Use Cases in Big Data Software and Analytics

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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

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REFERENCES

[1] Ferrovial Blog. 2017. Big data will control pollution in your city. Webpage. (April 2017). http://blog.ferrovial.com/en/2017/04/big-data-pollution-control-in-cities/

[2] Jay Hardikar. 2017. Environmental analysis in the era of cloud and big data platforms. Webpage. (Jan. 2017). https://www.ibm.com/blogs/bluemix/2017/01/environmental-analysis-era-cloud-big-data-platforms/
[3] Alexander Howard. 2015. How IBM Is Using Big Data To Battle Air Pollution In Cities. Webpage. (Sept. 2015). https://www.ibm.com/blogs/bluemix/2017/01/environmental-analysis-era-cloud-big-data-platforms/
[4] Gaganjot Kaur Kang, Jerry Gao, Sen Chiao, Shengqiang Lu, and Gang Xie. 2017. Air Quality Prediction: Big data and Machine Learning Approaches. *International Conference on Sustainable Environment and Agriculture* 1 (10 2017).
[5] Research Applications Laboratory. 2016. Air Pollution: A Global Problem. Webpage. (April 2016). https://ral.ucar.edu/pressroom/features/air-pollution-a-global-problem
[6] Ruiyun Yu, Yu Yang, Leyou Yang, Guangjie Han, and Oguti Ann Move. 2016. RAQ: A Random Forest Approach for Predicting Air Quality in Urban Sensing Systems. *Sensors* 16 (2016), 1–86. http://www.mdpi.com/1424-8220/16/1/86

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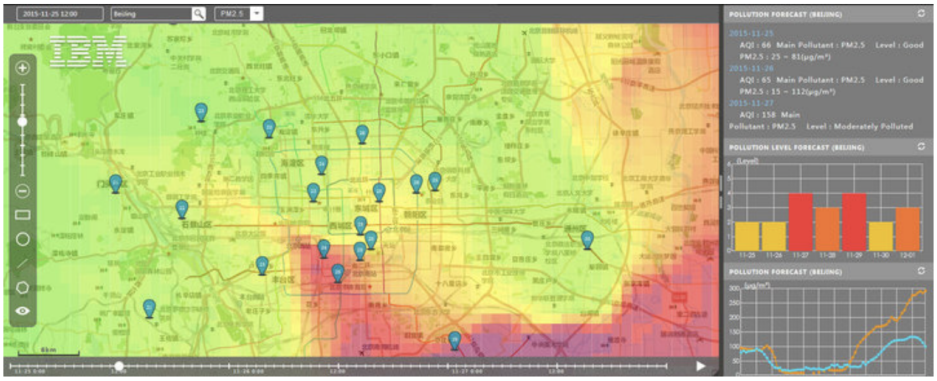

Figure 1: Green Horizons air quality management for Beijing [3]

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]

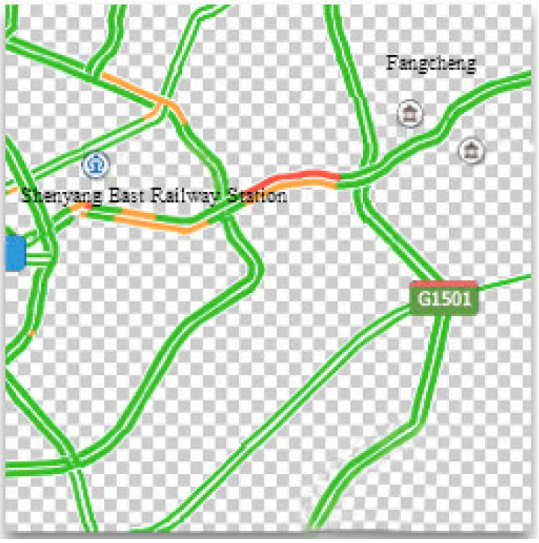

Figure 3: Traffic Congestion[6]

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temperature Numeric	humility Numeric	pressure Numeric	wind Numeric	visibility Numeric	road_length Numeric	tfs Numeric	poi_number Numeric	aqi Nominal
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Figure 4: Structure of RAQ data[6]

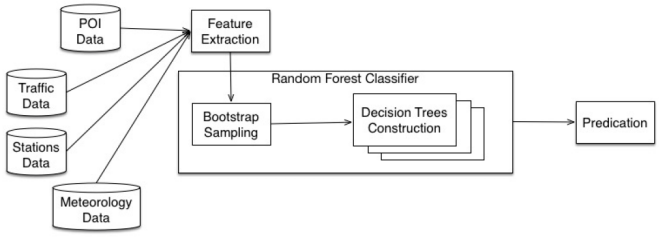

Figure 5: Procedure of RAQ [6]

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 UI; 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]

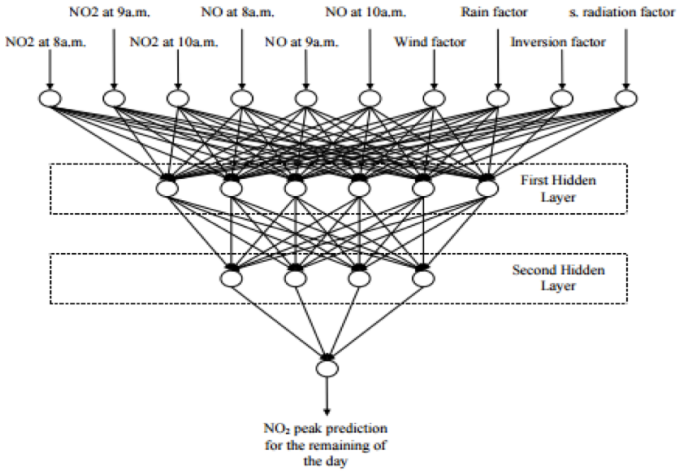

Figure 7: Artificial Neural Network(ANN) Model [4]

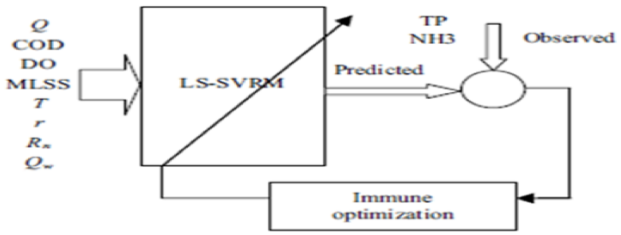

Figure 8: Least squares Support Vector Machine Model [4]

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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.

REFERENCES

[1] ELIST10. 2014. Top 10 Major Problems in Third World Countries. Web page as Article. (June 2014). http://www.elist10.com/top-10-major-problems-third-world-countries/

[2] Institute of Ecolonomics. 2015. Top 5 Challenges the Third World is Facing Today. Web page as Blog. (May 2015). http://ecolonomics.org/top-5-challenges-the-third-world-is-facing-today/

[3] Travis Korte. 2014. How Data Analytics Can Help the Develping World. Web page as Article. (Sept. 2014). https://www.huffingtonpost.com/travis-korte/how-data-and-analytics-ca_b_5609411.html

[4] Nir Kshetri. 2016. *Big Data's Big Potential in Developing Economies.* CABI, Wallingford Oxfordshire, UK.

[5] United Nations Global Pulse. 2012. Big Data for Development Challenges and Opportunities. Web page as paper. (May 2012). http://www.unglobalpulse.org/sites/default/files/BigDataforDevelopment-UNGlobalPulseMay2012.pdf

[6] Mark Van Rijmenam. 2017. How Big Data Analytics Can Help the Developing World Beat Poverty. Web page as Article. (July 2017). https://datafloq.com/read/big-data-developing-world-beat-poverty/168

[7] Wikipedia. 2017. Developing Country. Web page. (Oct. 2017). https://en.wikipedia.org/wiki/Developing_country

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The style file: ACM-Reference-Format.bst
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latex report
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Typesetting of "report.tex" completed in 0.8s.

================================================================================
Compliance Report
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name: Judy Phillips
hid:  332
paper1: Oct 31 2017 100%
paper2: 100%
project: In progress

yamlcheck
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wordcount
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4
wc 332 paper2 4 2991 report.tex
wc 332 paper2 4 2983 report.pdf
wc 332 paper2 4 302 report.bib
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find "
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35: The statistics are dismal. "Almost 1.3 billion people living in
    developing countries live on less than 1.50 dollars a day"
    \cite{www-google-top5}.  "According to the United Nations,
    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
    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. \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
    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" \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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floats
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figures 0
tables 0
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floats 0

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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label errors


bibtex errors

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The style file: ACM-Reference-Format.bst
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bibtex_empty_fields
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entries in general should not be empty in bibtex


find ""
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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 {
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passed: True
```

Big Data Analysis for Computer Network Defense

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

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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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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floats
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figures 0
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True : ref check passed: (refs >= figures + tables)
True : label check passed: (refs >= figures + tables)
True : include graphics passed: (figures >= includegraphics)
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When using figures use columnwidth
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label errors


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entries in general should not be empty in bibtex


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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 {
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passed: True
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Big Data Analytics and IoT Smart Refridgerators

Robert W. Gasiewicz
Indiana University
711 N. Park Avenue
Bloomington, IN 47408
rgasiewi@iu.edu

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.

REFERENCES

[1] 2017. Cisco and Google Cloud. (2017). Retrieved October 30th, 2017 from https://www.cisco.com/c/en/us/solutions/strategic-partners/google-cloud.html
[2] 2017. The Expected Life of a Refrigerator. (2017). Retrieved October 30th, 2017 from http://homeguides.sfgate.com/expected-life-refrigerator-88577.html

[3] 2017. Food and Agriculture Organization of the United Nations: Food Loss and Food Waste. (2017). Retrieved October 30th, 2017 from http://www.fao.org/food-loss-and-food-waste/en/
[4] 2017. Innit. (2017). Retrieved October 30th, 2017 from http://www.innit.com
[5] Kevin Ashton. 2009. That 'Internet of Things' Thing. *RFID Journal* (jun 2009), 1. http://www.rfidjournal.com/articles/view?4986
[6] Swapnil Bhartiya. 2017. Your smart fridge may kill you: The dark side of IoT. (2017). Retrieved October 30th, 2017 from https://www.infoworld.com/article/3176673/internet-of-things/your-smart-fridge-may-kill-you-the-dark-side-of-iot.html
[7] Inc. Gartner. 2017. Technologies Underpin the Hype Cycle for the Internet of Things, 2016. (2017). Retrieved October 30th, 2017 from https://www.gartner.com/smarterwithgartner/7-technologies-underpin-the-hype-cycle-for-the-internet-of-things-2016/
[8] Rik Henderson. 2017. Samsung Family Hub 2.0 refrigerator preview: Spotify and sausages. (2017). Retrieved October 30th, 2017 from http://www.pocket-lint.com/review/139892-samsung-family-hub-2-0-refrigerator-preview-spotify-and-sausages
[9] Stuart Miles. 2016. Samsung Family Hub Refrigerator comes with giant 21.5-inch screen and camera to spy on your food. (2016). Retrieved October 30th, 2017 from http://www.pocket-lint.com/news/136305-samsung-family-hub-refrigerator-comes-with-giant-21-5-inch-screen-and-camera-to-spy-on-your-food
[10] Rohini Nambiar. 2016. Smart kitchens are a new phase in the Internet of Things, as Innit explains. (2016). Retrieved October 30th, 2017 from https://www.cnbc.com/2016/07/26/smart-kitchens-are-a-new-phase-in-the-internet-of-things-as-innit-explains.html
[11] John Ramkey. 2016. Toast of the IoT: The 1990 Interop Internet Toaster. *IEEE* 6, Article 1 (dec 2016), 3 pages. https://doi.org/10.1109/MCE.2016.2614740
[12] Michael Stroh. 1999. Network systems allow us to live more like the Jetsons. (1999). Retrieved October 30th, 2017 from https://news.google.com/newspapers?nid=336&dat=19990116&id=lu8jAAAAIBAJ&sjid=iewDAAAAIBAJ&pg=3607,488766&hl=en

List of Figures

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Big Data Applications in Virtual Assistants

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Bloomington, IN 47408
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ABSTRACT

This paper provides

KEYWORDS

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

1 INTRODUCTION

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2 FIGURES

3 LONG EXAMPLE

4 CONCLUSION

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ACKNOWLEDGMENTS

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

REFERENCES

[1] Ethan Baron. 2017. One bot to rule them all? Not likely, with Apple, Google, Amazon and Microsoft virtual assistants. Web Page. (Feb. 2017). http://www.mercurynews.com/2017/02/06/one-bot-to-rule-them-all-not-likely-with-apple-google-amazon-and-microsoft-virtual-assistants/ HID: 233, Accessed: 2017-10-24.

[2] Clint Boulton. 2016. Slack CEO describes 'Holy Grail' of virtual assistants. Web Page. (Oct. 2016). https://www.cio.com/article/3131536/collaboration/slack-ceo-describes-holy-grail-of-virtual-assistants.html HID: 233, Accessed: 2017-10-24.

[3] Mike Elgan. 2016. These three virtual assistants point the way to the future. Web Page. (June 2016). https://www.computerworld.com/article/3078829/artificial-intelligence/these-three-virtual-assistants-point-the-way-to-the-future.html HID: 233, Accessed: 2017-10-18.

[4] Darrell Etherington. 2014. The Virtual Assistant Could Be The Next Interpreter Of Enterprise Data, Starting With Google Now. Web Page. (Aug. 2014). https://techcrunch.com/2014/08/13/the-virtual-assistant-could-be-the-next-interpreter-of-enterprise-data-starting-with-google-now/ HID: 233, Accessed: 2017-10-24.

[5] Lars Hard. 2014. The Disruptive Potential of Artificial Intelligence Applications. Web Page. (Jan. 2014). http://data-informed.com/disruptive-potential-artificial-intelligence-applications/ HID: 233, Accessed: 2017-10-18.

[6] Eran Kinsbruner. 2017. Building the virtual assistant everyone wants. Web Page. (July 2017). https://www.infoworld.com/article/3210488/machine-learning/building-the-virtual-assistant-everyone-wants.html HID: 233, Accessed: 2017-10-24.

[7] Rob Marvin. 2017. What Are Virtual Assistants and What Can You Do With Them? Web Page. (June 2017). https://www.pcmag.com/article/354371/what-are-virtual-assistants-and-what-can-you-do-with-them HID: 233, Accessed: 2017-10-24.

[8] Susanne Mueller. 2016. Rhiza Launches Rhizabot, First Virtual Assistant for Analytics. Web Page. (Aug. 2016). http://rhiza.com/2016/08/10/rhiza-launches-rhizabot-first-virtual-assistant-analytics/ HID: 233, Accessed: 2017-10-18.

[9] Tom Simonite. 2016. How Alexa, Siri, and Google Assistant Will Make Money Off You. Web Page. (May 2016). https://www.technologyreview.com/s/601583/how-alexa-siri-and-google-assistant-will-make-money-off-you/ HID: 233, Accessed: 2017-10-24.

[10] Anubhav Srivastava. 2016. Why the virtual assistants market is on the upswing? Web Page. (July 2016). http://thinkbigdata.in/virtual-assistants-market-upswing/ HID: 233, Accessed: 2017-10-24.

[11] David Tal. 2015. Forecast — Rise of the big data-powered virtual assistants: Future of the Internet P3. Web page. (Nov. 2015). http://www.quantumrun.com/prediction/rise-big-data-powered-virtual-assistants-future-internet-p3 HID: 233, Accessed: 2017-10-18.

[12] Spotfire Blogging Team. 2012. Meet Your Companyfis New Virtual Assistant fi?! Big Data. Web Page. (May 2012). https://www.tibco.com/blog/2012/05/11/meet-your-companys-new-virtual-assistant-big-data/ HID: 233, Accessed: 2017-10-18.

[13] Richard Waters. 2015. Artificial intelligence: A virtual assistant for life. Web page. (Feb. 2015). https://www.ft.com/content/4f2f97ea-b8ec-11e4-b8e6-00144feab7de?mhq5j=e5 HID: 233, Accessed: 2017-10-18.

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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.

REFERENCES

[1] Mark Chang. 2016. Applied Deep Learning 11/03 Convolutional Neural Networks. (Oct. 2016). https://www.slideshare.net/ckmarkohchang/applied-deep-learning-1103-convolutional-neural-networks

[2] Christopher Olah. 2014. Conv Nets: A Modular Perspective. (July 2014). http://colah.github.io/posts/2014-07-Conv-Nets-Modular/

[3] Ian Goodfellow, Yoshua Bengio, and Aaron Courville. 2016. *Deep Learning*. MIT Press. http://www.deeplearningbook.org

[4] Vikas Gupta. 2017. Understanding Feedforward Neural Networks. (Oct. 2017). https://www.learnopencv.com/understanding-feedforward-neural-networks/

[5] Influx. [n. d.]. *InfluxDB is the Time Series Database in the TICK stack*. Technical Report. Influx. https://www.influxdata.com/time-series-platform/influxdb/

[6] Jason Brownlee. 2014. Discover Feature Engineering, How to Engineer Features and How to Get Good at It. (Sept. 2014). https://machinelearningmastery.com/discover-feature-engineering-how-to-engineer-features-and-how-to-get-good-at-it/

[7] Yann LeCun, Yoshua Bengio, and Geoffrey Hinton. 2015. Deep learning. (May 2015). http://www.nature.com/nature/journal/v521/n7553/fig_tab/nature14539_F5.html

[8] Nicholas Leonard. 2016. Language modeling a billion words. (July 2016). http://torch.ch/blog/2016/07/25/nce.html

[9] Christopher Olah. 2015. Understanding LSTM Networks. (Aug. 2015). http://colah.github.io/posts/2015-08-Understanding-LSTMs/

[10] Rajesh Sampathkumar. 2016. Time Series Analysis of Sensor Data. (Aug. 2016). http://www.thedatateam.in/time-series-analysis-of-sensor-data/

[11] Natalia Vassilieva. 2016. *Sense Making in an IOT World: Sensor Data Analysis with Deep Learning*. Technical Report. Hewlett Packard Labs. http://on-demand.gputechconf.com/gtc/2016/presentation/s6773-natalia-vassilieva-sensor-data-analysis.pdf

List of Figures

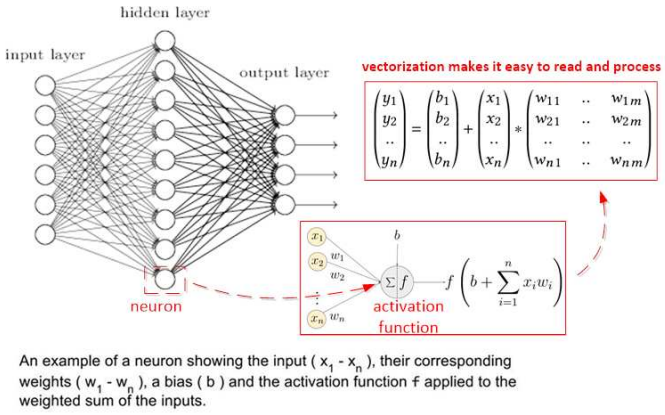

Figure 1: Simple Neural Network [3, 4].

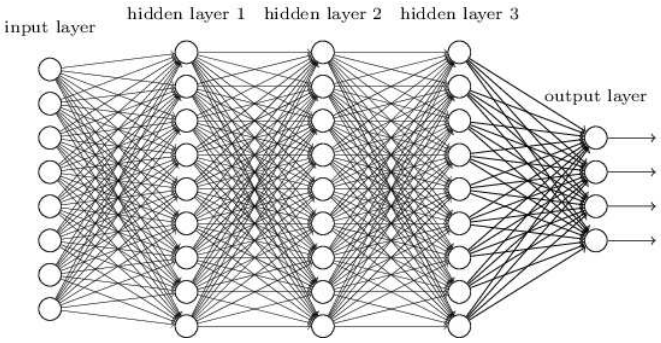

Figure 2: Deep Neural Network with three hidden layers [3].

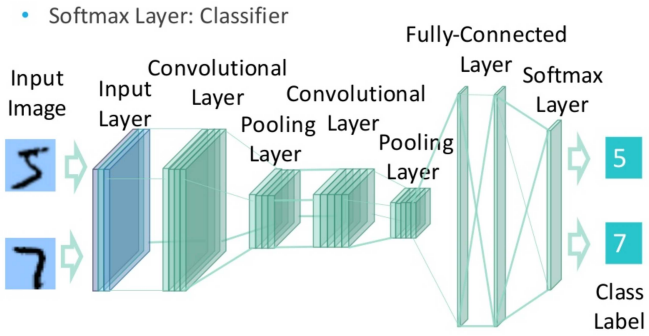

Figure 3: Sample Convolutional Neural Network [1].

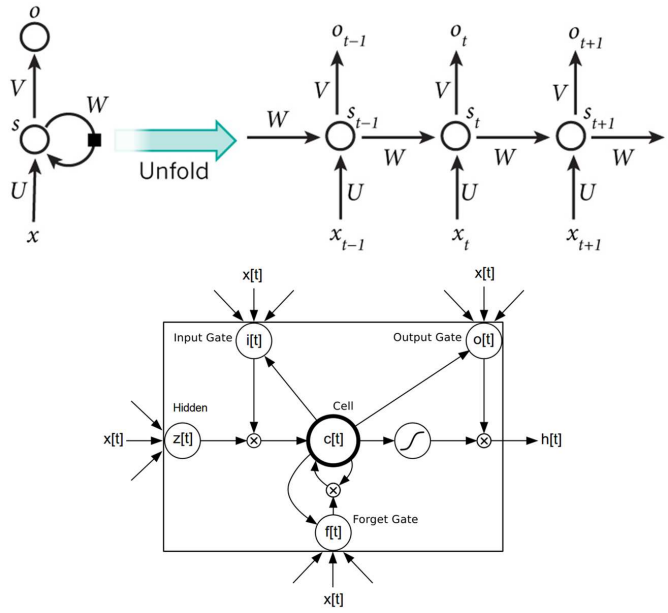

Figure 4: Recursive Neural Network Loop and LSTM Cell State [7, 8].

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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--empty address in Goodfellow2016
Warning--empty year in Influx
(There were 2 warnings)

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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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.
../README.yml
  8:63      error    trailing spaces  (trailing-spaces)
  9:63      error    trailing spaces  (trailing-spaces)
  11:61     error    trailing spaces  (trailing-spaces)
  12:60     error    trailing spaces  (trailing-spaces)
  25:67     error    trailing spaces  (trailing-spaces)
  26:66     error    trailing spaces  (trailing-spaces)
  27:63     error    trailing spaces  (trailing-spaces)
  28:53     error    trailing spaces  (trailing-spaces)
  29:62     error    trailing spaces  (trailing-spaces)
  30:61     error    trailing spaces  (trailing-spaces)
  31:55     error    trailing spaces  (trailing-spaces)
  41:10     error    too many spaces after colon  (colons)
```

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


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hid:  306
paper1: 100%; 10/26/2017
paper2: 100%; 11/4/2017

yamlcheck
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wordcount
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wc 306 paper2 6 1931 report.pdf
wc 306 paper2 6 273 report.bib

find "
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passed: True

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

passed: True

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

4: \input{format/i523}

passed: True

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

45: \begin{figure}
47: \includegraphics[width=0.5\textwidth]{images/neuralnetwork}
48: \caption{Simple Neural Network \cite{Goodfellow2016, Gupta2017}.}
```

```
    \label{fig:figure1}
56: \begin{figure}
58: \includegraphics[width=0.5\textwidth]{images/deepnetwork}
59: \caption{Deep Neural Network with three hidden layers
    \cite{Goodfellow2016}.} \label{fig:figure2}
71: \begin{figure}
73: \includegraphics[width=0.5\textwidth]{images/cnn}
74: \caption{Sample Convolutional Neural Network \cite{Chang2016}.}
    \label{fig:figure3}
77: \begin{figure}
79: \includegraphics[width=0.5\textwidth]{images/rnn}
80: \caption{Recursive Neural Network Loop and LSTM Cell State
    \cite{LeCun2015, Leonard2016}.} \label{fig:figure4}

figures 4
tables 0
includegraphics 4
labels 4
refs 0
floats 4

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
passed: True

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


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

47: \includegraphics[width=0.5\textwidth]{images/neuralnetwork}

58: \includegraphics[width=0.5\textwidth]{images/deepnetwork}

73: \includegraphics[width=0.5\textwidth]{images/cnn}

79: \includegraphics[width=0.5\textwidth]{images/rnn}

passed: False
```

```
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--empty address in Goodfellow2016
Warning--empty year in Influx
(There were 2 warnings)

bibtex_empty_fields
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entries in general should not be empty in bibtex


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

passed: True

ascii
--------------------------------------------------------------------------------


================================================================================
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


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
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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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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: Lipe-Melton, Josh
hid:  105
paper1: 100% October 27, 2017

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


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

6
wc 105 paper2 6 518 report.tex
wc 105 paper2 6 1163 report.pdf
wc 105 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}
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
--------------------------------------------------------------------------------

passed: True

bibtex
--------------------------------------------------------------------------------


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
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Warning--I didn't find a database entry for "editor00"
(There was 1 warning)

bibtex_empty_fields
-------------------------------------------------------------------------------


entries in general should not be empty in bibtex


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

15: note            = "",

passed: False

ascii
-------------------------------------------------------------------------------


===============================================================================
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 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

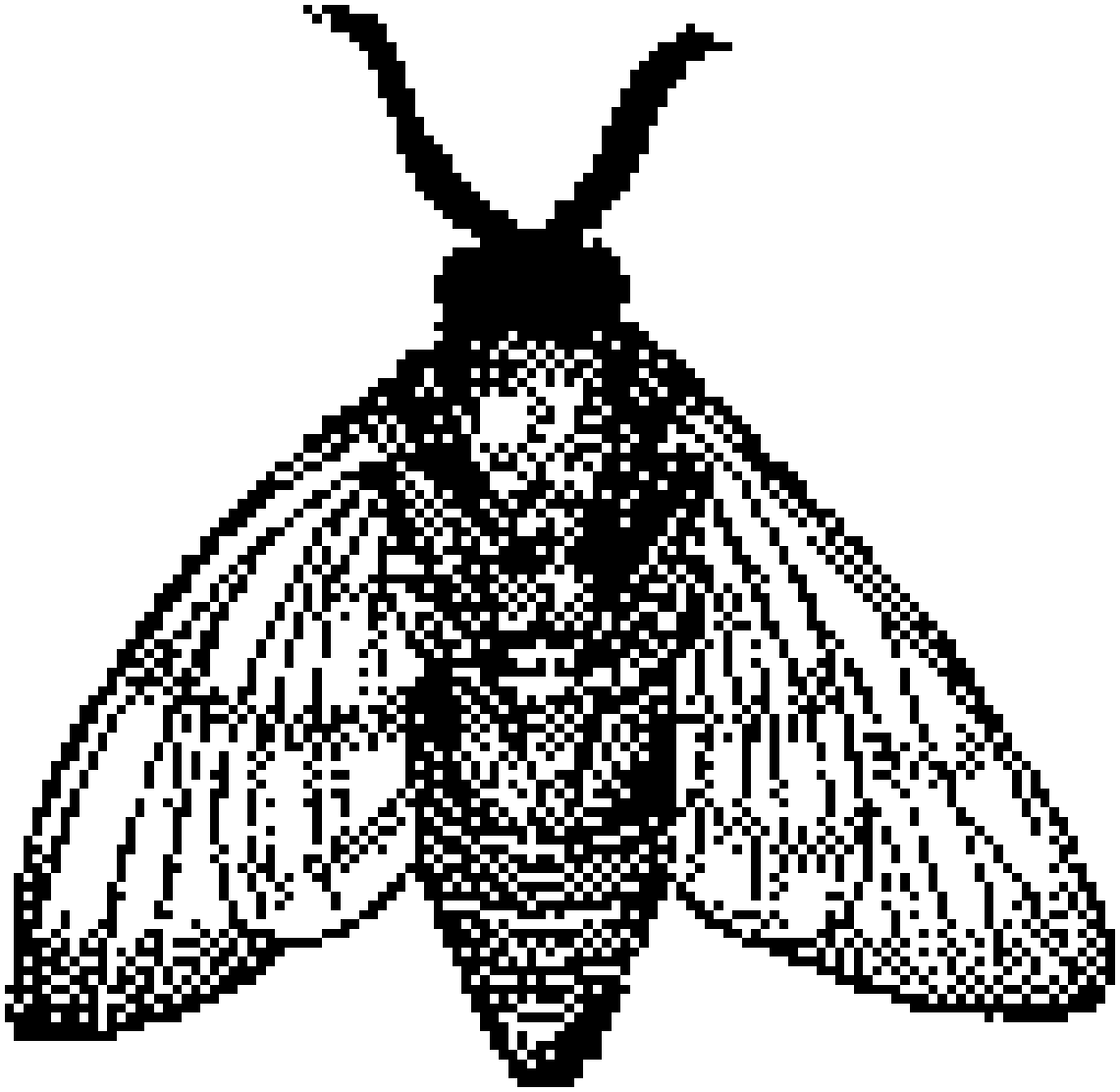

Figure 1: Example caption

4

List of Tables

Table 1: My caption

1	2	3
4	5	6
7	8	9

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bibtext report
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(There was 1 warning)

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latex report
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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 1.1s.
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  8:81      error    trailing spaces  (trailing-spaces)
```

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12:81     error    line too long (81 > 80 characters)  (line-length)
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13:81     error    line too long (82 > 80 characters)  (line-length)
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15:83     error    trailing spaces  (trailing-spaces)
16:81     error    line too long (86 > 80 characters)  (line-length)
16:86     error    trailing spaces  (trailing-spaces)
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34:87     error    trailing spaces  (trailing-spaces)
35:81     error    line too long (90 > 80 characters)  (line-length)
36:81     error    line too long (86 > 80 characters)  (line-length)
36:86     error    trailing spaces  (trailing-spaces)
37:81     error    line too long (88 > 80 characters)  (line-length)
37:88     error    trailing spaces  (trailing-spaces)
38:81     error    line too long (88 > 80 characters)  (line-length)
38:80     error    trailing spaces  (trailing-spaces)
49:81     error    line too long (89 > 80 characters)  (line-length)
49:89     error    trailing spaces  (trailing-spaces)
50:81     error    line too long (88 > 80 characters)  (line-length)
50:88     error    trailing spaces  (trailing-spaces)
51:81     error    line too long (87 > 80 characters)  (line-length)
51:87     error    trailing spaces  (trailing-spaces)
52:81     error    line too long (87 > 80 characters)  (line-length)
53:81     error    line too long (91 > 80 characters)  (line-length)
53:91     error    trailing spaces  (trailing-spaces)
54:81     error    line too long (88 > 80 characters)  (line-length)
55:81     error    line too long (88 > 80 characters)  (line-length)
55:88     error    trailing spaces  (trailing-spaces)
56:66     error    trailing spaces  (trailing-spaces)
63:24     error    trailing spaces  (trailing-spaces)
```

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


name: Shiqi Shen
hid:  109
paper1: 100% Oct 27th
paper2: in progress 50%
project: in progress

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


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

6
wc 109 paper2 6 518 report.tex
wc 109 paper2 6 1163 report.pdf
wc 109 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
```

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

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

bibtex
--------------------------------------------------------------------------------


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
------------------------------------------------------------------------------


entries in general should not be empty in bibtex


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

15: note            = "",

passed: False

ascii
------------------------------------------------------------------------------


==============================================================================
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==============================================================================

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

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find cite {
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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
Institute for Clarity in Documentation
P.O. Box 1212
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re

List of Figures

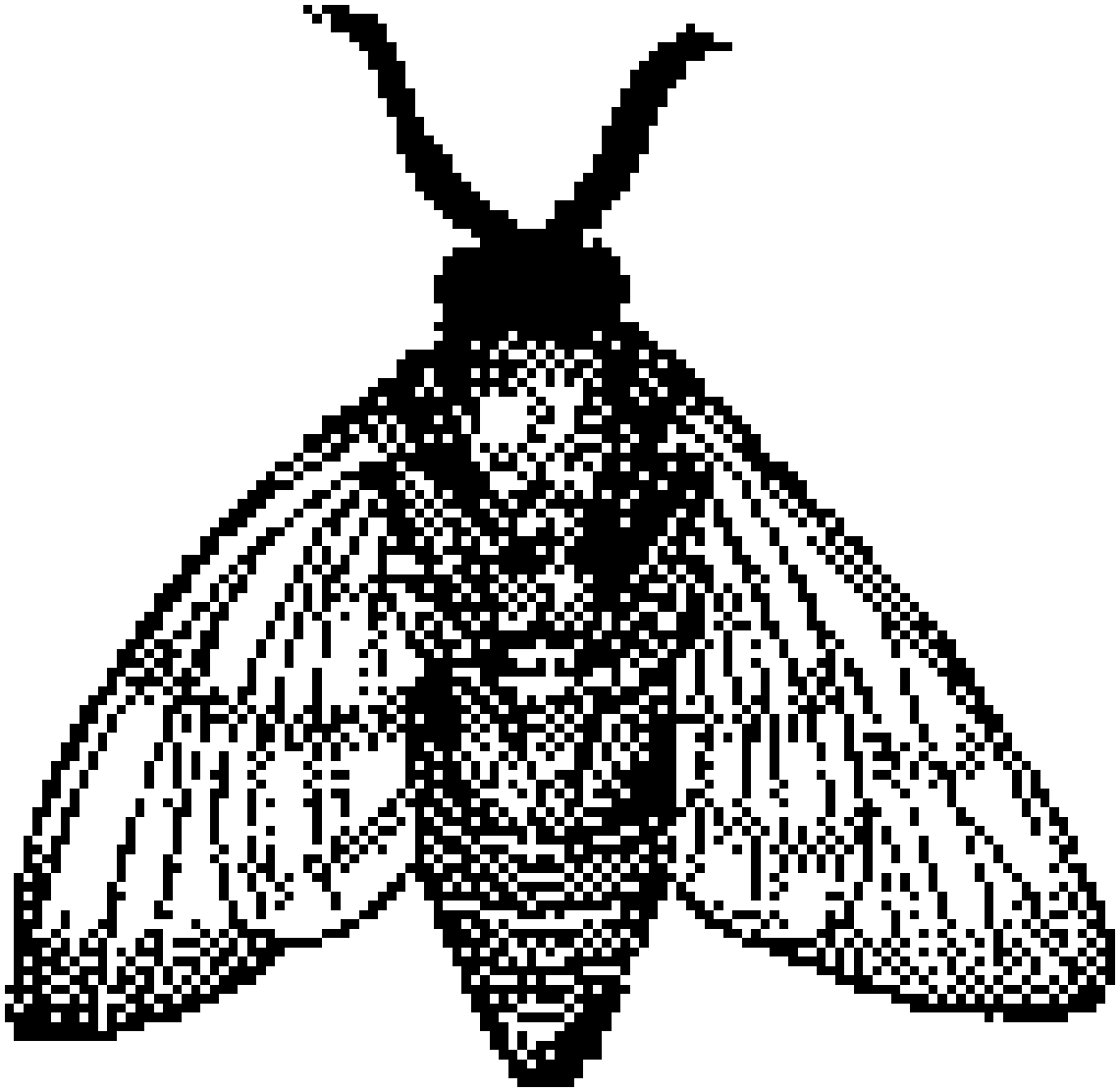

Figure 1: Example caption

[4]

List of Tables

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
==========================================

        [2017-11-04 22.30.58] 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 1.1s.
../README.yml
  9:81      error    line too long (83 > 80 characters)  (line-length)
  10:81     error    line too long (81 > 80 characters)  (line-length)
```

```
  11:81     error    line too long (82 > 80 characters)  (line-length)
  12:81     error    line too long (81 > 80 characters)  (line-length)
  13:81     error    line too long (81 > 80 characters)  (line-length)


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


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

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


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

6
wc 201 paper2 6 518 report.tex
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find "
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```

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figures 1
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bibtex
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Big Data for Edge Computing

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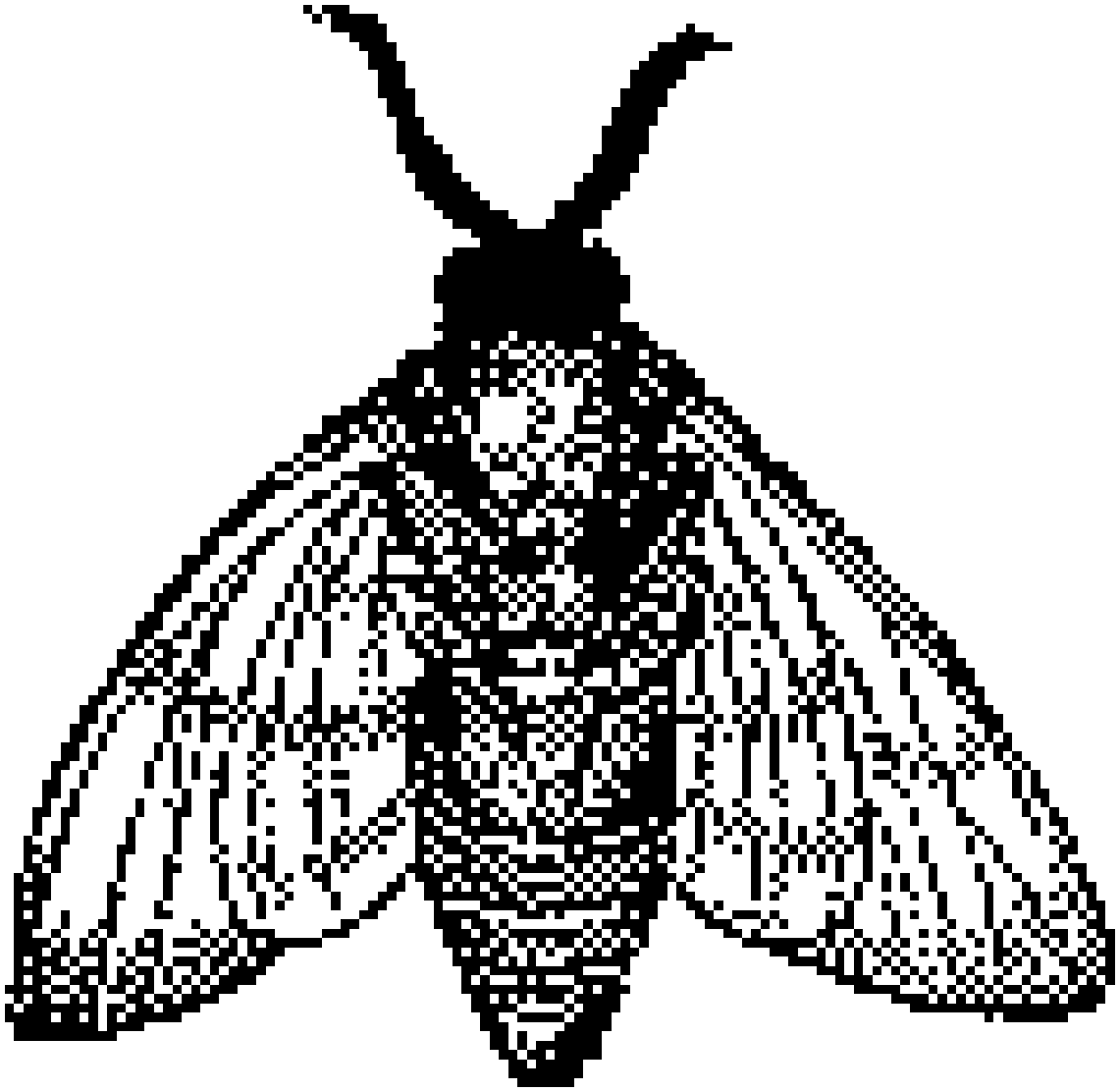

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1	2	3
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```
bibtext report
==========================================

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bibtext _ label error
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../README.yml
  1:1       warning  missing document start "---"  (document-start)
  6:4       error    wrong indentation: expected 4 but found 3  (indentation)
```

```
  6:11      error    trailing spaces  (trailing-spaces)
  11:15     error    trailing spaces  (trailing-spaces)
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  31:11     error    trailing spaces  (trailing-spaces)
  36:61     error    trailing spaces  (trailing-spaces)
  38:4      error    duplication of key "type" in mapping  (key-duplicates)


================================================================================
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
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--------------------------------------------------------------------------------

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```

Big Data and Artificial Intelligence with Computer Vision

Bharat Mallala
Indiana University
Bloomington, IN 47408, USA
bmallala@iu.edu

ABSTRACT

Big data refers to a problem of dealing with huge volumes of data. With the increase in the amount of data generated every day from various fields, it is becoming extremely hard to store and process this data efficiently. Artificial Intelligence is a research field aiming at replicating human work through machines. Computer vision refers to a research area within AI dealing with training computers to recognize certain subjects of interest. With the exponential growth of AI and computer vision in the recent years, there is need to address the big data problem associated with it.

KEYWORDS

Artificial Intelligence, Computer vision, Perceptron Deep Learning, Convolutional Neural Networks

1 INTRODUCTION

Artificial Intelligence is an aim at replicating human intelligence through machines. The term AI was in existence form the late 1950's during which there was a lot of enthusiasm on its potential during which Alan Turing introduced the Turing test. A lot of research was carried out in AI during the 1960's with the introduction of perceptron theory and its ability to solve problems. There was a major setback for AI in the early 1970's during which Minsky in his book on perceptrons has pointed out the major drawbacks of perceptrons in dealing with complex problems.[]

There has been a consistent growth in AI from the 1990's with the introduction of the statistical approach to problem-solving. With the increase in the use of Big data from 2010, there was a lot of development in the field of AI with many voice assistants, self-driving cars, automated robots etc. Many AI problems which were np-hard previously would now take minutes to solve thanks to recent advancements in big data. Professor Crandall quoted during his lecture quoted that "Problems that seem to require intelligence usually require exploring multiple choices".[], which is a way of exhibiting intelligence without actually having it. For example for a machine to win a tic-tac-toe game against a human it basically has to explore all the possible choices, it can make from any given state.

Hence we can map an AI problem as a search problem, but it usually requires searching through huge search spaces, this is when it becomes a Big data problem. For example, for a computer t win against a human in chess it needs to search through hundreds of thousands of states. To deal with such huge data, there is a need to apply big data technologies to better store data and efficiently manage it. Ai problems typically involve using both structured and unstructured kind of data in huge volumes. The traditional RDBMS methods have a hard time dealing with unstructured data. This is an area where Big data shines with the ability to deal with both structured and unstructured data efficiently.

"Computer vision is an interdisciplinary field that deals with how computers can be made for gaining high-level understanding from digital images or videos".[**?**] It is an area of research within AI that aims at recognizing subjects in an environment from images or videos. Convolutional Neural Networks shines at image classification from images with minimal prepossessing of the input variables and still manages to obtain better classification. With the exponential rise of AI and especially CNN lately, there is an increased interest in computer vision for researchers. Computer vision involves training the model with huge sets of images and videos which indeed needs to be addressed using big data technologies.

2 RETHINKING THE INCEPTION ARCHITECTURE FOR COMPUTER VISION

2.1 CNN's for Computer vision

Convolutional Neural Networks(CNN's) is the key to advancements in computer vision in the recent years with its low parameter count and computational efficacy. A CNN has multiple layers with perceptrons in them that help in the information flow from the input to output. A CNN typically has filters that are mapped across the original image to extract useful features from the image. During the training phase of the model, CNN learns the values of the filters. A CNN architecture has mainly two phases convolution phase and pooling phase. In the convolution phase features are extracted from the image using filters. In the pooling phase, the width of the feature map is reduced by applying various techniques. This is done to remove unnecessary data from the features. These stages are iterated till the desired features are obtained from the image.[] Figure 1 shows a typical CNN architecture.[**?**]

2.2 Design methods

A lot of design principles need to followed when designing a CNN. With the numerous number of iterations required over the CNN phases, a good design decision can vastly improve the efficiency. Avoiding bottlenecks/cycles in the CNN helps to avoid infinitely

ACKNOWLEDGMENTS

The authors would like to thank Dr. Yuhua Li for providing the matlab code of the *BEPS* method.

The authors would also like to thank the anonymous referees for their valuable comments and helpful suggestions. The work is supported by the National Natural Science Foundation of China under Grant No.: 61273304 and Young Scientsts' Support Program (http://www.nnsf.cn/youngscientsts).

Big Data for Edge Computing

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[Table 1 about here.]

4 LONG EXAMPLE

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

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Incorrect README file

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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

List of Figures

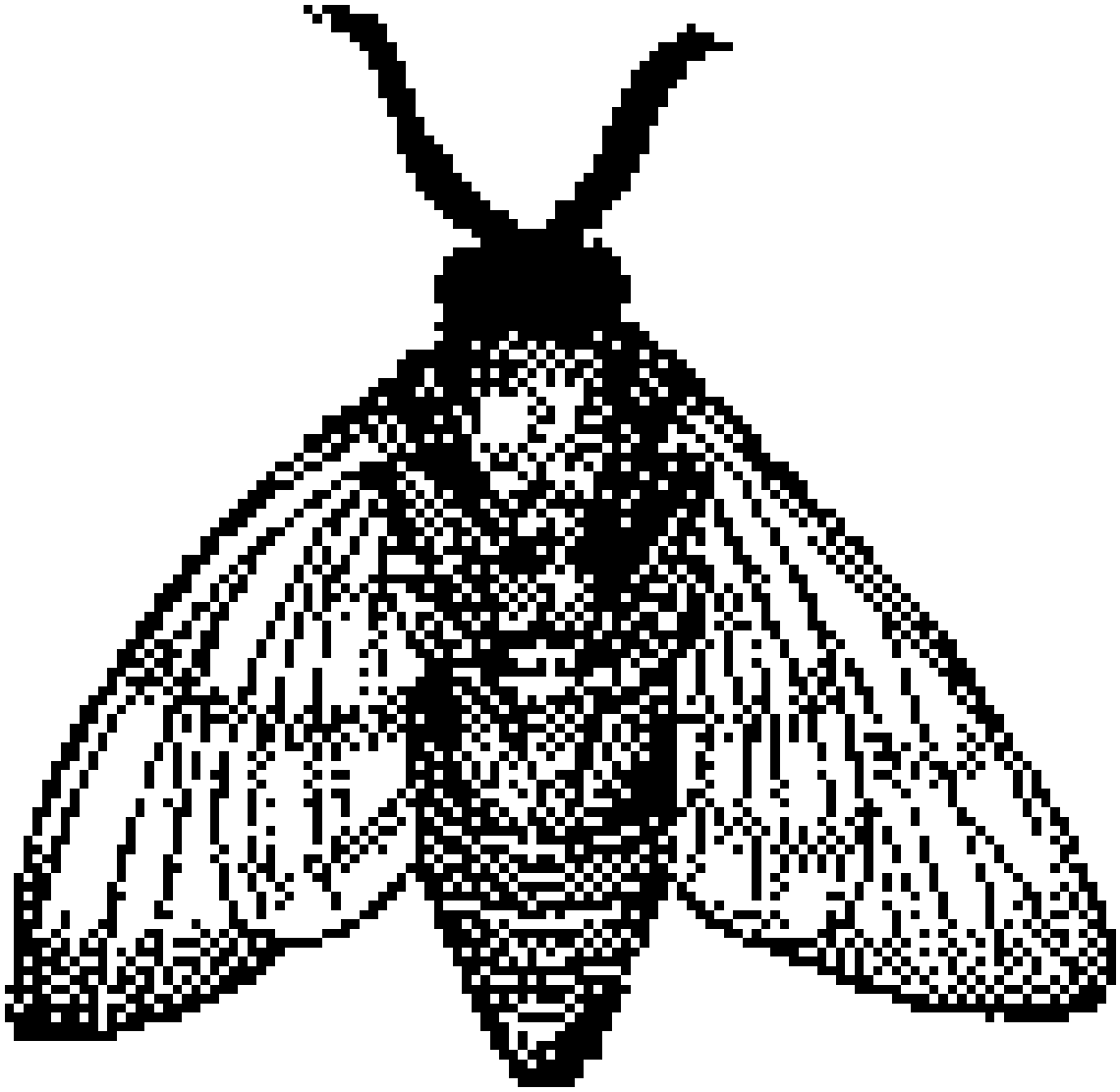

Figure 1: Example caption

4

List of Tables

Table 1: My caption

1	2	3
4	5	6
7	8	9

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bibtext report
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The top-level auxiliary file: report.aux
The style file: ACM-Reference-Format.bst
Database file #1: report.bib
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(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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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 1.1s.
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  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
================================================================================


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hid:  218
paper1: 100%
paper2: in progress

yamlcheck
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wordcount
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wc 218 paper2 6 1163 report.pdf
wc 218 paper2 6 50 report.bib

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find footnote
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passed: True

find input{format/i523}
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passed: True

floats
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67: In Figure \ref{f:fly} we show a fly. Please note that because we
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    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
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True : ref check passed: (refs >= figures + tables)
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passed: True

bibtex
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label errors


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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
-------------------------------------------------------------------------------

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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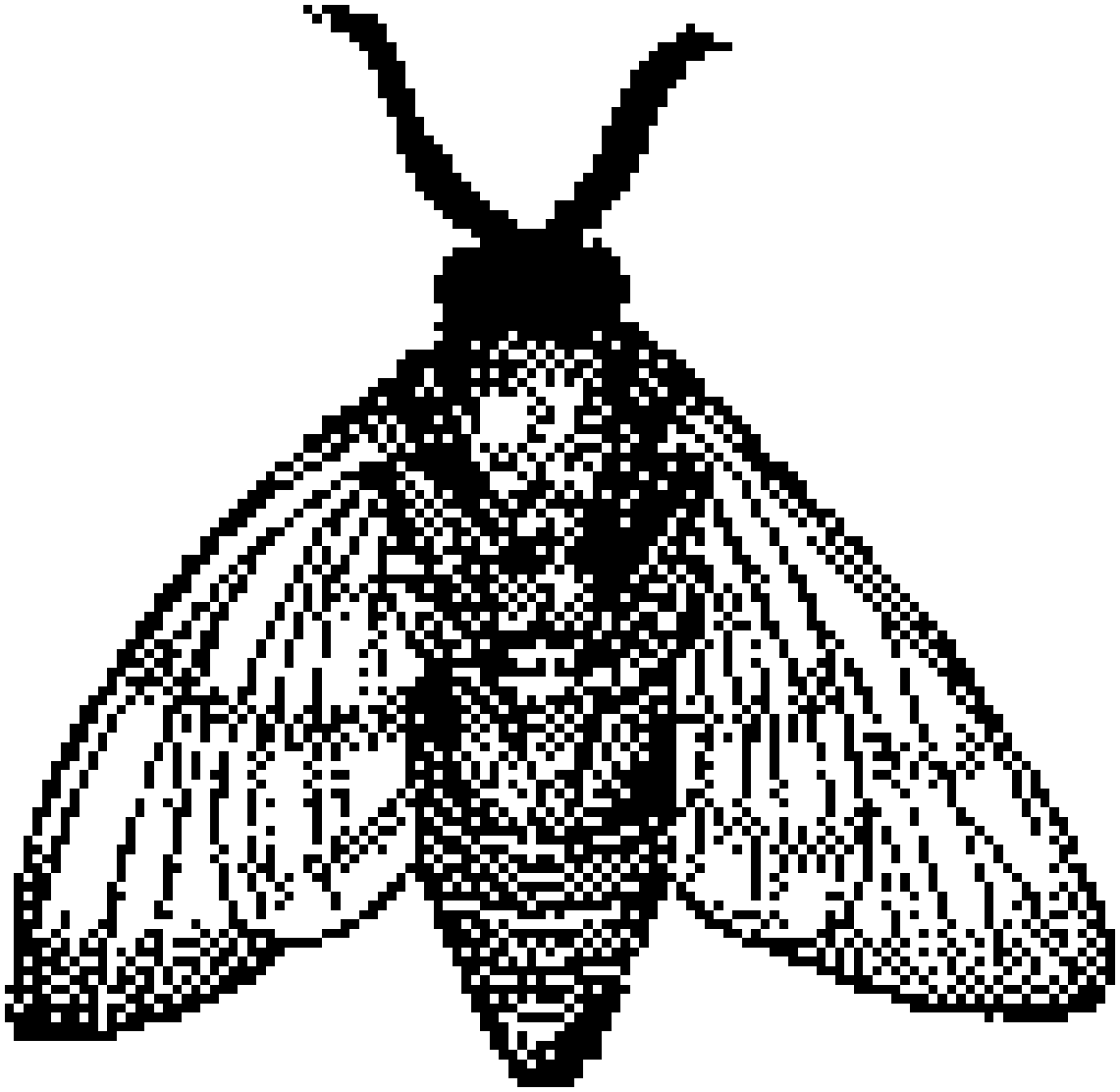

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Big Data Applications in Aviation Industry

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

[2]

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

        [2017-11-04 22.31.25] 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 0.8s.
../README.yml
  8:81      error    line too long (133 > 80 characters)  (line-length)
  9:81      error    line too long (110 > 80 characters)  (line-length)
  9:110     error    trailing spaces  (trailing-spaces)
  10:81     error    line too long (87 > 80 characters)  (line-length)
  10:87     error    trailing spaces  (trailing-spaces)
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=============================================================================
Compliance Report
=============================================================================


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hid:  228
paper1: Oct 20 17  100%
paper2: in progress
```

```
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wordcount
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wc 228 paper2 2 922 report.pdf
wc 228 paper2 2 261 report.bib

find "
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passed: True

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

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

passed: False

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)
```

```
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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

bibtex
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label errors


bibtex errors

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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 8217
non ascii found 8217

================================================================================
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 for Edge Computing

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

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Indiana University
Smith Research Center
Bloomington, IN 47408, USA
laszewski@gmail.com

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

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3 TABLES

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[Table 1 about here.]

4 LONG EXAMPLE

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

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

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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}
```

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e.g.

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

re

List of Figures

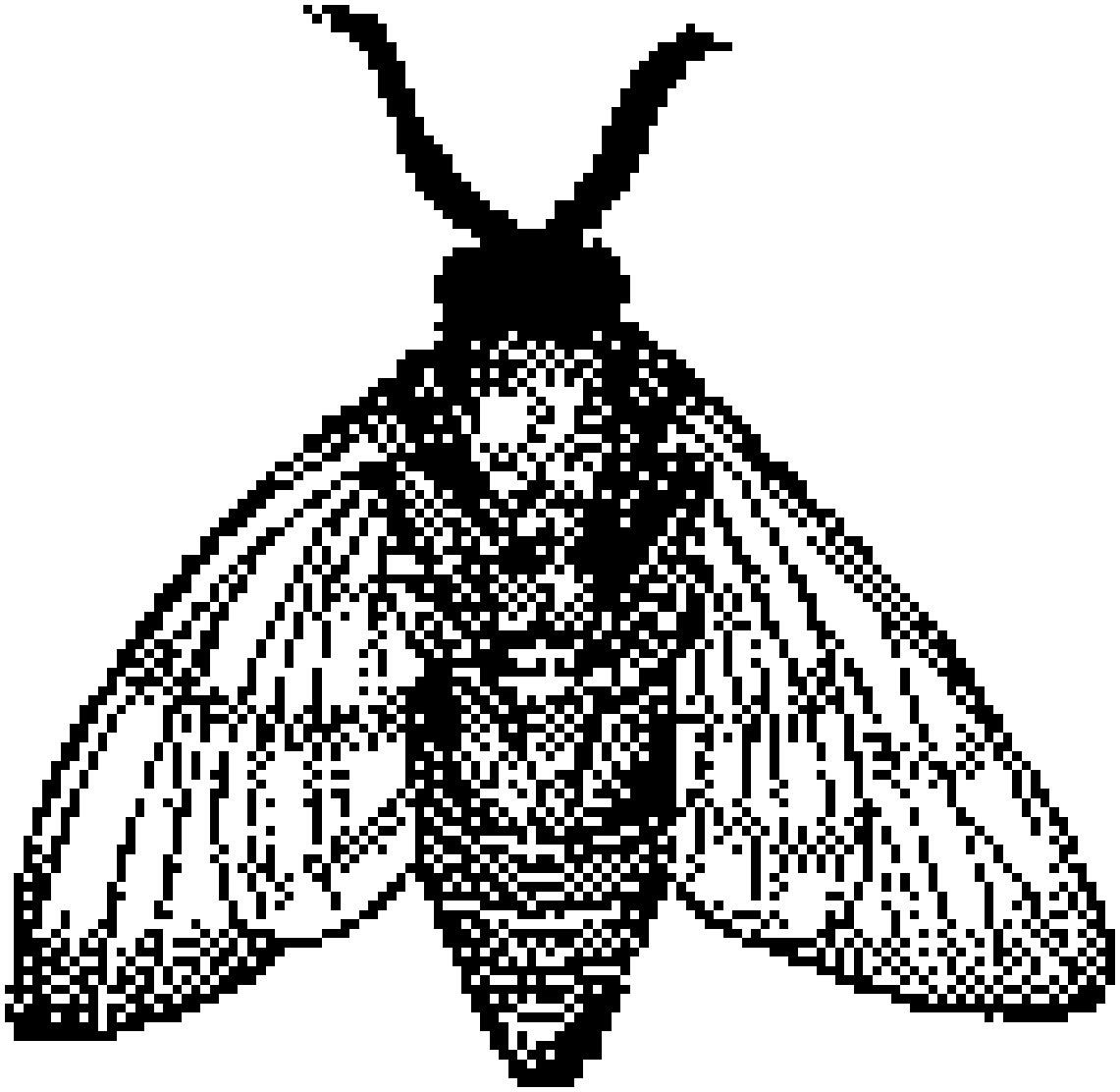

Figure 1: Example caption

4

List of Tables

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
=========================================

        [2017-11-04 22.31.42] 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.
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There were undefined references.
Typesetting of "report.tex" completed in 1.1s.
../README.yml
  9:81      error    line too long (86 > 80 characters)  (line-length)
  19:1      error    trailing spaces  (trailing-spaces)
```

```
  22:81     error    line too long (89 > 80 characters)  (line-length)
  22:89     error    trailing spaces  (trailing-spaces)
  23:77     error    trailing spaces  (trailing-spaces)
  24:81     error    line too long (106 > 80 characters)  (line-length)
  24:106    error    trailing spaces  (trailing-spaces)
  25:81     error    line too long (109 > 80 characters)  (line-length)
  25:109    error    trailing spaces  (trailing-spaces)
  33:9      error    trailing spaces  (trailing-spaces)
  34:1      error    trailing spaces  (trailing-spaces)
  37:81     error    line too long (88 > 80 characters)  (line-length)
  37:88     error    trailing spaces  (trailing-spaces)
  38:81     error    line too long (87 > 80 characters)  (line-length)
  38:87     error    trailing spaces  (trailing-spaces)
  39:49     error    trailing spaces  (trailing-spaces)
  46:9      error    trailing spaces  (trailing-spaces)


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


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

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


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

6
wc 235 paper2 6 518 report.tex
wc 235 paper2 6 1163 report.pdf
wc 235 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]
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figures 1
tables 1
includegraphics 1
labels 2
refs 2
floats 2

True : ref check passed: (refs >= figures + tables)
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find textwidth
------------------------------------------------------------------------------
```

```
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15: note            = "",

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Big Data Analytics for Social Media Threat Intelligence

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trovato@corporation.com

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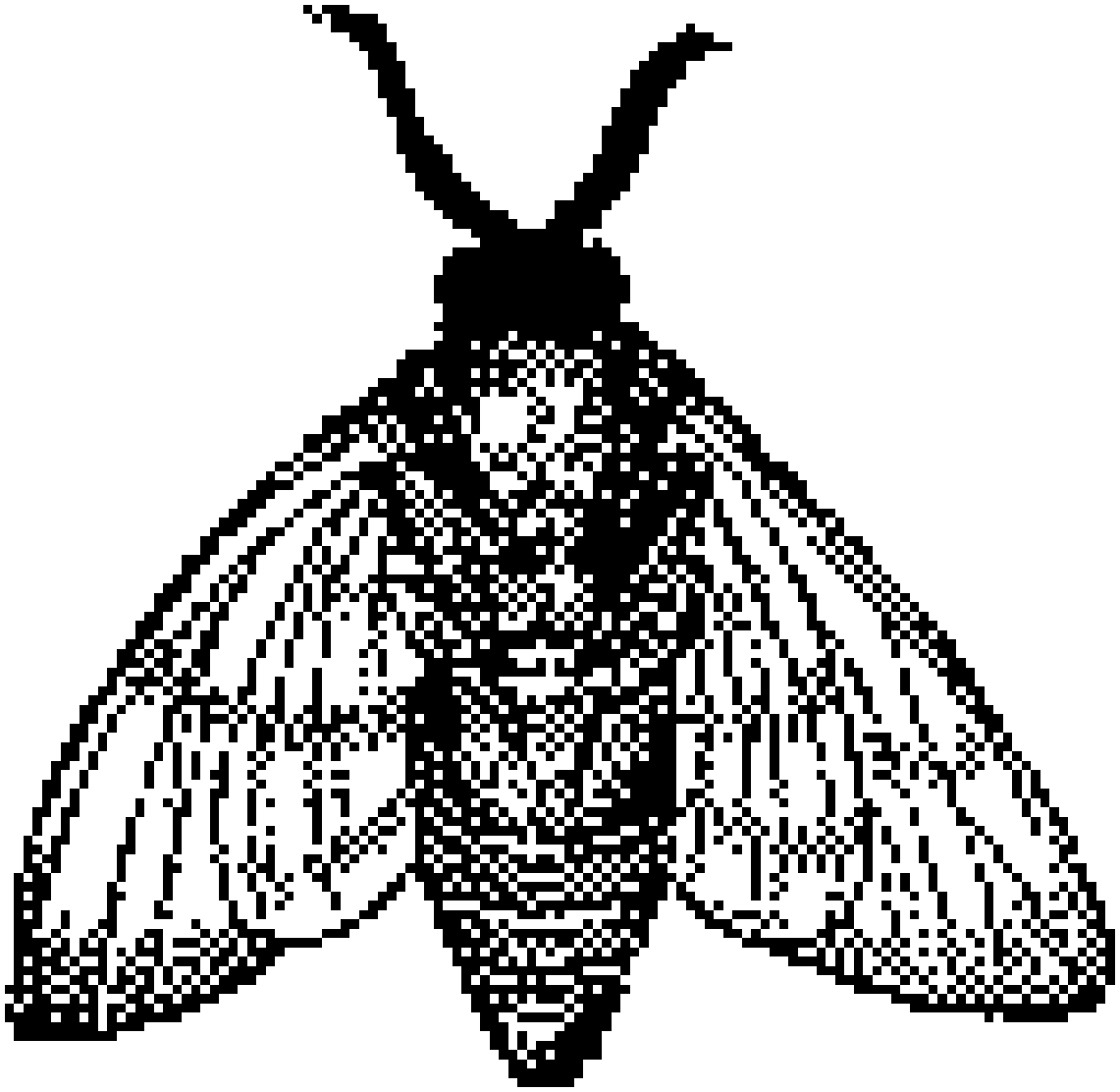
re

2

List of Figures



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```
bibtext report
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bookmark level for unknown  defaults to 0.
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  9:81      error    line too long (84 > 80 characters)  (line-length)
```

```
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  12:81     error    line too long (86 > 80 characters)  (line-length)
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  14:81     error    line too long (81 > 80 characters)  (line-length)
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  16:81     error    line too long (84 > 80 characters)  (line-length)
  37:1      error    trailing spaces  (trailing-spaces)
  39:4      error    wrong indentation: expected 4 but found 3  (indentation)
  39:17     error    trailing spaces  (trailing-spaces)
  41:4      error    wrong indentation: expected 7 but found 3  (indentation)
  43:4      error    wrong indentation: expected 7 but found 3  (indentation)
  47:81     error    line too long (117 > 80 characters)  (line-length)
  47:117    error    trailing spaces  (trailing-spaces)
  48:81     error    line too long (121 > 80 characters)  (line-length)
  49:81     error    line too long (123 > 80 characters)  (line-length)
  50:75     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
--------------------------------------------------------------------------------


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

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

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

passed: True
```

```
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find input{format/i523}
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figures 1
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includegraphics 1
labels 2
refs 2
floats 2

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```
--------------------------------------------------------------------------------

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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

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REFERENCES

[1] Nadav Aharony, Wei Pan, Cory Ip, Inas Khayal, and Alex Pentland. 2011. The Social fMRI: Measuring, Understanding, and Designing Social Mechanisms in the Real World. In *Proceedings of the 13th International Conference on Ubiquitous Computing (UbiComp '11)*. ACM, New York, NY, USA, 445–454. https://doi.org/10.1145/2030112.2030171

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

[3] Ye Chen, Dmitry Pavlov, and John F. Canny. 2009. Large-scale Behavioral Targeting. In *Proceedings of the 15th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining (KDD '09)*. ACM, New York, NY, USA, 209–218. https://doi.org/10.1145/1557019.1557048

[4] Adam D. I. Kramer and Kerry Rodden. 2008. Word usage and posting behaviors: Modeling blogs with unobtrusive data collection methods. (01 2008), 1125-1128 pages.

[5] Samuel Gosling, Sam Gaddis, and Simine Vazire. 2007. Personality Impressions Based on Facebook Profiles. *ICWSM* 7 (Jan. 2007), 1–4.

[6] Lucy Hornby. 2017. China changes tack on fisocial creditfi scheme plan. eNewsPaper. (July 2017). https://www.ft.com/content/f772a9ce-60c4-11e7-91a7-502f7ee26895 China changes tack on fisocial creditfi scheme plan.

[7] Sean Illing. 2017. A political scientist explains how big data is transforming politics. vox. (March 2017). https://www.vox.com/conversations/2017/3/16/14935336/big-data-politics-donald-trump-2016-elections-polarization

[8] Michal Kosinski, David Stillwell, and Thore Graepel. 2013. Private traits and attributes are predictable from digital records of human behavior. *Proceedings of the National Academy of Sciences* 110, 15 (2013), 5802–5805. https://doi.org/10.1073/pnas.1218772110 arXiv:http://www.pnas.org/content/110/15/5802.full.pdf

[9] Renaud Lambiotte and Michal Kosinski. 2014. Tracking the Digital Footprints of Personality. *IEEE* 102 (12 2014), 1934–1939.

[10] Arvind Narayanan and Vitaly Shmatikov. 2008. Robust De-anonymization of Large Sparse Datasets. (06 2008), 111-125 pages.

[11] Lewis R. Goldberg. 1993. The structure of phenotypic personality traits. *American Psychologist* 48 (02 1993), 26–34.

[12] Kern ML Dziurzynski L Ramones SM Agrawal M Shah A Kosinski M Stillwell D Seligman ME Ungar LH. Schwartz H, Eichstaedt JC. 2013. Personality, gender, and age in the language of social media: the open-vocabulary approach. (2013). https://www.ncbi.nlm.nih.gov/pubmed/24086296

[13] Chuck Todd and Carrie Dann. 2017. How Big Data Broke American Politics. eNewsPaper. (March 2017). https://www.nbcnews.com/politics/elections/how-big-data-broke-american-politics-n732901 How Big Data Broke American Politics.

[14] Youyou Wu, Michal Kosinski, and David Stillwell. 2015. Computer-based personality judgments are more accurate than those made by humans. *PNAS* 112 (01 2015), 1–5.

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.

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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
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    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.

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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83: \textbf{\textit{Step 1}}: Build binary matrix with Facebook user
    profile on vertical axis and Facebook page as horizontal
    axis.\newline

84: \textbf{\textit{Step 2}}: Populate the binary matrix with one and
    zero depending on if person has liked the page or not.\newline

85: \textbf{\textit{Step 3}}: Sort Facebook page columns depending on
    the factors mentioned in FFM.\newline

86: \textbf{\textit{Step 4}}: Use this matrix to build correlational
    matrix represents how each person is correlated with each other
    based on the five factors.\newline

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Hadoop and MongoDB in support of Big Data Applications and Analytics

Sushant Athaley
Indiana University
sathaley@iu.edu

ABSTRACT

Big data processing is beyond capability of traditional tool. It requires specialized tools like Hadoop and MongoDB. We will explore Haddop and MongoDB technically as a tool and how they provide support/help in big data analysis. TBD

KEYWORDS

i523, hid302, big data, Hadoop, MongoDB

1 INTRODUCTION

Describe about big data, hadoop and mongodb. Describe what this paper will do. Papers organization.

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

introduce hadoop, architecture, support to big data, real life examples 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 are the collection of the utilities to support the Hadoop modules. This is the core package which provide 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 high fault tolerant which contains mechanism for quick fault detection and auto recovery. HDFS is designed to port across heterogeneous hardware and software platform. It does data computation on 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 name space 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 datablocks on the node as per the instruction by the NameNode. DataNode also sends block-report to NameNode which has list of all blocks on the DataNode. DataNode sends heartbeat message to NameNode which helps in identifying the failure nodes. If 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 provide 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 application 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 capability to process vast amount of data in distributed manner. Processing is done in parallel on various nodes utilizing local machine processor and memory which results in high computation power. 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 provides map and reduce method to process the data.

3.5 Big Data Support

4 MONGODB

5 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.]

6 LONG EXAMPLE

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

7 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

[1] Shiva Achari. 2015. *Hadoop Essentials.* Packt Publishing, Birmingham.
[2] Apache. [n. d.]. Apache Hadoop. ([n. d.]). http://hadoop.apache.org/
[3] Apache. 2017. Apache Hadoop YARN. web. (2017). http://hadoop.apache.org/docs/current/hadoop-yarn/hadoop-yarn-site/YARN.html
[4] Apache. 2017. HDFS Architecture. web. (2017). http://hadoop.apache.org/docs/current/hadoop-project-dist/hadoop-hdfs/HdfsDesign.html

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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List of Figures

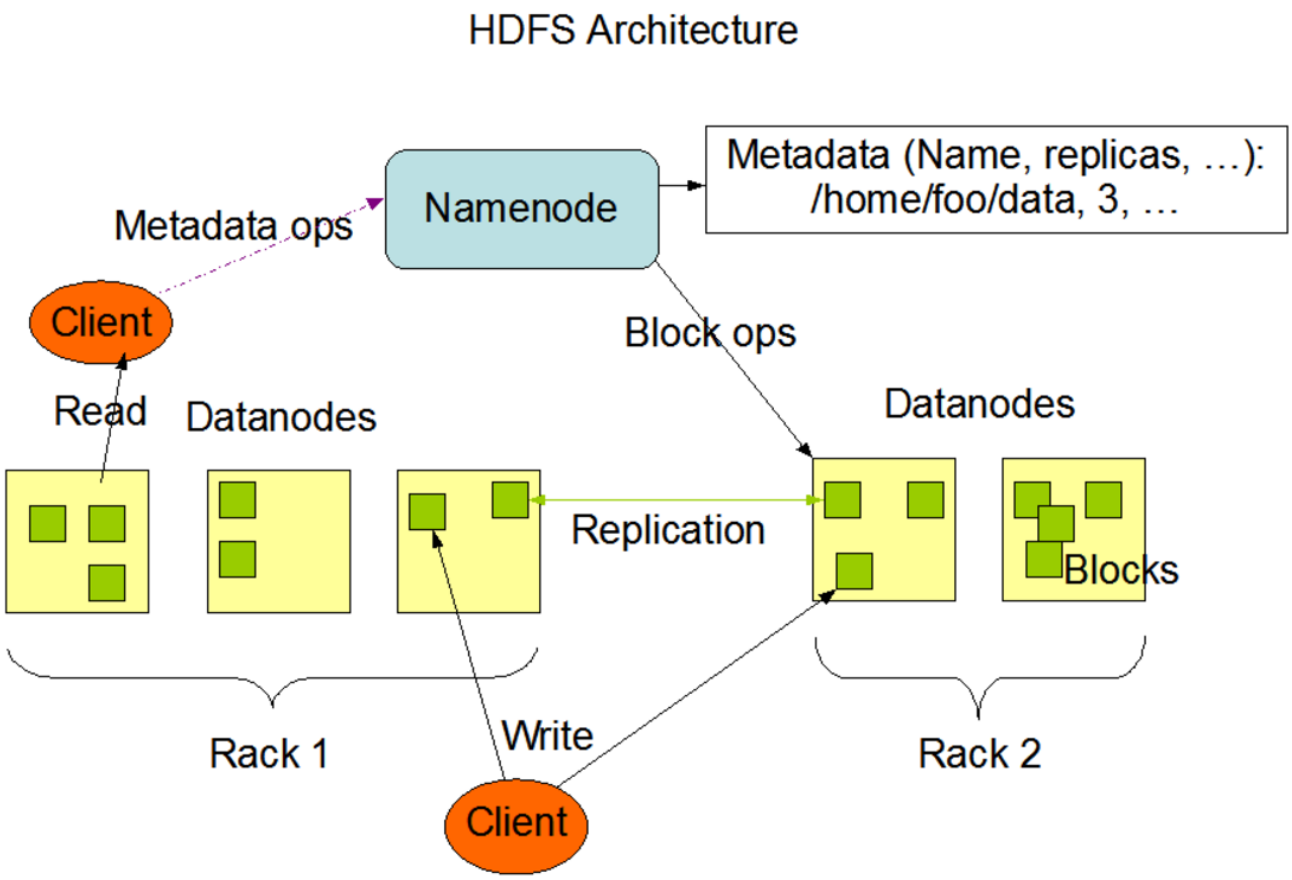

Figure 1: HDFS Architecture [4]

[5]

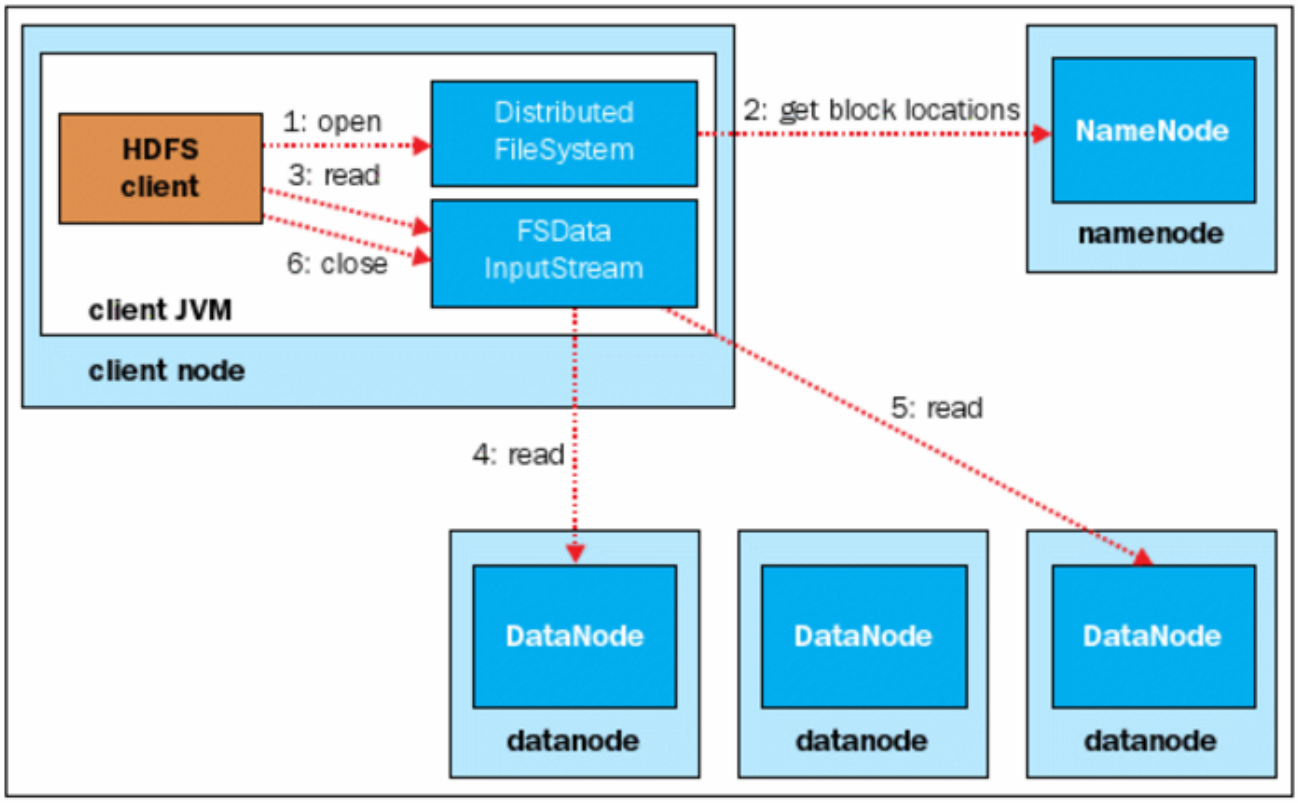

Figure 2: HDFS Read [1, Ch. 3, p. 38]

[6]

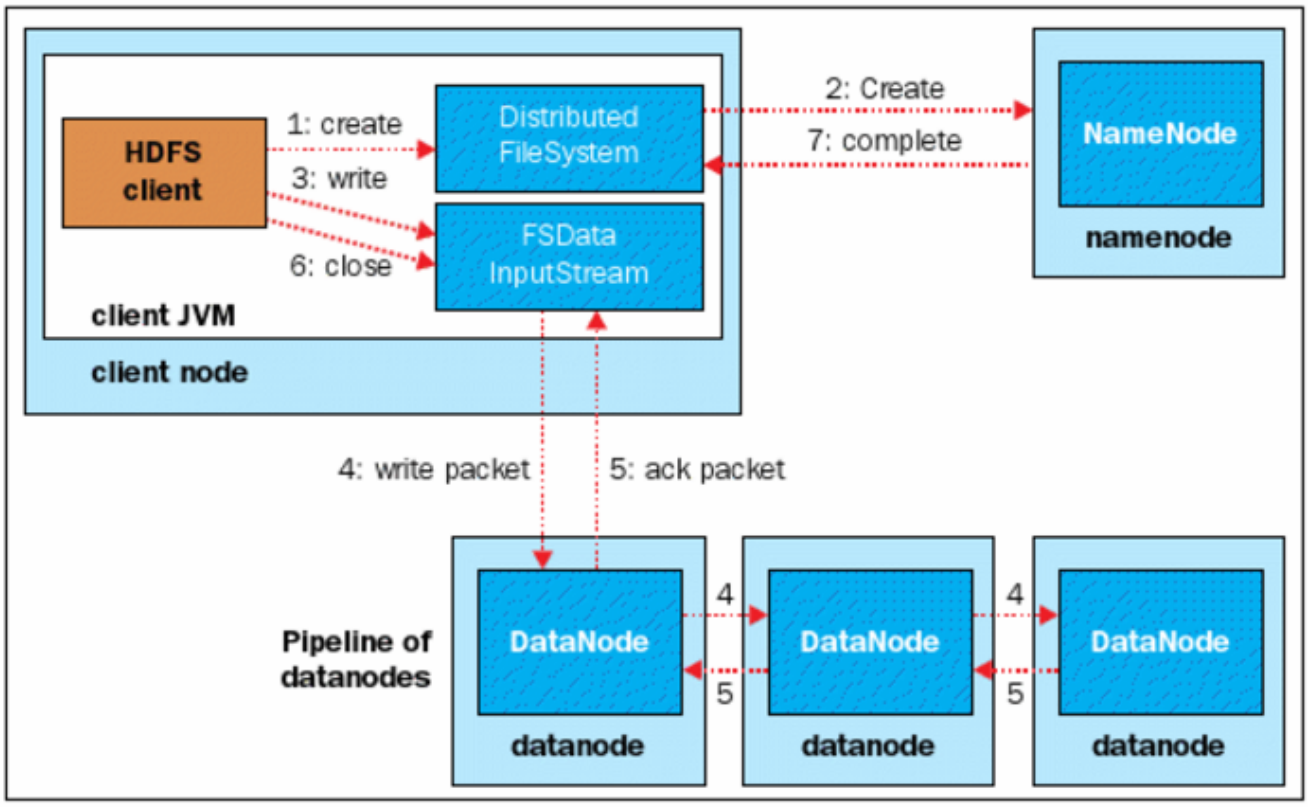

Figure 3: HDFS Write [1, Ch. 3, p. 39]

[7]

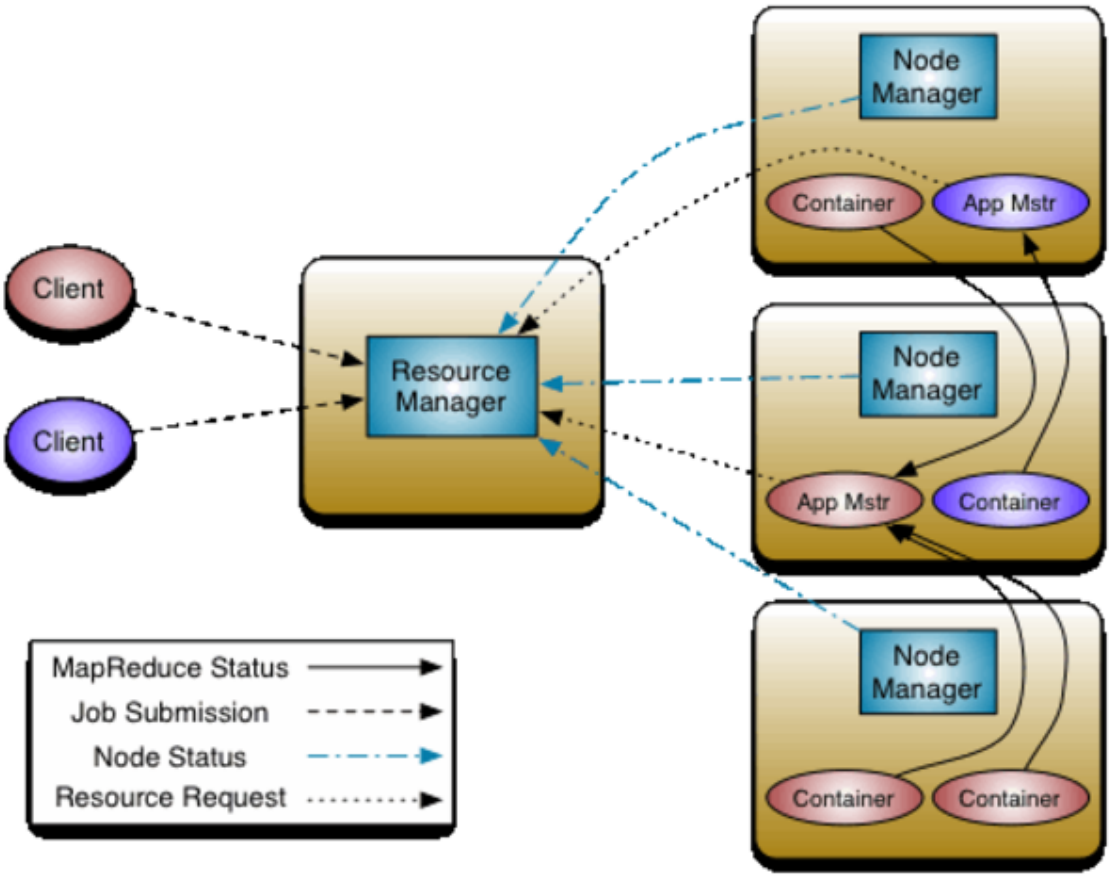

Figure 4: YARN Architecture [3]

8

List of Tables

Table 1: My caption

1	2	3
4	5	6
7	8	9

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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--empty year in www-hadoop
(There was 1 warning)

bibtext _ label error
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latex report
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        [2017-11-04 22.31.59] pdflatex report.tex
This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
p.2   L96   : 't:mytable' undefined
Missing character: ""
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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 1.4s.

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

```
name: Sushant Athaley
hid:  302
paper1: Nov 3 2017 100%
paper2: 30%

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


wordcount
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10
wc 302 paper2 10 1325 report.tex
wc 302 paper2 10 2017 report.pdf
wc 302 paper2 10 214 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}

passed: True

floats
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55: 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 high
    fault tolerant which contains mechanism for quick fault detection
    and auto recovery. HDFS is designed to port across heterogeneous
    hardware and software platform. It does data computation on same
    node instead of moving data to the server which is faster as well
    as avoid network congestion. It provides scalability by adding or
```

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    removing nodes in the HDFS cluster and can support hundreds of
    nodes in single cluster \cite{www-hdfs-arch}. Figure \ref{f:hdfs-
    arch} shows HDFS architecture.
56: \begin{figure}[!ht]
57: \centering\includegraphics[width=\columnwidth]{images/hdfsArch.PNG
    }
58: \caption{HDFS Architecture \cite{www-hdfs-arch}}\label{f:hdfs-
    arch}
61: 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 name space 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 datablocks on the node as per the instruction by the
    NameNode. DataNode also sends block-report to NameNode which has
    list of all blocks on the DataNode. DataNode sends heartbeat
    message to NameNode which helps in identifying the failure nodes.
    If heartbeat is not received by NameNode in specified interval
    then that DataNode is marked as dead and NameNode usage different
    DataNode. Figure \ref{f:hdfs-read} and \ref{f:hdfs-write} depicts
    read and write in HDFS respectively.
63: \begin{figure}[!ht]
64: \centering\includegraphics[width=\columnwidth]{images/hdfsRead.PNG
    }
65: \caption{HDFS Read \cite[Ch.\ 3, p.
    38]{AchariShiva2015HE}}\label{f:hdfs-read}
68: \begin{figure}[!ht]
69: \centering\includegraphics[width=\columnwidth]{images/hdfsWrite.PN
    G}
70: \caption{HDFS Write \cite[Ch.\ 3, p.
    39]{AchariShiva2015HE}}\label{f:hdfs-write}
76: Figure \ref{f:yarn-arch} shows YARN architecture.
77: \begin{figure}[!ht]
78: \centering\includegraphics[width=\columnwidth]{images/yarnArch.PNG
    }
79: \caption{YARN Architecture \cite{www-apache-yarn}}\label{f:yarn-
    arch}
97: or generate them by hand while using the provided template in
    Table\ref{t:mytable}. Not ethat
100: \begin{table}[htb]
103: \label{t:mytabble}

figures 4
tables 1
```

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includegraphics 4
labels 5
refs 4
floats 5

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
passed: True

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


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

passed: True

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--empty year in www-hadoop
(There was 1 warning)

bibtex_empty_fields
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entries in general should not be empty in bibtex
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find ""
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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 {
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Big Data Applications in Historical Studies

Neil Eliason
Indiana Unversity
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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

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

REFERENCES

[1] C.L. Philip Chen and Chun-Yang Zhang. 2014. Data-intensive applications, challenges, techniques and technologies: A survey on Big Data. *Information Sciences* 275, Supplement C (2014), 314 – 347. https://doi.org/10.1016/j.ins.2014.01.015

[2] B.J. Copeland. 2017. artificial intelligence (AI). Webpage. (01 2017). https://www.britannica.com/technology/artificial-intelligence

[3] Malte C. Ebach, Michaelis S. Michael, Wendy S. Shaw, James Goff, Daniel J. Murphy, and Slade Matthews. 2016. Big data and the historical sciences: A critique. *Geoforum* 71, Supplement C (2016), 1 – 4. https://doi.org/10.1016/j.geoforum.2016.02.020

[4] Dan Edelstein, Paula Findlen, Giovanna Ceserani, Caroline Winterer, and Nicole Coleman. 2017. Historical Research in a Digital Age: Reflections from the Mapping the Republic of Letters ProjectHistorical Research in a Digital Age. *The American Historical Review* 122, 2 (2017), 400. http://proxyiub.uits.iu.edu/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsoaf&AN=edsoaf.a29ec0ac934f1257030b477fa5986b1cff6def96&site=eds-live&scope=site

[5] Amir Gandomi and Murtaza Haider. 2015. Beyond the hype: Big data concepts, methods, and analytics. *International Journal of Information Management* 35, 2 (2015), 137 – 144. https://doi.org/10.1016/j.ijinfomgt.2014.10.007

[6] Stanford Humanities and Design. 2017. Palladio. Visualize complex historical data with ease. webpage. (2017). http://hdlab.stanford.edu/palladio/about/

[7] Eijnatten Joris van, Pieters Toine, and Verheul Jaap. 2013. Big Data for Global History: The Transformative Promise of Digital Humanities. *BMGN: Low Countries Historical Review, Vol 128, Iss 4, Pp 55-77 (2013)* 128, 4 (2013), 55. http://proxyiub.uits.iu.edu/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=edsdoj&AN=edsdoj.6259f58bab4740485225cd4776fcf48&site=eds-live&scope=site

[8] Editorial Board of the Programming Historian. 2017. About the Programming Historian. Website. (10 2017). https://programminghistorian.org/about

[9] Technopedia. 2017. Natural Language Processing (NLP). Webpage. (2017). https://www.techopedia.com/definition/653/natural-language-processing-nlp

[10] Sandra1 Tuppen, Stephen2 Rose, and Loukia Drosopoulou. 2016. LIBRARY CATALOGUE RECORDS AS A RESEARCH RESOURCE: INTRODUCING 'A BIG DATA HISTORY OF MUSIC'. *Fontes Artis Musicae* 63, 2 (2016), 67 – 88. http://proxyiub.uits.iu.edu/login?url=https://search.ebscohost.com/login.aspx?direct=true&db=llf&AN=114128249&site=eds-live&scope=site

5 ISSUES

DONE:

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 inflate 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

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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

bibtext _ label error
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bibtext comma label error
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latex report
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        [2017-11-04 22.32.10] pdflatex report.tex
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  9:81      error    line too long (89 > 80 characters)  (line-length)
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  25:81     error    line too long (97 > 80 characters)  (line-length)
  25:97     error    trailing spaces  (trailing-spaces)
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================================================================================
Compliance Report
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name: Neil Eliason
hid:  312
paper1: Review on 3 Nov 2017
paper2: 95%
project: not yet started

yamlcheck
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wordcount
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wc 312 paper2 5 3508 report.pdf
wc 312 paper2 5 1064 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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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
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passed: True

bibtex
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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
Database file #1: report.bib

bibtex_empty_fields
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entries in general should not be empty in bibtex
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find ""
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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 Applications in Using Neural Networks for Medical Image Analysis

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711 N. Park Avenue
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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 assistive tools. Machine learning algorithms, especially artifical neural networks (ANN), are being leveraged to help identify problems 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 expected 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, 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-aided diagnosis (CAD) tools to help mitigate errors. These are systems that 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]. Early implementations leveraged various machine learning algorithms to perform classification tasks around identifying the presence of abnormalities, but the effectiveness of these tools was reported as low in clinical studies. Specifically, CAD assessments included more false positives than human assessments, which led to additional, unnecessary medical tests and biopsies [**?**].

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 computer power [3][4]. These factors combine to create an ideal state for research related to artifical neural networks (ANN) and

the implementation of tools that can rival, and even outperform, the assessment of highly trained radiologists.

2 ARTIFICIAL NEURAL NETWORKS

history of

simple applications - numbers

math used - sigmoid function - why what does this do

back propagation

black box

how compare to other classification algorithms.

In a field that relies heavily on the perception of the reviewer, the occurrence of error is not especially surprising.

Describe the workflow of a radiologist. what is the history of the profession

what is the error rate of radiologists. burnout

machine learning - what is it. what kinds of problems can it solve

why is image recognition well suited for deep learning

how much data is there

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

what is the history of neural networks, why is now the time that it's proliferating

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

how is this service being offered, which companies are selling, what are they doing

problems, controversies, how is it being accepted. differences in how images are taken, quality

applications of neural networks Applications fi?! hip ortho, diabetic retinopathy, mammogram, melanoma detection, lung nodules, myositis

The increased attention and effectiveness of these tools is brought on by several factors, including sufficient computing power and the availability of sufficiently large train sets needed by the ANN to understand patterns in the data [**?**].

3 NEURAL NETWORKS

4 INFRASTRUCTURE

big data computing, how long it takes to train on these problems. GPUs vs CPUs

5 CONCLUSION

This is my conclusion.

ACKNOWLEDGMENTS

These are my acknowledgements

REFERENCES

[1] Michael Bruno, Eric Walker, and Hani Abujudeh. 2015. Understanding and Confronting Our Mistakes: The Epidemiology of Error in Radiology and Strategies for Error Reduction. *RadioGraphics* 35, 6 (2015), 1668–1676. https://doi.org/0.1148/rg.2015150023

[2] Kunio Doi. 2007. Computer-Aided Diagnosis in Medical Imaging: Historical Review, Current Status and Future Potential. *Comput Med Imaging Graph* 31, 4-5 (2007), 198–211.

[3] Tae-Yun Kim, Jaebum Son, and Kwang-Gi Kim. 2011. The Recent Progress in Quantitative Medical Image Analysis for Computer Aided Diagnosis Systems. *Healthcare Informatics Research* 17, 3 (September 2011), 143–149. https://doi.org/10.4258/hir.2011.17.3.143

[4] June-Goo Lee, Sanghoon Jun, Young-Won Cho, Hyunna Lee, Guk Bae Kim, Joon Beom Seo, and Namkug Kim. 2017. Deep Learning in Medical Imaging: General Overview. *Korean Journal of Radiology* 18, 4 (2017), 570–584. https://doi.org/10.3348/kjr.2017.18.4.570

[5] Radiological Society of North America (RSNA). 2017. What Does a Radiologist Do? Online. (April 2017). https://www.radiologyinfo.org/en/info.cfm?pg=article-your-radiologist

[6] Morris Panner. 2015. Whatfis Next for the Health-Care Data Center? Online. (April 2015). http://www.datacenterjournal.com/whats-healthcare-data-center/

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

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

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Advancements in Drone Technology for the U.S. Military

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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.

ACKNOWLEDGMENTS

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REFERENCES

[1] Greg Allen and Taniel Chan. 2017. *Artificial Intelligence and National Security.* Technical Report. Harvard Kennedy School - Belfer Center for Science and International Affairs, 79 JFK Street, Cambridge, MA 02138.

[2] Sebastian Anthony. 2013. DARPA shows off 1.8-gigapixel surveillance drone, can spot a terrorist from 20,000 feet. Website. (01 2013). http://www.extremetech.com/extreme/146909-darpa-shows-off-1-8-gigapixel-surveillance-drone-can-spot-a-terrorist-from-20000-feet

[3] Allison Barrie. 2015. 'Star Trek'-style surveillance drone for the US military. Website. (09 2015). http://www.foxnews.com/tech/2016/09/15/star-trek-style-surveillance-drone-for-us-military.html

[4] Richard A. Burgess. 2015. ACTUV Sea Trials Set for Early 2016. Website. (11 2015). http://science.dodlive.mil/2015/11/09/actuv-sea-trials-set-for-early-2016/

[5] Jamie Condliffe. 2017. *A 100-Drone Swarm, Dropped from Jets, Plans Its Own Moves.* resreport. MIT Technology Review.

[6] Deagel. 2017. RQ-4A Global Hawk. Website. (04 2017). http://www.deagel.com/Support-Aircraft/RQ-4A-Global-Hawk_a000556001.aspx

[7] The Economist. 2017. *Taking Flight.* resreport. The Economist: Technology Quarterly.

[8] Emily Feng and Charles Clover. 2017. Drone swarms vs conventional arms: Chinafis military debate. Website. (08 2017). https://www.ft.com/content/302fc14a-66ef-11e7-8526-7b38dcaef614?mhq5j=e7

[9] Gartner. 2017. Gartner Says Almost 3 Million Personal and Commercial Drones Will Be Shipped in 2017. Press Release. (02 2017). https://www.gartner.com/newsroom/id/3602317

[10] Dan Gettinger. 2017. *Drones in the Defense Budget.* resreport. Center for the Study of Drones, Bard College.

[11] Northrop Grumman. 2017. Global Hawk. Website. (2017).

[12] Derrick Harris. 2015. Google: Our new system for recognizing faces is the best one ever. Website. (03 2015). http://fortune.com/2015/03/17/google-facenet-artificial-intelligence/

[13] Dan Lamothe. 2016. Watch Perdix, the secretive Pentagon program dropping tiny drones from jets. Website. (03 2016). https://www.washingtonpost.com/news/checkpoint/wp/2016/03/08/watch-perdix-the-secretive-pentagon-program-dropping-tiny-drones-from-jets/?utm_term=.0a44c6311045

[14] John Markoff. 2013. Military Lags in Push for Robotic Ground Vehicles. Website. (09 2013). http://www.nytimes.com/2013/09/24/science/military-lags-in-push-for-robotic-ground-vehicles.html

[15] 60 Minutes. 2017. New generation of drones set to revolutionize warfare. Television. (01 2017). Correspondent David Martin.

[16] Kyle Mizokami. 2017. The Pentagon's Autonomous Swarming Drones Are the Most Unsettling Thing You'll See Today. Website. (01 2017). http://www.popularmechanics.com/military/aviation/a24675/pentagon-autonomous-swarming-drones/

[17] Kris Osborn. 2017. Navy sub-hunting drone ship goes on offense. Website. (01 2017). https://defensesystems.com/articles/2017/01/11/seahunter.aspx

[18] Caroline Reese. 2017. Endeavor Robotics to Provide U.S. Government with Throwable UGV. Website. (09 2017). http://www.unmannedsystemstechnology.com/2017/09/endeavor-robotics-provide-u-s-government-throwable-ugv/

[19] Tyler Rogoway. 2014. Why The USAF's Massive $10 Billion Global Hawk UAV Is Worth The Money. Website. (09 2014). https://foxtrotalpha.jalopnik.com/why-the-usafs-massive-10-billion-global-hawk-uav-was-w-1629932000

[20] Adam Stone. 2016. ACTUV on track for Navy success story. Website. (12 2016). https://www.c4isrnet.com/unmanned/uas/2016/12/21/actuv-on-track-for-navy-success-story/

[21] Patrick W. Watson. 2017. U.S. Military May Soon Deploy Millions Of Drones, Which Presents A Big Investment Opportunity. Website. (08 2017). https://www.forbes.com/sites/patrickwwatson/2017/08/02/u-s-military-may-soon-deploy-millions-of-drones-which-presents-a-big-investment-opportunity/#4068439334a8

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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
    to be aggregated together by the thousands and carry out
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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) generate to collect vital health data in the treatment of opioid addiction.

KEYWORDS

Big Data Applications, Health Analytics, Wearable Sensors, i535, HID335

1 INTRODUCTION

In the increasingly connected digital age, personal electronic devices are generating huge volumes of data with important applications for health analytics. 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 epideic 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 nature of the opioid epidemic is complex, and to understand how technological interventions can play a role in mitigating the crisis, it is necessary to consider the nature of addiction and 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, but then are released back into the same environment associated with their drug use. The lack of continuity in the treatment of addiction disorders, leaves addicts in recovery at high risk for relapse into substance use and abuse. Second, individuals with severe addiction disorders end up at emergency rooms for care following acute intoxication, often after law enforcement interventions. Emergency personal are capable with 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 response to cues in the environmental 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 individuals 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 focuses cognitive-behavioral skills, 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 measured 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 based 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-medicationfifi model has commonly been used to explain the association between alcohol abuse is used 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 and addiction, which can trigger 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 patients leaving 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, 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, such as medication monitoring system could be very beneficial in anticipating opioid addiction and preventing overdose death.

[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 is 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. The findings provide evidence to support the use of wearable sensors to detect drug use in real time, though in a relatively 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 future efforts to explore the effectiveness of wearable biosensors in the context of environments that individuals in recovery associate with drug use where relapse can occur.

[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 (LoRaB) performs best in terms of sensitivity (-149 dBm), supports bit rates of 18 pbs to 37.5 kbps, provides whole home coverage, and is the only option 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 -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. Overall, 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 and recovery.

[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

2.0.1 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 individuals in recovery are released back into the environmental settings associated with their drug use. Recent advances in signal technologies such as LoRa Backscatter and Graphene tattoo sensors can lead to the more efficient collection of biometric signals and cost effective transmission of health data for subsequent analysis. The opioid addiction epidemic is a complex phenomenon, with underlying sociological 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. 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, which occurs in non-clinical and unregulated settings. Big data offers potential for transforming health care and addition treatment; however, increasing levels of data about opioid addiction may not lead to a decrease in rates of overdose death if the overall availability of illicit and alternative opioids remains high.

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REFERENCES

[1] Shideh Kabiri Ameri, Rebecca Ho, Hongwoo Jang, Li Tao, Youhua Wang, Liu Wang, David M. Schnyer, Deji Akinwande, and Nanshu Lu. 2017. Graphene Electronic Tattoo Sensors. *ACS Nano* 11, 8 (2017), 7634–7641. https://doi.org/10.1021/acsnano.7b02182 arXiv:http://dx.doi.org/10.1021/acsnano.7b02182 PMID: 28719739.

[2] Louis Atallah, Gareth G. Jones, Raza Ali, Julian J. H. Leong, Benny Lo, and Guang-Zhong Yang. 2011. Observing Recovery from Knee-Replacement Surgery by Using Wearable Sensors. In *Proceedings of the 2011 International Conference on Body Sensor Networks (BSN '11)*. IEEE Computer Society, Washington, DC, USA, 29–34. https://doi.org/10.1109/BSN.2011.10

[3] Katherine Bourzac. 2017. Graphene Temporary Tattoo Tracks Vital Signs. online. (Jan. 2017). https://spectrum.ieee.org/nanoclast/semiconductors/nanotechnology/graphene-temporary-tattoo IEEE Spectrum.

[4] E.W. Boyer, D. Smelson, R. Fletcher, D Ziedonis, and Picard R. W. 2010. Wireless Technologies, Ubiquitous Computing and Mobile Health: Application to Drug Abuse Treatment and Compliance with HIV Therapies. *Journal of Medical Toxicology* 6, 2 (2010), 212–216. https://doi.org/doi:10.1007/s13181-010-0080-z

[5] Stephanie Carreiro, David Smelson, Megan Ranney, Keith J. Horvath, R. W. Picard, Edwin D. Boudreaux, Rashelle Hayes, and Edward W. Boyer. 2015. Real-Time Mobile Detection of Drug Use with Wearable Biosensors: A Pilot Study. *Journal of Medical Toxicology*. 11, 1 (Oct. 2015), 73–79. https://doi.org/10.1007/s13181-014-0439-7.

[6] K.M. Carroll, S.A. Ball, S. Martino, and et al. 2008. Computer-assisted delivery of cognitive-behavioral therapy for addiction: a randomized trial of CBT4CBT. *Am J Psychiatry* 165, 7 (2008), 881fi?!8. https://doi.org/10.1176/appi.ajp.2008.07111835

[7] Melinda Gomez Michael Schwartz David Metcalf, Sharlin T.J. Milliard. 2016. Wearables and the Internet of Things for Health. *IEEE Pulse* (Oct. 2016). https://pulse.embs.org/september-2016/wearables-internet-of-things-iot-health/

[8] Richard Ribon Fletcher, Ken ichi Amemori, Matthew Goodwin, and Ann M. Graybiel. 2012. Wearable wireless sensor platform for studying autonomic activity and social behavior in non-human primates. In *Engineering in Medicine and Biology Society (EMBC), 2012 Annual International Conference of the IEEE*, Annual International Conference of the IEEE (Ed.). IEEE, IEEE, San Diego, CA, USA. https://doi.org/10.1109/EMBC.2012.6346855

[9] Centers for Disease Control and Prevention. 2017. Prescription Opioid Overdose Data. online. (Oct. 2017). https://www.cdc.gov/drugoverdose/data/overdose.html

[10] D.H. Gustafson, F.M. McTavish, M.-Y. Chih, A.K. Atwood, R.G. Johnson, M. Boyle, and M. ... Shah. 2014. A smartphone application to support recovery from alcoholism: A randomized controlled trial. *JAMA psychiatry*. 71, 5 (May 2014), 566–572. https://doi.org/10.1001/jamapsychiatry.2013.4642

[11] K. Johnson, A. Isham, D.V. Shah, and D.H. Gustafson. 2011. Potential Roles for New Communication Technologies in Treatment of Addiction. *Current psychiatry reports*. (2011). https://doi.org/10.1007/s11920-011-0218-y

[12] Lisa A. Marsch. 2012. Leveraging teachnology to enhance addiction treatment and recovery. *Journal of Addictive Diseases* 31, 3 (2012), 313–318. https://doi.org/10.1080/10550887.2012.694606

[13] L. A. Marsch and J. Dallery. 2012. Advances in the Psychosocial Treatment of Addiction: The Role of Technology in the Delivery of Evidence-Based Psychosocial Treatment. *The Psychiatric Clinics of North America* ;35(2):. doi:, 2 (2012), 481–493. https://doi.org/10.1016/j.psc.2012.03.009

[14] National Institute on Drug Abuse (NIDA). 2017. *Overdose Death Rates*. Summary. National Institutes of Health (NIH), Washington D.C. https://www.drugabuse.gov/related-topics/trends-statistics/overdose-death-rates

[15] Yavin Shaham, Uri Shalev, Lin Lu, Harriet de Wit, and Jane Stewart. 2003. The reinstatement model of drug relapse: history, methodology and major findings. *Psychopharmacology* 168, 1 (01 Jul 2003), 3–20. https://doi.org/10.1007/s00213-002-1224-x

[16] J. Swendsen. 2016. Contributions of mobile technologies to addiction research. *Dialogues Clinical Neuroscience* (2016). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4969708/

[17] Vamsi Talla, Mehrdad Hessar, Bryce Kellogg, Ali Najafi, Joshua R. Smith, and Shyamnath Gollakota. 2017. LoRa Backscatter: Enabling The Vision of Ubiquitous Connectivity. *CoRR* abs/1705.05953 (2017). http://arxiv.org/abs/1705.05953

[18] Upkar Varshney. 2013. Smart medication management system and multiple interventions for medication adherence. *Decision Support Systems* 55, 5 (May 2013), 538–551. https://doi.org/10.1016/j.dss.2012.10.011

[19] Upkar Varshney. 2014. Mobile Health: Medication Abuse and Addiction. In *Proceedings of the 4th ACM MobiHoc Workshop on Pervasive Wireless Healthcare (MobileHealth '14)*. ACM, New York, NY, USA, 37–42. https://doi.org/10.1145/2633651.2633656

[20] Nora D. Volkow, Thomas R. Frieden, Pamela S. Hyde, and Stephen S. Cha. 2014. Medication-Assisted Therapies: Tackling the Opioid-Overdose Epidemic. *New England Journal of Medicine* 370, 22 (2014), 2063–2066. https://doi.org/10.1056/NEJMp1402780 arXiv:http://dx.doi.org/10.1056/NEJMp1402780 PMID: 24758595.

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

e.g.

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

re

[6]

List of Figures

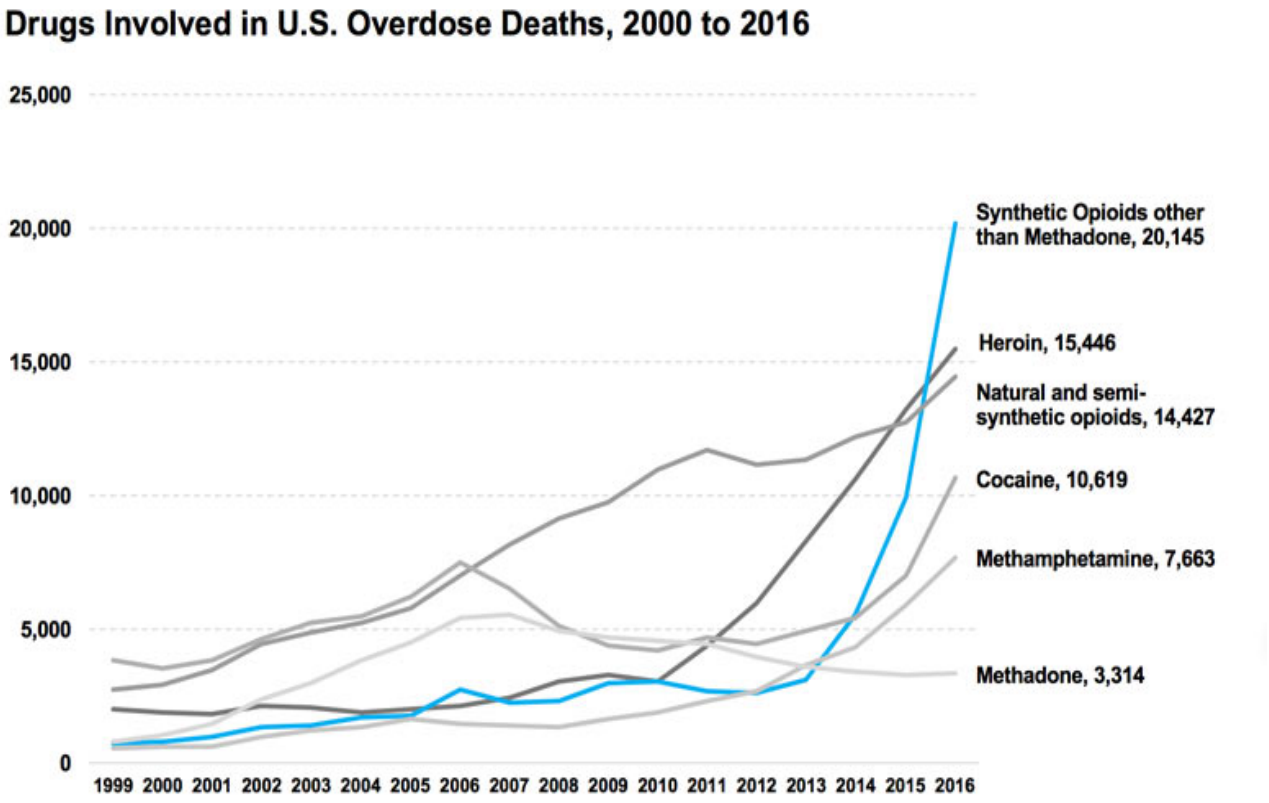
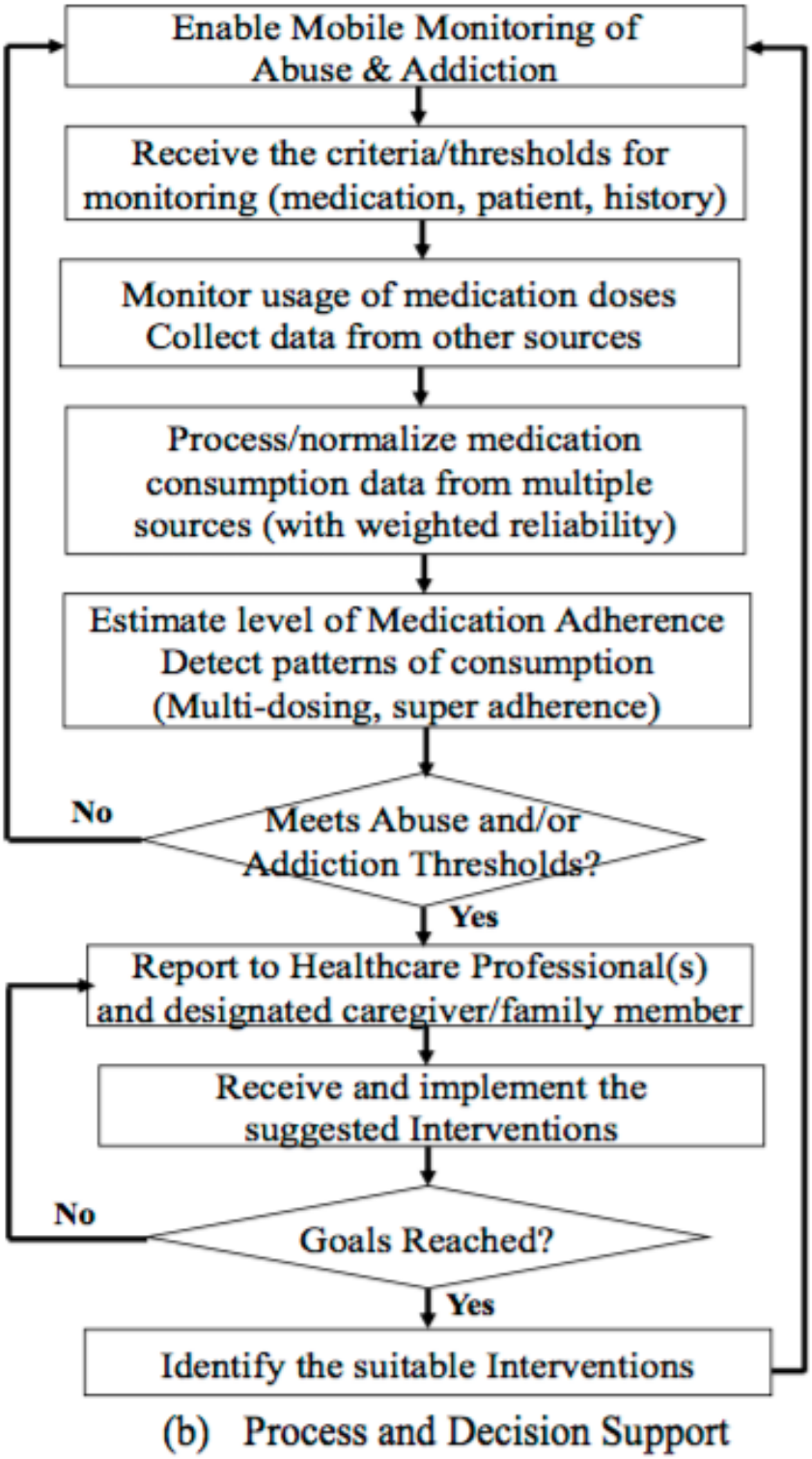


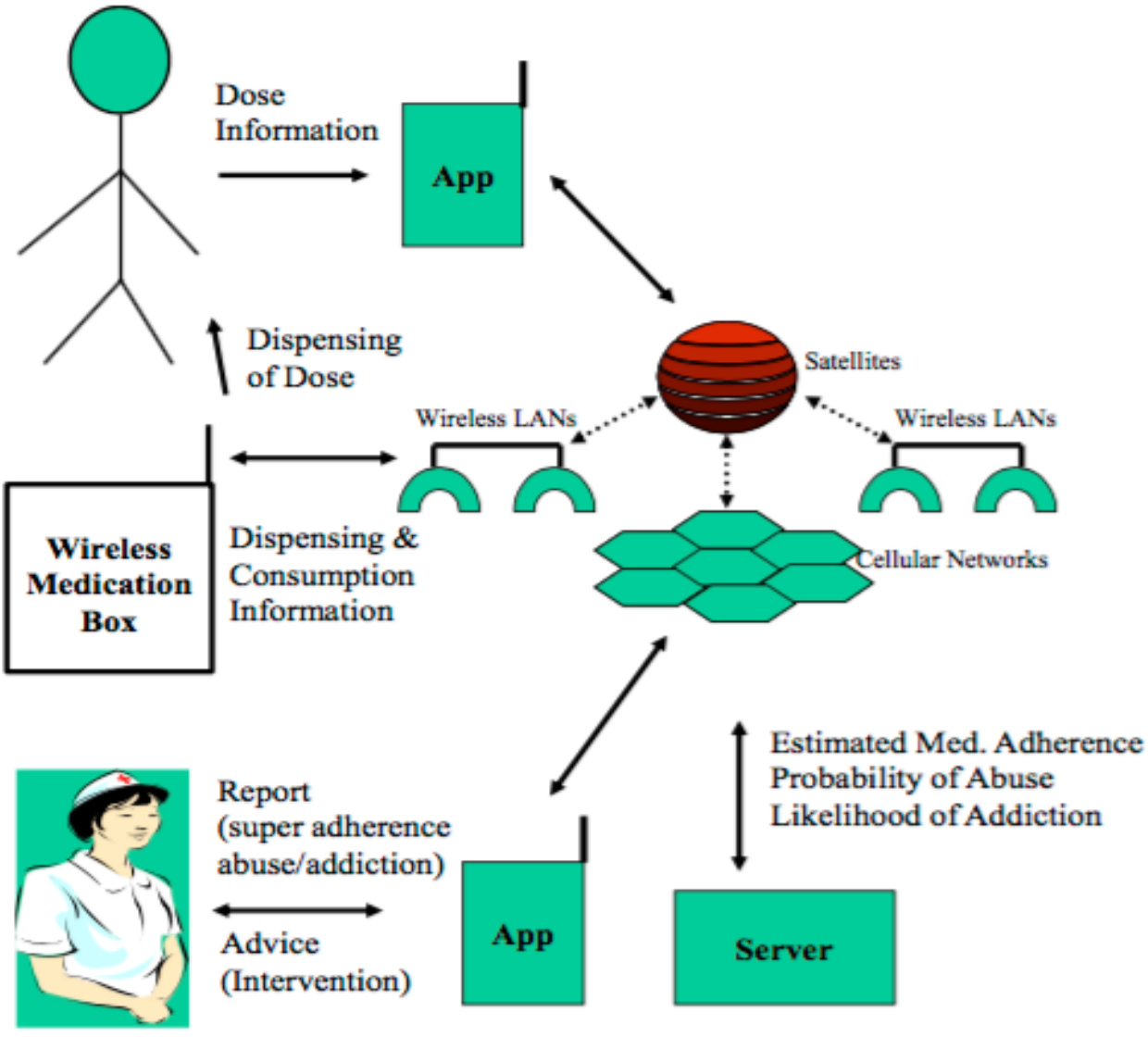
Figure 1: Drugs Involved in U.S. Overdose Deaths from 2000 to 2016, National Institute on Drug Addiction (NIDS) [14]

8



9

Figure 2: Process and Decision Support for Abuse Monitoring System [19]



(a) Architecture of the Abuse Monitoring System

Figure 3: Architecture for Abuse Monitoring System [19]

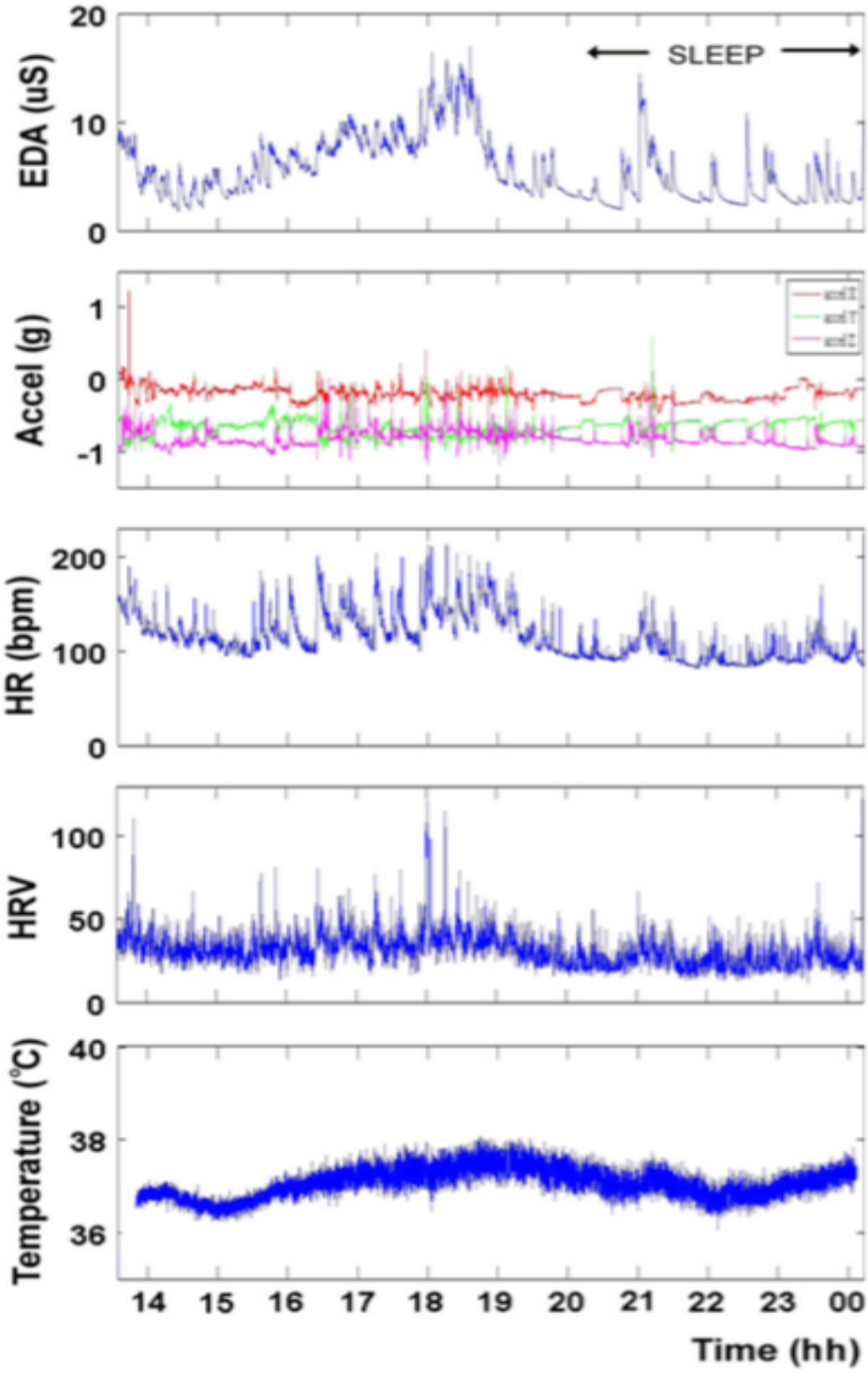
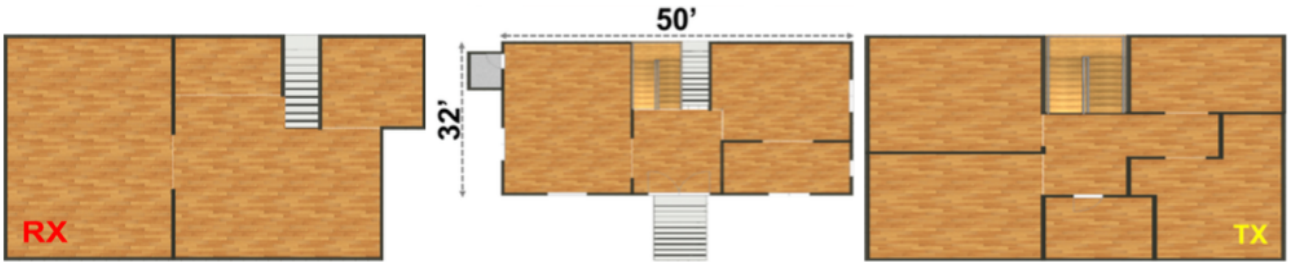
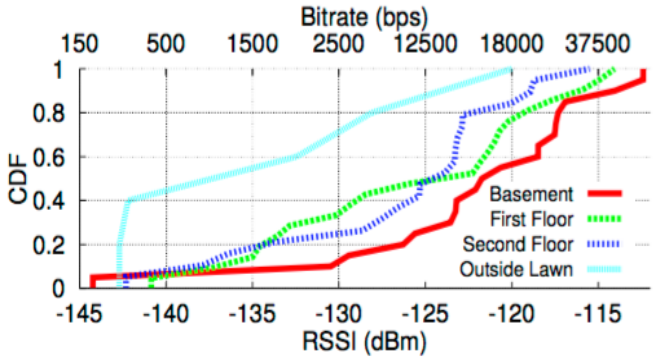


Figure 4: Sample Ambulatory Data from Rhesus Macaque Recorded on Wearable Sensor for 11+ hours Inside Large Primate Cage Facility [8]



(a) Basement (b) First Floor (c) Second Floor



(d) CDF

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]

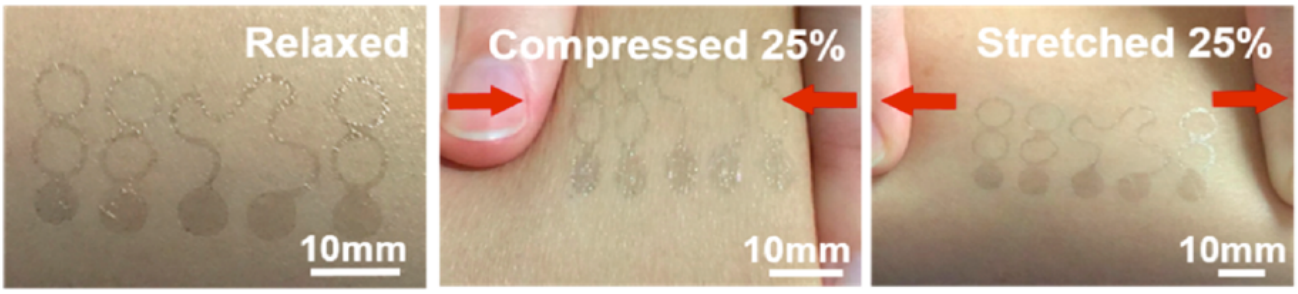


Figure 7: Graphene Electronic Tatoo Biosensor [1]

13

List of Tables

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

```
bibtext report
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Database file #1: report.bib
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while executing---line 3085 of file ACM-Reference-Format.bst
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while executing---line 3085 of file ACM-Reference-Format.bst
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while executing---line 3131 of file ACM-Reference-Format.bst
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while executing---line 3131 of file ACM-Reference-Format.bst
Warning--numpages field, but no articleno or eid field, in atallah11
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while executing---line 3229 of file ACM-Reference-Format.bst
Name 4 in "Boyer, E.W. and Smelson, D. and Fletcher, R. and Ziedonis, D, and Picard R. W
while executing---line 3229 of file ACM-Reference-Format.bst
Warning--unrecognized DOI value [doi:10.1007/s13181-010-0080-z]
Too many commas in name 1 of "David Metcalf, Sharlin T.J. Milliard, Melinda Gomez, Micha
while executing---line 3229 of file ACM-Reference-Format.bst
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while executing---line 3229 of file ACM-Reference-Format.bst
Warning--no number and no volume in metcalf16
Warning--page numbers missing in both pages and numpages fields in metcalf16
Warning--page numbers missing in both pages and numpages fields in fletcher12
Warning--no number and no volume in johnson11
Warning--page numbers missing in both pages and numpages fields in johnson11
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make[2]: *** [bibtex] Error 2
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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
Label ‘tab:freq’ multiply defined.
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
Missing character: ""
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Missing character: ""
Missing character: ""
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.
Float too large for page by 51.24545pt.
Float too large for page by 51.24545pt.
Float too large for page by 62.24545pt.
The anchor of a bookmark and its parent’s must not be the same. Added a new anchor.
There were multiply-defined labels.
Typesetting of "report.tex" completed in 1.2s.
../README.yml
  13:5      error    wrong indentation: expected 8 but found 4  (indentation)
  15:5      error    wrong indentation: expected 8 but found 4  (indentation)
  38:5      error    wrong indentation: expected 8 but found 4  (indentation)
  40:5      error    wrong indentation: expected 8 but found 4  (indentation)
  53:4      error    wrong indentation: expected 4 but found 3  (indentation)
  53:17     error    trailing spaces  (trailing-spaces)
  55:4      error    wrong indentation: expected 7 but found 3  (indentation)
  57:4      error    wrong indentation: expected 7 but found 3  (indentation)
  74:70     error    trailing spaces  (trailing-spaces)
  78:33     error    trailing spaces  (trailing-spaces)
  80:81     error    line too long (91 > 80 characters)  (line-length)


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


name: Sean Shiverick
hid:  335
```

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paper1: 10/25/17 100%
paper2: 90%
project: in progress

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


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

15
wc 335 paper2 15 3451 report.tex
wc 335 paper2 15 4691 report.pdf
wc 335 paper2 15 1096 report.bib

find "
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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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76: \begin{figure}[!ht]
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80: }\label{f:Figure1}
192: \begin{figure}[!ht]
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394: }\label{f:Figure7}

figures 7
tables 2
includegraphics 7
labels 9
refs 0
floats 9

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
61: more than 180,000 deaths between 1999 to 2015. Figure 1 shows that
    the dramatic
206: Figure 2 illustrates several steps in a process and decision
     support structure
215: status, and patient motivation. Figure 3 shows a model
     architecture of a system
242: medication in an emergency room setting \cite{carreiro15}. Table
     1 provides a
281: in real time. Figure 4 shows sample ambulatory data from a rhesus
     macaque
310: (i.e., yards) \cite{talla17}. Table 1 shows the sensitivity and
```

```
     supported data
320: one-acre farm. Figure 5 shows the layout of the house with the RF
     source (TX)
325: sensor shown in Figure 6, that provided reliable connectivity
     across a 3,300
378: As depicted in Figure 7, the GET sensor is is flexible,
     stretchable, and
421: medication abuse, Table 1 shows the rate of overdose deaths is
     growing more
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


find textwidth
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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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The style file: ACM-Reference-Format.bst
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Warning--numpages field, but no articleno or eid field, in Varshney14
(There were 12 error messages)

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entries in general should not be empty in bibtex


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non ascii found 8217
non ascii found 8217

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

Natural Language Processing (NLP) to analyze human speech data

Ashok Reddy Singam
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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

1 INTRODUCTION

As voice becoming a common user interface, the need for accurate and intelligent speech recognition technologies is growing. In speech processing technology there are two main subtasks

- Speaker Recognition
- Speech Recognition

Although the performance of current speaker and speech recognition systems is far from perfect, these systems have already proven their usefulness in many applications.

2 SPEAKER RECOGNITION

Speaker identification is one of the important task in speech processing. Each person has a voice that is different from everyone else's.Speaker recognition is the process of identifying who is speaking by using acoustic features of speech.Speaker recognition has been applied mostly in security applications to control access. Current speaker recognition systems are not very accurate for large speaker populations.

3 NLP FOR SPEECH RECOGNITION

Speech recognition is the ability to identify spoken words. It is the process of converting speech into text. This process prepares the input data (speech) to be appropriate for Natural Language Processing(NLP). NLP is the processing of the text to understand the meaning of the text. It comes as the next step of speech recognition. *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, 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 languagefis 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 (knowledge driven)**: Rule based approach requires huge human effort to prepare the rules, parts of speech triggers etc. 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 (data driven)**: 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.

  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.

4 CONCLUSION

ACKNOWLEDGMENTS

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

REFERENCES

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bibtext report
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This is BibTeX, Version 0.99d (TeX Live 2016)
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This is pdfTeX, Version 3.14159265-2.6-1.40.17 (TeX Live 2016) (preloaded format=pdflate
Missing character: ""
Missing character: ""
Empty ‘thebibliography’ environment.
Typesetting of "report.tex" completed in 0.8s.

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


name: Ashok Reddy Singam
hid:  337
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paper2: Nov 06 17 60%
project: not started

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-----------------------------------------------------------------------------


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

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wc 337 paper2 2 765 report.pdf
wc 337 paper2 2 66 report.bib

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    description of the structure of a given languages 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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passed: True

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4: \input{format/i523}

passed: True

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


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

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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)

Label/ref check
passed: True

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[width=1.0\columnwidth]
do not cahnge the number to a smaller fraction
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passed: True

bibtex
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label errors


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ascii
--------------------------------------------------------------------------------

non ascii found 8217

================================================================================
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 {
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passed: True
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