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EPROM: Entrepreneurial Programming and Research on Mobiles for the Developing World

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This position paper makes the case for a mobile phone programming curriculum that will equip computer science students with the skills to design mobile phone applications specifically for the needs of people in the developing world. While mobile phones are becoming the continent's dominant computing platform, most computer science courses in Africa currently focus exclusively on programming traditional desktop computers. However, our over-subscribed pilot courses at the University of Nairobi confirmed the overwhelming demand from both students and faculty for the addition of a mobile phone programming curriculum. We are also introducing mobile phone programming courses in other universities across Africa, most recently at the GSTIT in Addis Abeba, Ethiopia. It is our belief that the creation of localized mobile services will continue to improve the economic welfare of the 1.4 billion mobile phone subscribers living in the developing world.

MOBILE PHONES IN AFRICA

Today's mobile phones are designed to meet Western needs. Subscribers in developing countries, however, now represent the majority of 2.4 billion mobile phone users worldwide. Africa, with Kenya at its forefront, is currently the fastest growing mobile phone market in the world. Over the past five years the continent's mobile phone use has increased at an annual rate of 65 percent - twice the global average. In June of 1999, Kenya had 15,000 mobile phone subscribers. By the end of 2004 the country had 3.4 million subscribers, and in the last 18 months this number has grown to over 5.6 million , despite the fact that only 200,000 Kenyan households have electricity.

According to the government's 2005 Economic Survey, Kenya's small business sector, which employs the majority of workers in the nation, created approximately 437,900 new jobs last year. The boom of mobile phones in Kenya has been credited for much of this growth. Indeed, it has been shown that adding an additional ten mobile phones per 100 people boosts a typical developing country's GDP growth by 0.6 percent.

A large part of this boost comes from the innovative use of mobile phone technology by local

entrepreneurs. In contrast to their use in the developed world, mobile phones in Africa are used for a wide variety of tasks, from sending money to family members to buying a fish from the market. Kenyan business men, farmers, and laborers are finding new uses for a tool thought of as simply a voice communication device in the West, and are coming up with original methods for solving their own problems. For example, contract laborers can now provide their phone numbers to potential employers and move on, instead of having to wait for hours at a workplace in case a job arises. Access to market information through mobile phones also provides rural communities with invaluable information about centers of business; many African fishermen check the local fish market prices on their phones to determine where to bring the day's catch. The Kenya Agricultural Commodity Exchange (Kace), now provides crop growers with up-to-date commodity information via text message (sms). This allows farmers to access daily fruit and vegetable prices from a dozen markets; many have quadrupled their earnings because they have access to information about potential buyers and prices before making the often arduous journey into urban centers to sell their produce. The community payphone, another innovation unique to the developing world, has helped bring mobile phone usage to the poorest areas of Africa. These payphones are owned and operated by entrepreneurs who buy airtime from the network and subsequently sell it to local people who don't own phones themselves. According to the CCK, over 5,000 of these community phones had been established by the end of 2004. A recent survey reported that 97% of Tanzanians now have access to a mobile phone thanks to the community payphone model, despite the lack of electrical infrastructure for much of the country. The payphones are easy to operate in isolated areas far from the nearest traditional telephone landline, and can be used even where there is no electricity, as they can be powered by either solar or car batteries. Africa's adaptation of mobile phone technology shows the value of inexpensive, mobile computing for a people representative of the 1.4 billion mobile phone users living in the developing world today.

RETHINKING COMPUTER SCIENCE

Africa is well-suited as a testbed for the development of a mobile phone programming curriculum. Given their massive adoption and widespread use, as well as the recent technological advances in their computational power, mobile phones are ideal substitutes for the personal computer throughout the continent. Customized applications could have profound implications for the economic development of some of the poorest communities in Africa. Despite the unprecedented growth of mobile phone usage however, these applications are rare. Furthermore, the computer science curricula of universities throughout the continent still focus entirely on traditional desktop computer programming. As a result, African computer science graduates are not qualified to address the computing needs of African people. At such a critical point in the evolution of computing technology, there is a need to equip these computer science students with the skills to develop mobile phone applications specifically for African users.

We are in the process of developing a mobile phone programming curriculum at the University of Nairobi that emphasizes the entrepreneurial aspects of mobile phone application development. In collaboration with Professor Katherine Getao, the Director of the School of Computing and Informatics at the University of Nairobi, these mobile phone programming classes will be designed to empower students to build applications specifically for the unique needs of African communities.

We are currently offering three courses designed for students with different levels of programming experience. For those with limited programming experience we are teaching the "Python for Rapid Mobile Application Development" pilot course we originally introduced during the summer of 2006 to faculty and students at the University of Nairobi. This course provides an overview of how to

efficiently develop applications for mobile phones with minimal amounts of coding. Additionally, we are preparing a joint MIT / University of Nairobi project-based course entitled "Mobile Phone Programming for Entrepreneurs", which will team MIT and University of Nairobi students together to develop, market, and launch their own mobile phone application in Nairobi. While many of these applications will be SMS server-based services similar to Kace's vegetable pricing system, we are also emphasizing applications for the significant fraction of mobile phone subscribers in Kenya who have phones capable of accessing the internet. We have received pledges from industry sponsors to provide seed funding to turn the best class projects into commercial ventures in Nairobi. For those students who have already had a course on object-oriented (preferably Java) programming, we have developed the "Introduction to Mobile Phone Application Development in Java" syllabus from our existing MIT course material, with the help of Professor Getao. The proposed curriculum has now been approved by the Principal of the College and Deputy Vice Chancellor of Academics at the University of Nairobi. In Ethiopia, after giving a pilot course at the Graduate School of Telecommunication and Information Technology (GSTIT) in Addis Abeba, we are now working with Professor Fisseha Mekuria, Head of the Telecom Engineering Department, to bring a similar curriculum to the GSTIT.

Students who take these courses will be enabled to take an active role in the creation of an African community of mobile phone application developers. By creating a mobile phone application developer community in Kenya, we hope to provide a foundation for the development of mobile phone applications that are not only tailored to local needs but also applicable globally in other developing countries.

MOBILE PHONE ENTREPRENEURSHIP & RESEARCH

To further our understanding of the underlying factors driving entrepreneurship and mobile phone growth in Africa, we are involving several students as research assistants for our research work on behavioral and mobile phone usage patterns. Dr. Peter Waiganjo Wagacha in the School of Computing and Informatics is helping us work with these students to run an experiment similar to my doctoral work at MIT. We are in the process of distributing Nokia N70 smartphones to fifty individuals in different demographics and log their behavior over the course of six months. The phones will have a custom application that continuously logs location, nearby peers, communication, and phone usage statistics, similar to the data collected for 100 people during the Reality Mining project at MIT[1]. In this previous research, we generated models of our subjects' lives with such precision that they could be used to accurately predict subsequent behavior. Based solely on data logged by our custom phone application, we have successfully shown that after two months logging it is possible not only to predict behavior, but also to infer friendships, differentiate demographics, validate survey responses, and even quantify the dynamics of an organization. With the help of two research assistants who have taken Dr. Wagacha's course on machine learning, it is our hope that this data will provide an analogous quantitative description of Kenyan social networks and mobile phone usage behaviors. Nokia has agreed to sponsor such research as an extension of the Reality Mining collaboration, and we are currently in talks with Safaricom (a major mobile phone service provider in Kenya) to provide the service required for the donated phones.

Dr. Wagacha and several of his colleagues have agreed to collaborate with our multi-university group of over a dozen researchers, whose intent is to analyze the massive amount of behavioral data currently being collected from mobile phones. The objective of the initiative is to create a unified

[1] http://reality.media.mit.edu

academic community incorporating disciplines such as urban planning, statistical physics, social science, machine learning, computational epidemiology, and organizational behavior. With Dr. Wagacha's help, it is our hope that the proposed mobile phone experiment will culminate in a paper to be submitted to IEEE Transactions on Pattern Analysis & Machine Intelligence. We will be addressing the issues and outcomes involved with learning about phone usage data for different demographics in Kenya and contrasting it with the previous work from students in North America. I would like to use this publicity to draw attention to the new knowledge and attitudes Kenya mobile phone users are acquiring, as well as the lessons we can learn from them.

CONCLUDING REMARKS

Today's phones are programmable, powerful, and capable of accessing the internet. Lacking a traditional PC, many Kenyans are turning to their mobile phones to connect with people, information, and services. Empowering Kenyan computer science students with the skills necessary to program these increasingly ubiquitous devices is the first step towards nurturing an African mobile phone application developer community. This new community of programmers will be focused on building entrepreneurial applications, designed specifically to meet the unique needs of the African people. It is our hope that this paper has shed light on the truly extraordinary phenomenon the mobile phone explosion in Africa represents, and has convinced the reader of the importance of empowering computer science students throughout Africa with the ability to design applications specifically for the 1.4 billion underserved mobile phone subscribers living in the developing world today.

For more information on EPROM, please go to: http://mit.edu/eprom.