The Case for a Humanitarian Web Made Possible by Big Data Analytics

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Abstract—The World Wide Web (WWW) has come a long way in improving the quality of lives of people, mostly the elite and working classes, all over the world. This article examines whether the Web can serve the needs of the underprivileged with the advent of promising technologies like Big Data Analytics, Internet of Things, Virtualization, Cloud Computing, Augmented Reality, and Brain-to-Brain Communication. The article discusses the trends, enablers, and use-cases to make an argument for a Humanitarian Web that serves more pressing needs, particularly of the lower echelons of the society.

Index Terms—World Wide Web, Big Data, Analytics, Cloud Computing, Internet of Things, Augmented Reality, Virtualization, Healthcare, Cybersecurity, Brain-to-Brain Communication, Augmented Reality

1 Introduction

The Web browser has virtually become a window to the world and is a significant component of Big Data. With the advent of cloud technology, most of the interactions with computing resources have also moved to the browser. There is still plenty of scope to evolve the Web and make it yet another tool for human empowerment, as we identified in [2]. Quite a few industries are moving to the Web. The entire stock exchange is now online. Publishing went online with the advent of the Web. Education is going online – we now have a number of Massive Open Online Courses (MOOC) that can be taken on the Web. There is scope for taking more and more industries online in order to make them serve wider populations, particularly in the developing countries. Analytics plays a significant role in each and every such industry. The following sections highlight some of the trends and use cases that make the case for a humanitarian Web backed by Big Data Analytics stronger.

2 Ubiquitous Computing and Analytics as a Service (AaaS)

Computing everywhere is an important enabler for crowdsourcing projects. With the advent of the cloud computing paradigm and push button deployment of compute intense applications, the Web can increasingly be used in computing for user-specified, non-conventional applications and possibly for raw computing as well. It has a potential to help populations from developing countries, which cannot afford to own substantial computing resources to get online and contribute to the computing revolution. The Web, with its broad reach and pervasiveness, can then be perceived as the Ubiquitous Computer [1]. The enabler that the Web is, becomes indistinguishable from the service it provides, namely ubiquitous computing. Online storage is free today, so raw computing power could as well be made available for no or very little expense. When information, which is more expensive than the computing power, is made available for free on the Web, computational power is likely to follow. We propose that the Web be the conduit for this free access to computing resources.

A vast majority of technology is still too complex or inaccessible for routine use by a significant majority of the population. Lowering the bar to use technology and increasing technical insights among masses are necessary steps in the advancement of mankind and the Web's role in enabling ubiquitous computing is a key factor in achieving this goal. Cloud Computing already offers the technology to create Virtual Machine (VM) instances on the fly. The Web protocols should be able to support provisioning this instance to the Web user on a request from a client. Users will then be able to use the Web for running applications of their choice in a VM like instance.

Other than for certain specific areas such as expensive corporate computing needs, Cloud computing should become synonymous with the Web in the long run. It should be possible to deploy user-defined applications on the Web without much effort and harness them via mobile devices. The mobile devices in turn will then be able to serve a plethora of humanitarian needs. The Web usage is bound to experience a paradigm shift from server-defined computing to serving user defined computing needs at the point-of-use.

All aspects of cloud computing, namely, Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS) and more importantly, Analytics as a

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Service (AaaS) need to be offered free. Only then can the true power of computing be unleashed to the masses. Provisioning Analytics tooling is time-consuming and resource incentive. Coupled with ubiquitous computing, AaaS will go a long way in deploying a number of humanitarian applications to serve the underprivileged.

AaaS is part of the evolving trend towards Big Data as a Service (BDaaS), a term used for provisioning various aspects of Big Data, from the data itself to the analytics that run on that data, as a service on the cloud. Amazon's Elastic Map Reduce (EMR) offered on its Web Services infrastructure (AWS) is an example of the BDaaS offering. As AaaS and BDaaS grow in their usage, the expense to use them should come down and help with humanitarian applications.

A Web that provides free computing resources in the cloud gains increasing prominence as more and more things become part of it as we describe below. Mobile devices do not have the computing power to process intense computing as needed for running, for instance, Augmented Reality (AR) applications. These ubiquitous devices will need to connect to the Web to enable compute intense applications. It is therefore also important that the Web protocols support AR.

3 Humanitarian Verticals

Internet of Things (IoT) brings a great promise to transform the Web and our lives as well. IoT is about making dumb products smart by network-enabling them. We discussed some of the futuristic aspects of the Web that will be enabled by IoT in our paper cited as [2]. IoT devices have a potential to be deployed in almost every topic identified on the call for papers for this conference, such as electrification or transportation. For instance, in one of the IEEE Global Humanitarian Technology Conferences, there was a discussion on how IoT can help control the movement of wheelchairs [3]. The Web of Things of these IoT devices can dramatically improve the quality of lives of the underprivileged populations across the world. Web of Things (WoT) provides the application interface to the IoT. The things then become part of the World Wide Web.

IoT gives the Web, the ability to see, hear, and sense the world in realtime. While social network websites help in discovering macro trends like an epidemic breakout or happenings in disaster relief, the Web of Things can help in micro-monitoring. For instance, WoT can help in smart energy management to eliminate power wastage or smart irrigation to optimize water usage. In these and other humanitarian verticals such as transportation, sensors, which are now available for a few cents can be deployed to get readings needed to optimize resource usage.

The data also helps to predict any maintenance required by running predictive analytics. Misbehaving IoT devices can be detected by aggregating the data and analyzing it for deviations. All this computing is done in the cloud, which as we pointed out earlier, should become synonymous with the Web. Another important vertical in the developing world is agriculture. It is the largest consumer of water, that has become a valuable commodity in view of the recent droughts. Table 1 lists the disruptions that WoT can bring about in this essential sector, including its impact on saving water.

Thing	Benefit
Farms	Monitor temperature, moisture, and fertility of soil for a better harvest.
Farming equipment	Driverless navigation of vehicles that can automatically sow seeds precisely at optimum points based on soil fertility.
Cows	Monitor herd of cows, know when they get into labor and prevent a miscarriage, track their health and milk yield.
Irrigation equipment	Water leakage monitoring, usage optimiztion, pollution level checks.

Table 1 Connecting things to the emerging economies to the Web: Example of the Agriculture Vertical

Air quality is a significant conern in the developing world. WoT can help in monitoring it, so as to be able to take preventive steps to improve it. WoT can also help in ensuring safety of civil engineering structures such as Dams, bridges, and huge buildings by measuring their health parameters such as pressure, temperature, and movements using sensors and analyzing that data. Transportation sector can similarly benefit by the analytics run on the data that the sensors in the vehicles send. There is a huge scope to bring all these applications over to the Web. While the Internet connects the things, the Web can connect the applications of the things. For instance, the application which monitors the safety of bridges can work with the application that monitors traffic to regulate or divert the vehicles proceeding to the bridge. These applications heavily rely on analytics software to provide useful humanitarian services. The Web can bring about seamless interconnection of disparate things, resulting in enormous synergy.

4 Healthcare

Healthcare is placed high on the humanitarian agenda. The Web, using cloud technology, can facilitate the deployment of healthcare applications supported by analytics engines, for mass usage. Medical diagnosis, that we presented in one of the IEEE's flagship humanitarian conference, GHTC [4] and further elaborated in [5] and in [6] in the previous issue of Visleshana is an example. Mining the information on social networks can help predict epidemics. Brain-to-brain communication is now a possibility. When human brains can communicate with microchips embedded in them, they can potentially become yet another thing in the Web of Things. Human brains can have an IP address and communicate with other human brains and machines directly, resulting in limitless man-machine synergy. The Web, with its power to connect, can help unleash this limitless potential. As we

stated above, WoT can help in micro-monitoring and a good example is monitoring type-I diabetics.

An ambitious humanitarian project would be to monitor all type-I diabetics in the world using a single WoT application. The diabetics, wearing insulin monitors, pumps and other medical devices can immensely benefit from such monitoring. Fatalities can be avoided and roads become safer, as the danger of a diabetic getting into coma while driving can be prevented. Aggregating and analyzing anonymous data from those wearables may reveal patterns that can help in further medical research and inventions. There are other chronic conditions like epilepsy, where such monitoring will immensely help.

A growing trend with Medical providers is video consultation. Patients can consult with the doctor entirely online, by transmitting a realtime video captured by a camera attached to a web-enabled device. When combined with the Web conferencing feature, a Primary Care Physician can conference-in a speacialist in the same session to provide conclusive diagnosis and prescription to the patient. The physician can also combine this feature with the analytics applications described in the above paragraph to substantiate his findings. These Web-enabled applications are a boon to the many parts of the world where access of healthcare is unacceptably low.

Web protocols do not yet support Augmented Reality (AR). An important research direction for the Web, as we identified in [2] is to encompass AR. Video consultation becomes much more effective with the advent of AR. The possibilities in healthcare with video and AR are many. For instance, images from MRI scans can be superimposed on a patient's body to note the exact location of points of concern. It must be noted that whatever technology can enable needs to be evaluated against the backdrop of public policy. Medical domain is highly regulated, which is actually impeding research and investment in healthcare. Striking a delicate balance between public safety and entrepreneurial initiatives is essential for a sustained advancement in this area.

5 Crisis Management

The Web played a major role in disaster relief in the past. During the Haiti earthquake, funds could be quickly pooled with the help of SMS and Web technology. Hundreds of people could collaborate using these technologies to collaboratively assist in the relief operations. The Web can help in knowledge and volunteer management, decision and logistics support, and information dissemination in case of such emergencies. Web-based projects such as Ushahidi and the crisis mapping initiative of the National Institute of Health have played a major role in disaster management.

Social media has caused a revolution in the quality of life in the world. It has placed a lot of power in the hands of the people to influence and change the social order. Several public safety issues and human rights violations have been successfully addressed by tweets and videos on the social media sites. Mining the information on the social networking websites and running analytics, can reveal important patterns and enable to create applications that can aid in humanitarian tasks. One such application is the Crisis Oriented Search Engine (COSE) proposed a few years ago. The COSE project indexes social media posts for subsequent retrieval and analysis. While data aggregation from the social media websites helps in on-site engagement, information posted on them can also help in outreach to solicit outsider involvement for fundraising or recruitment.

6 Resource Sharing

There are growing numbers of people willing to share their resources and give back to the society. Lyft, Uber, Wingz, AirBnB are ventures based on this Premise. With the advent of cloud computing and virtualization, people almost do not have to possess anything physically. It was machines to start with. A machine with the configuration the user wants could be easily provisioned in the cloud. Now there are applications which can be used to share not just machines, but even clothes. This technology is an important enabler in resource contrained locations, where resource utilization needs to be optimized. More web applications need to be developed for mapping need with excess capacity to enable easy pooling and sharing of resources. These applications will continue to be supported by analytics engines.

Education web-portals, offering Massive Open Online Courses (MOOC), such as Coursera also fall in this category. Knowledge is the commodity that is shared through these courses. Beyond the basic needs, education is probably the next major concern after healthcare. MOOC movement is limited to relatively advanced topics for the underprivileged. Learning has the best impact when the teacher is a peer. A significant humanitarian project will be to build the knowledge ground-up, for, of, and by the underprivileged populations through MOOCs. The Web can possibly enable more such ventures, for the underserved populations.

Information exchange is key to collective development. While there are efforts to develop ontologies [7] and supply chain kinds of mechanisms [8] for information exchange in the humanitarian domain, more needs to be done to facilitate the exchange even among individuals. Another web-enabled project that can be taken up is to pair every child in a developing country with at least one mentor in a developed world. The mentor can then interact with the child using all possible mechanisms that the Web protocols support. The project can be extended to grown-ups and even to those fighting depression and other psychological ailments all over the world.

7 Human Rights

The Web has furthered the exercise of fundamental rights of the citizens in multiple ways. Websites such as change.org help citizens to inquire the government about humanitarian causes. But there has also been research on how civil and human rights such as the right to privacy and the freedom to assemble have been violated by governments to gain control over the data and operations on the Web. The Chinese government's efforts at censoring collective action on the Web and NSA's role in undermining NIST's cyber security standards are recent examples. Politics always had and will have an upper hand over technology. With the growing outreach and

power of the Web, governments will naturally try to gain as much control over it as citizens would tolerate.

Technology can help counter governments that encroach upon citizen's rights, but only to some extent. Data encryption has the potential to let the originator of the data decide who can access it. But if governments deter attempts at tougher encryption standards as in the case of NIST, there is no recourse. Similarly, if governments decide to reign-in tighter control by enforcing country-wide VPNs, technology will not be able to side with the citizens. VPNs certainly protect against hackers and malicious attacks from outside the borders, but can be used to give the governments far more control over citizens' access to and activities on the Web.

Some of the controls and legal checks are necessary. For instance, health data by its very nature is personal. Privacy slows technological pace, but in such domains, is necessary. Transmitting cleartext medical data or other privacy violations in US attracts a 7 year prison term. Health-related Web transactions are therefore invariably encrypted. However to enable mass web applications such as online medical diagnosis that we described in [4], governments should allow release of anonymous or pseudonymous data for research use. Privacy is still a basic human right, that continues to be encroached upon not only by governments, but private parties as well. There are numerous examples such as "Uber's ride of glory," where sensitive information was unethically mined. Public policy needs to catch-up with technology to prevent such privacy violations.

The Web has been helping the governments in humanitarian efforts such as to enhance public safety. The trend towards smart cities include predictive policing to prevent crime. By running analytics on the data collected from geographical locations, the software is able to predict where crime is likely to occur next and show it on the Web. The Web combined with the mobile devices is empowering the common man in many ways and promoting citizen engagement. For instance, citizens can upload a picture of a crime scene or damaged infrastructure and file a complaint in minutes as contrasted to the hours it takes for conventional methods. It can be easily seen that incorporating Augmented Reality in the Web protocols will immensely enhance all these applications.

7 Conclusion

The Web holds a great potential to bring more and more people into the core echelons of the society. This article examined some of the ways this can be achieved.

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