machine learning* problem. They use supervised or unsupervised statistical machine learning algorithms. This method applies learning algorithm to a large body of previously translated text(large data) known as a parallel corpus. Systems based on Statistical approach can be made more accurate by simply supplying more input data.The main advantage of the statistical approach is its language Independence.Provided there are annotated data, the same algorithm can be used for learning rules or models for any language. The statistical approach is significantly leading in terms of accuracy against manually annotated corpora, as well as in overall number of statistical parsers compared to the number of rule-based parsers. Fast, cheap computing hardware, advances in processor speed, random access memory size, secondary storage, and grid computing making Statistical approach as popular choice. One example parser with his approach is MaltParser [128], a data-driven parser-generator for dependency parsing that supports several parsing algorithms and learning algorithms and allows user-defined feature models, consisting of arbitrary combinations of lexical features, part-of-speech features and dependency features.

Efficient approach is to use both approaches, first use a rule-based model, then use its results as data for the statistical model.

2.5 Speech Recognition Technologies

Google Cloud Speech API: Google Cloud Speech API converts audio to text by applying powerful neural network models in an easy to use API. The API recognizes over 110 languages and supports audio files up to three hours in length. Two basic use cases where Google Cloud Speech apis can be best applied are

- human-computer interaction
- speech analytics on human-to-human interactions.

IBM Watson Speech to Text: Powerful real-time speech recognition software.Automatically transcribe audio from 7 languages in real-time. Rapidly identify and transcribe what is being discussed, even from lower quality audio, across a variety of audio formats and programming interfaces.

Dragon NaturallySpeaking: Dragon NaturallySpeaking (DNS) is a speech recognition software package developed by Dragon Systems of Newton, Massachusetts. It recognizes and transcribes words at a high speed, and gives flexibility to dictate for any situation.

In terms of freely available resources, Carnegie Mellon University's Sphinx toolkit is one good software for speech recognition. Another resource (free but copyrighted) is the HTK toolkit. For more recent and state-of-the-art techniques, Kaldi toolkit can be used.

2.6 Confidence Scoring or Speaker Verification

The confidence scoring process is used to provide a confidence score for each individual word in the recognized string. The scores are produced by extracting confidence features from the computation of the recognition hypothesis and processing the features using accept/reject classifier for word utterance hypothesis. The output of the confidence classifiers can then be incorporated into the parsing mechanism of the language understanding component [4].

3 BIG DATA CONTEXT IN SPEECH ANALYTICS

To get better insight in to customer behavior, satisfaction, and trends information businesses are depending on big data technologies for voice analysis by analyzing large volumes of call data. The use of voice analytics combined with big data technologies will help call centers to improve performance by reducing the call time and repeat calls, providing customer satisfaction information etc.
When applications need continuous recording and processing of large volumes of human speech data for home, industry or public enterprise security/information/entertainment purposes then big data technologies will help meeting the computing and storage demands.

4 INTEGRATED SPEECH AND VOICE RECOGNITION APPLICATIONS

Voice biometrics, customer service, truth detection, and personal voice assistant are some of the applications currently being used by the industry with speech recognition and analytics as key underlying technologies. Voice recognition technology has been in use by security systems with voice activated locks, law enforcement and criminology for truth detection.

In the customer service industry, speech analytics is playing key role to get complete insight in to customer behaviors and interests. Customers will interact with service providers using multiple channels such as email, social media, SMS, phone call, and in-person etc. The technology advancements are creating even more channels or options to interact with customers and service providers. However, with speech analytics systems the business can get more hidden insights for improving the customer satisfaction and loyalty. The capabilities such as phonetic-indexing, speech-to-text transcripts, speaker separation, emotion detection, and hot topics etc. are already in use by several businesses to improve their customer service performance.

The integrated speech and voice recognition will take the solution use cases one step beyond the current applications use and help improving the business performances. For example, systems will recognize returning customers with voice recognition technology and engage them with personalized interests/conversations.

5 CONCLUSION

The voice and speech recognition technology and NLP combined with big data technologies can be used in solving much complex problems than the current applications. Potential applications include personalized customer services, personal voice assists, and public information desks etc. Some of the unsolved technologies such as cross language translators and accurate speaker recognition are still in research, which when solved can unleash the great potential across the world.

ACKNOWLEDGMENTS

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REFERENCES

A WORK BREAKDOWN

A.1 HID 333:Anil Ravi

- Identified Paper1 topic
- Reviewed the draft paper

A.2 HID 337:Ashok Reddy Singam

- Editing Latex template using ShareLatex online tool
- Managed JabRef entries
- Reviewed the draft paper

```
bibtext report
==========================================

This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
I found no \citation commands---while reading file report.aux
Database file #1: report.bib
(There was 1 error message)
make[2]: *** [bibtex] Error 2

latex report
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        [2017-11-05 20.51.06] pdflatex report.tex
This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
Missing character: ""
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Empty ‘thebibliography’ environment.
Typesetting of "report.tex" completed in 0.9s.

================================================================================
Compliance Report
================================================================================



name: Ashok Reddy Singam
hid:  337
paper1: Nov 01 17 100%
paper2: Nov 06 17 60%
project: not started

yamlcheck
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wordcount
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2
wc 337 paper2 2 2596 report.tex
wc 337 paper2 2 2451 report.pdf
wc 337 paper2 2 66 report.bib
```

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find "
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85: There is no "standard" set of features for speech recognition.
    Instead, various combinations of acoustic, articulatory, and
    auditory features have been utilized in a range of speech
    recognition systems [2]. The input human speech signal, s[n], is
    converted to the series of feature vectors, X = {x1, x2, , xT},
    by the feature analysis or spectral analysis module. These feature
    vectors represent the temporal spectral characteristics of the
    speech signal in the form of mel frequency cepstrum coefficients.

107: Morphological analysis is the identification, analysis, and
     description of the structure of a given language's root
     words,word boundaries, affixes, parts of speech, etc. The term
     Morpheme means the "minimal unit of meaning". For ex: if you take
     word "unhappiness" it has three morphemes each carrying its own
     meaning.

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floats
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65: \begin{figure}
66: \includegraphics[width=1.0\columnwidth]{images/speechrecognition.p
    df}
75: \begin{figure}
76: \includegraphics[width=1.0\columnwidth]{images/speakerrecognition.
    pdf}

figures 2
tables 0
includegraphics 2
labels 0
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refs 0
floats 2

True : ref check passed: (refs >= figures + tables)
True : label check passed: (refs >= figures + tables)
True : include graphics passed: (figures >= includegraphics)
True : check if all figures are refered to: (refs >= labels)

Label/ref check
69: A simple conceptual model of human speech production and
    recognition is shown in Figure 1. The human speech waveform
    creation process from the speaker intention is referred as Speaker
    Model which reflects speakers accent and choice of words. The
    Speech Recognizer consists of acoustic processor which analyzes
    the speech signal and converts it into a set of acoustic
    (spectral, temporal) features followed by linguistic decoder to
    estimate the words of spoken sentence.
72: The speaker recognition technology is multidisciplinary, which
    requires hardware based sensors to convert voice in to electrical
    signals, speech processing module that converters the electrical
    signals in to digitized data using advanced digital signal
    processors (DSP). The basic recognition process involves modeling
    the acoustic data and the natural language to search for patterns.
    Figure 2 shows the basic concept of voice recognition.
passed: False -> labels or refs used wrong

When using figures use columnwidth
[width=1.0\columnwidth]
do not cahnge the number to a smaller fraction


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bibtex
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label errors
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bibtex errors

This is BibTeX, Version 0.99d (TeX Live 2016)
The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
I found no \citation commands---while reading file report.aux
Database file #1: report.bib
(There was 1 error message)

bibtex_empty_fields
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entries in general should not be empty in bibtex


find ""
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passed: True

ascii
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non ascii found 8217
non ascii found 8230

================================================================================
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Tip: newlines can often be replaced just by an empty line

find newline
--------------------------------------------------------------------------------

74: \newline

148: \newline

passed: False
cites should have a space before \cite{} but not before the {

find cite {
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