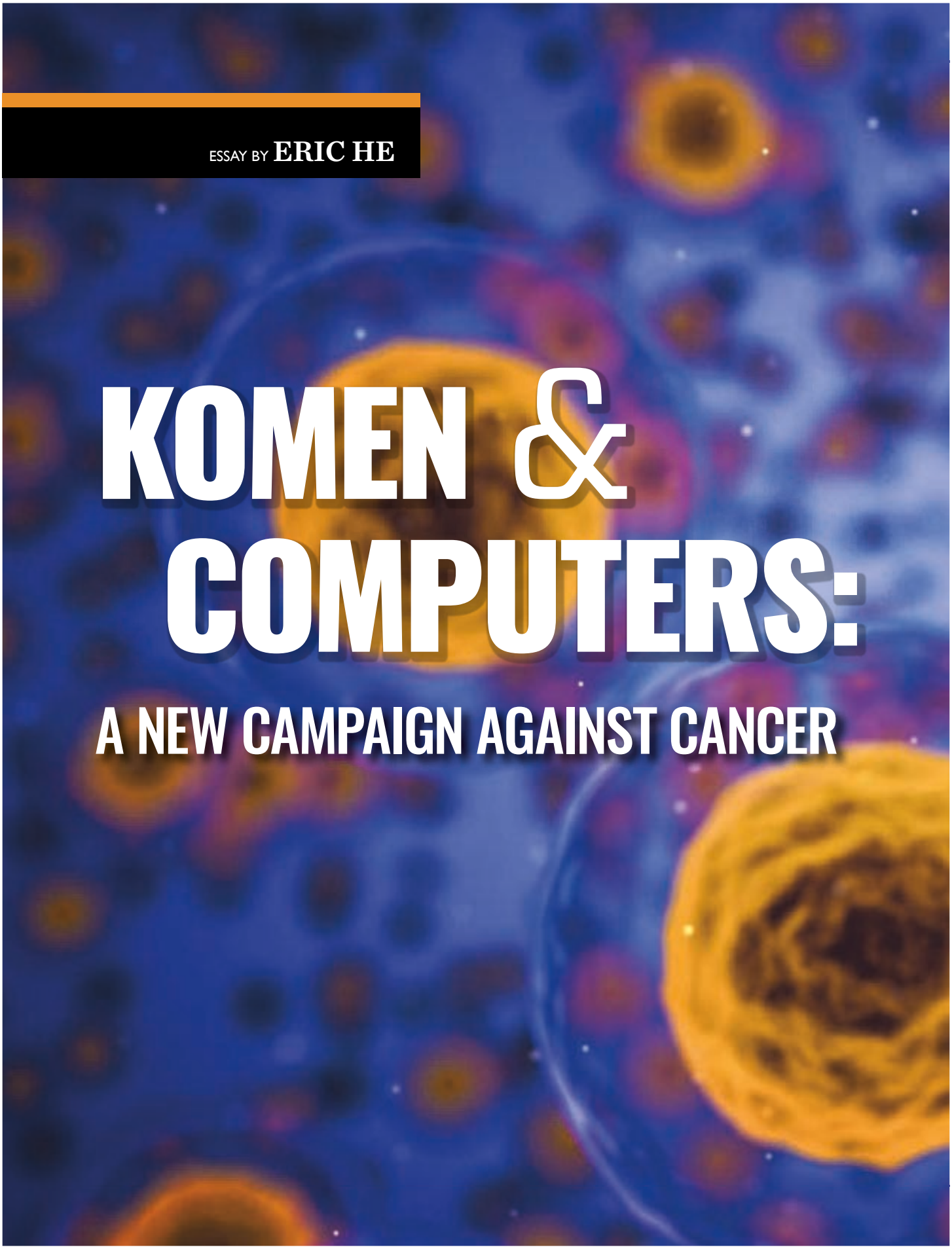
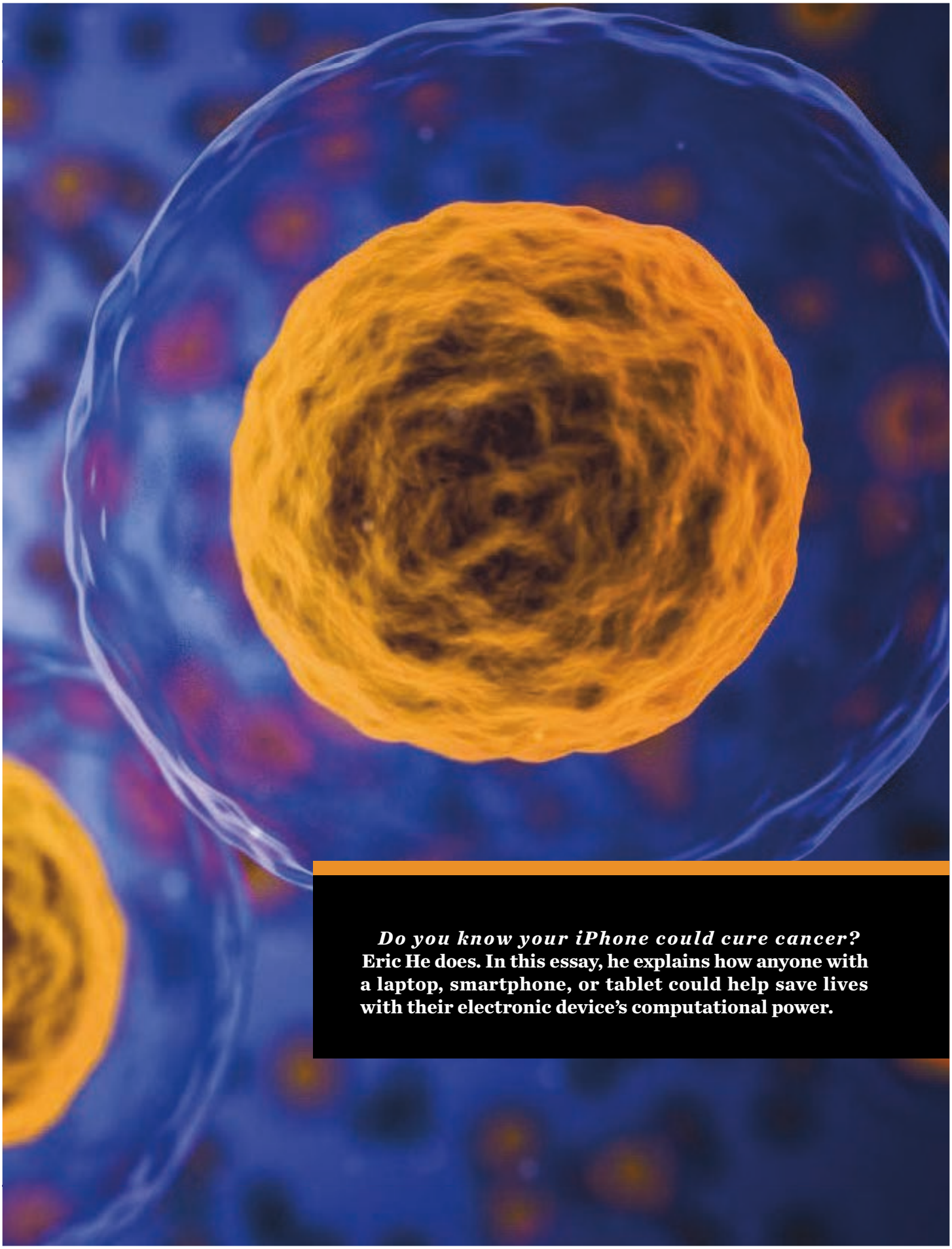


ESSAY BY ERIC HE

KOMEN & COMPUTERS:

A NEW CAMPAIGN AGAINST CANCER



Do you know your iPhone could cure cancer? **Eric He does. In this essay, he explains how anyone with a laptop, smartphone, or tablet could help save lives with their electronic device's computational power.**

This essay will explore how Susan G. Komen, one of the largest breast cancer awareness foundations in America, can assist in treating the most intractable and prominent diseases humanity faces today – by encouraging citizens to download and run the Berkeley Open Infrastructure for Network Computing (BOINC), a software which allows scientists to distribute massive computational problems to individual computers for solving. The essay will explain the benefits for BOINC, Komen, and humanity, and detail two major problems with the undertaking.

Cancer is a set of diseases commonly characterized by "the rapid creation of abnormal cells that grow beyond their usual boundaries, and which can then invade adjoining parts of the body and spread to other organs."[1] The chances of obtaining cancer increases as mutations in the cells' DNA stack up over time; so the disease remains the primary enemy of old age. This makes curing cancer one of the top priorities for Americans who now have life expectancies of about eighty years.[2]

Despite the sheer amount of effort and money poured into cancer research, there has been very little progress made. As of 2009, the National Cancer Institute "has alone spent $105 billion," since President Richard Nixon declared a War on Cancer in 1971. "Yet the death rate for cancer... dropped only 5 percent from 1950 to 2005."[3] In comparison with smallpox, the flu, and heart disease, the fight against cancer has returned dismal results.

A major reason for this failure is that so little is known about the fundamental forces driving cancer. One of the biggest breakthroughs in cancer research was the link between smoking and cancer. However, even today, the "mechanics and molecular causes" relating smoking to cancer are still unknown; though we know what can cause cancer, we do not know how cancer is caused.[4]

In trying to understand these mechanics, scientists have come up against a host of gargantuan computational problems, such as in the study of proteins. Proteins are the "nanoscale machinery of all the known cellular life...[with] functions includ[ing] metabolism, photosynthesis, signal processing in the brain, immune response, and many others."[5] A protein, which begins as a chain of amino acids, will settle into a natural three-dimensional shape in a process called "folding." This process usually takes milliseconds within the body, but simulating folding requires so much computing power that a specially designed supercomputer for that specific task, *Anton*, took "about 100 days" to complete a single millisecond of the folding process for a single protein.[6]

Predicting a protein's final shape and simulating how a protein might interact with a cell wall are two other massive computational problems. Thus, if a group of scientists wanted to see if a single protein could attach to and destroy a cancer cell, they would immediately face three huge obstacles, each of which would take modern supercomputers months or even years to calculate. To complicate matters further, there would be a nearly infinite number of proteins to test.

The supercomputers required to solve these computations are few in supply and high in demand, forcing many scientists to crowdsource work using citizen-computing power. BOINC is a citizen computing software which allows scientists to chop up a massive computation into tiny pieces that can be sent out to individual devices (computers or phones) to evaluate. Citizens from all over the world can allow programs hosted by BOINC to run on their computers, choosing from a vast array of scientific and mathematical projects such as MilkyWay@home, which maps stellar streams in our galaxy (so named because you can run it *at home*), or Enigma@home, which tries to solve uncracked Enigma codes from World War II.[7]

Those interested in biotechnology projects can pick from Rosetta@home, POEM@home, and GPUGRID, which seek to solve the aforementioned problems pertaining to proteins.[8] Additionally, citizens can help the World Community Grid, an umbrella project funded by IBM which is currently conducting five studies on tuberculosis, AIDS, Ebola, cancer, and the human genome. Its sixth is devoted to finding better materials for solar panel construction.[9]

Hundreds of papers have been

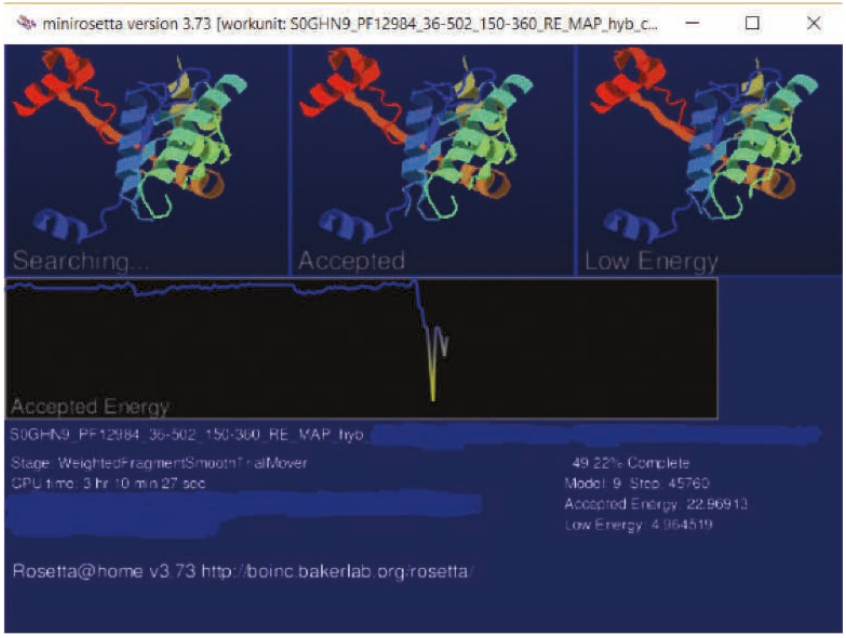


FIGURE 1: A screencap of a protein folding simulation. My identification has been blotted out.

published using BOINC, all of which are freely available online. From 2006 to 2011, Rosetta@home alone published 17 papers on protein structures.[10] This work was done by 500,000 active volunteers contributing 1,000,000 computers and phones, which adds up to a shocking computation speed of 11.4 petaflops, a metric which would place BOINC as the fourth most powerful supercomputer in the world.[11] [12] But BOINC has the potential to become the most powerful supercomputer in the world.

Of the world population, approximately 3.5 billion people have access to a device that can access the Internet, and in the United States a single person may own multiple devices, such as smartphones, laptops, tablets, and gaming consoles.[13] Of these 3.5 billion active devices in the world 0.02 percent are contributing to BOINC. It does not seem as if only 0.02 percent of the people in the world care about cures for cancer or next-generation materials for solar panels, so why does BOINC get such a lukewarm reception when it is possibly the easiest and most helpful way a person can contribute?

Primarily, nobody knows about it. Articles about papers and projects that used BOINC do not often mention it, and according to David Anderson, project director of BOINC, the group has "never advertised; [they] have no budget for doing so."[14] Another issue is BOINC's obscure and inactive forums, which is where many prospective volunteers might visit to learn more about the movement. The posts are filled with computer jargon, beginning with the relatively benign CPU (computer processing unit) and GPU (graphics processing unit) but quickly diving into terminology such as petaflops, the LINPACK benchmark, RAC, cuda55 or sse2 architecture, and scalable parallel computational geometry for coarse-grained multicomputers.[15]

In practice, the message boards have become places to troubleshoot the software, so it is inevitable that they get technical. However, this does not mean that the public face of BOINC has to look so complex. With a serious marketing effort, BOINC could become immensely more powerful, which could lead to revolutionary breakthroughs in research. Susan G. Komen, the nation's most well-funded breast cancer awareness charity, has both the proper resources and motivations to do just that.

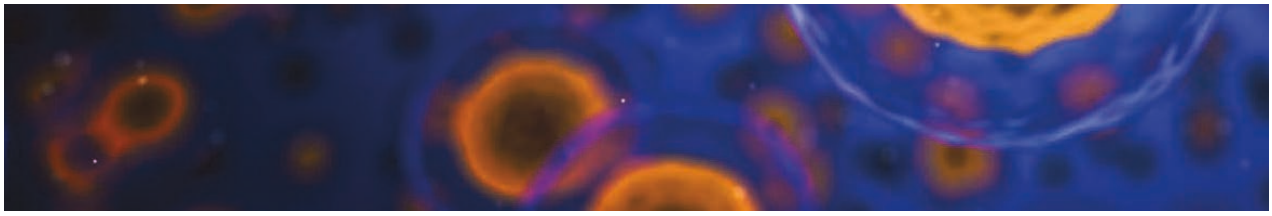
Komen's strength is its outreach, as shown by its financials. Its report for the fiscal year of 2014-2015 claims total expenses of $268 million of which the largest portion, 37 percent, is spent on "education."[16] This task essentially means reaching out to the population to inform them of the existence and danger of breast cancer and to encourage women to get mammograms. Komen has been wildly successful. At the time of its foundation, women were ashamed to admit they had breast cancer due to the intimate sexual nature of breasts. Yet now, October is breast cancer awareness month –and not any other kind of cancer. The pink ribbon and the color pink as a whole have been made synonymous with breast cancer and sponsors of Komen sell pink water bottles, football jerseys, KFC buckets, and more to show their support for the fight against breast cancer. Annual "Races for the Cure" attract more than 1.5 million participants globally.[17] Because of Komen, much of America is aware of breast cancer to the point where many do not think funding for awareness is useful anymore.

For a rough lower bound of the effect that Komen could achieve using BOINC, one can again look at the charity's budget: $268 million for the fiscal year of 2014-2015. The annual maintenance cost of Titan, the number 2 supercomputer in the world (at 27.11 petaflops, twice that of BOINC's), is $9 million per year. Komen's annual finances would be enough to sustain 30 Titans, or 60 BOINCs.[18]

We would expect money spent on promoting BOINC to have a greater impact on cancer research than a contribution to Komen directly – especially with awareness of BOINC so low. Yet a minimum of funding would be a dream come true for BOINC. Komen shifting some resources to promote BOINC would cost little money; its outreach programs with corporations, schools, and communities already exist. All the foundation has to do is design a new message, something it already needs.

In recent years, Komen has faced intense criticism over its finances and practices. In 2012, Komen faced a huge backlash for the decision to cut funding for Planned Parenthood. The controversy opened up several other cans of worms. Despite being a breast cancer *awareness* foundation which allocates only 20 percent of its budget to research grants, it has trademarked the phrase "for the cure" and has sued other nonprofits to protect it.[19] Further, some of the aforementioned pink products sold by firms in partnership with Komen were known to be carcinogenic, such as plastic water bottles and fried KFC food.[20] In light of these issues, Charity Navigator dropped Komen's rating from the full 4 stars to 3 in 2013, and then to 2 in 2015. In that time, so many supporters left Komen that its net donations dropped from $438 million in 2011[21] to $250 million in 2015.[22]

Of most relevance, Komen spends the bulk of its "education" money encouraging women to get annual mammograms starting at the age of 40,[23]



and another 16 percent of its budget funding them.[24] In contrast, the U.S. Preventative Services Task Force, "an expert group that reviews the latest research findings," recommends one mammogram every two years starting at age 50; any more would lead to "unnecessary tests, anxiety, and... surgeries."[25] So not only has Komen's mission of spreading awareness approached its saturation point in America, and not only does Komen need to rebuild its public image, but Komen's current activities are also arguably detrimental to public health. Yet if Komen did not promote mammograms so zealously, it would be unable to justify its current size. Komen is stuck, but BOINC offers a possible way out.

Advertising BOINC would use Komen's strength: outreach, to address its weakness: research. It would quash complaints of Komen's outreach programs being unneeded or even harmful and counter claims suggesting that monies would be better spent funding research. Komen would instead encourage the public to take part in direct research. It would reshape the foundation's image into a major supporter of cutting-edge research. The catch: promoting BOINC may not be as easy as previously claimed.

The first of two fundamental problems with advertising BOINC is its paradoxical message. The biotechnology projects on BOINC, and indeed this essay, introduce themselves as grand quests to cure all diseases known to man, and they are. But they are *so* boring.

Running BOINC consists of taking two minutes to download a program and then staring at progress bars for a seeming perpetuity. There are graphics such as Figure 1, but their endless repetition only makes the demoralizing state of the war against cancer more tangible. The only "solution" to BOINC's banality has been to make it run in the background, so people can forget it exists. This disconnect between BOINC's mission and the user experience has confounded a decade of attempts at marketing and might be the prime cause of both the high churn rate among BOINC participants and BOINC's failure to gain traction in the public consciousness. Surprisingly enough, a remedy exists which again, Komen is in an exceptionally favorable position to employ.

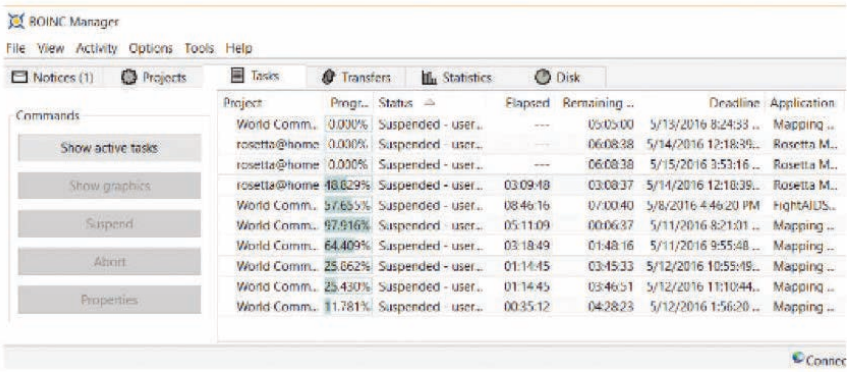


FIGURE 2: A screencap of my BOINC client.

Charity Engine is a private organization which sells citizen computing power to private companies. Most of the money generated is donated to charity, while some is reserved for the volunteers themselves. Charity Engine sets up a lottery where volunteers may receive awards based on how much computing work they have done.[26] Charity Engine runs the lottery in order to popularize citizen computing.

Komen volunteers would do best to stay separate from Charity Engine since performing computations for the private sector would only invite more criticism of the organization. However, Komen should devote some funding to a similar lottery system. Participants may then associate BOINC with the lottery and disregard BOINC's inherent passivity. Since the lottery scales with contribution, it naturally disqualifies inactive participants. Volunteers would stay conscious of BOINC, and re-download the program with each new device. This lottery system would be easy to construct because every BOINC project puts a tremendous amount of effort into designing a fair credit system to reward work done by contributors.[27]

The second fundamental problem is that the credit rewarded to volunteers to quantify completed work can be difficult to translate into tangible results. A million computers may spend several months evaluating molecules for use in solar panels, but only one device will find the one perfect molecule. The tremendous amount of work done by the other computers were only useful for declaring what molecules were *not* useful. Many BOINC computations are similar in nature, so Komen must find a way to fairly measure and reward the work done by volunteers.

Komen's promotion of BOINC has benefits even outside the ones already listed. Teaching about BOINC software would naturally lead to relationships with technology companies. Examples are NVIDIA, which makes graphics cards vital to citizen computing, and IBM, which runs many corporate social responsibility programs. IBM also has numerous corporate citizenship awards of which it would like the public to be aware.[28] Uniting the cancer movement with citizen computing would foster public interest in computer science, mathematics, cryptography, and physics – another win for society.

The financial power of Komen and other disease-focused charities makes it very clear that people care about cures. Running a background program to study cancer pales in effort compared to running a 5K, and there is little doubt that millions would do the former if everyone else was too. Komen is incredibly well-positioned to take on this task, and so are you. Consider running BOINC - it supports desktops, laptops, tablets, and even Android phones. ■

[1] "Cancer." *World Health Organization*. N.p., Feb. 2015. Web. 07 May 2016. <http://www.who.int/mediacentre/factsheets/fs297/en/ >.
[2] "Factbook." *Central Intelligence Agency*. Central Intelligence Agency, 30 Mar. 2016. Web. 07 May 2016. <https://www.cia.gov/library/publications/the-world-factbook/geos/us.html>.
[3] Kolata, Gina. "Advances Elusive in the Drive to Cure Cancer." *The New York Times*. The New York Times, 23 Apr. 2009. Web. 07 May 2016.
[4] Spector, Reynold. "The War on Cancer A Progress Report for Skeptics - CSI." *The War on Cancer A Progress Report for Skeptics - CSI*. Committee for Skeptical Inquiry, Feb. 2010. Web. 07 May 2016.
[5] "POEM About." *POEM@HOME*. N.p., n.d. Web. 07 May 2016. <http://boinc.fzk.de/poem/index.php?section=about>.
[6] Ledford, Heidi. "Supercomputer Sets Protein-folding Record." *Nature.com*. Nature Publishing Group, 14 Oct. 2010. Web. 07 May 2016.
[7] "BOINCstats." *Home | BOINCstats/BAM!* N.p., n.d. Web. 07 May 2016. <http://boincstats.com/en>.
[8] Ibid.
[9] "Research Overview." *World Community Grid* -. N.p., n.d. Web. 07 May 2016. <https://secure.worldcommunitygrid.org/research/viewAllProjects.do>.
[10] "BOINC Publications." - *BOINC*. N.p., n.d. Web. 07 May 2016. <https://boinc.berkeley.edu/wiki/Publications_by_BOINC_projects#Rosetta.40home>.
[11] "BOINC Homepage." *BOINC*. N.p., n.d. Web. 07 May 2016. <http://boinc.berkeley.edu/>.
[12] "TOP500ListNovember 2015." *Top500 List*. N.p., Nov. 2015. Web. 07 May 2016. <http://www.top500.org/list/2015/11/>.
[13] "Internet Users." *Number of Internet Users (2016)*. Internet Live Stats, n.d. Web. 07 May 2016. <http://www.internetlivestats.com/internet-users/>.
[14] Chamberlin, Johnnie. "The Strongest Supercomputer on Earth Still Needs Your Laptop to Cure Cancer." *Inverse*. Inverse, 20 Dec. 2015. Web. 07 May 2016.
[15] Ibid.
[16] "Annual Reports." *Annual Reports & Financial Statements*. Susan G. Komen, n.d. Web. 07 May 2016. <http://ww5.komen.org/AboutUs/FinancialInformation.html>.
[17] "Find a Race." *Komen Race for the Cure*. Susan G. Komen, n.d. Web. 07 May 2016. <http://apps.komen.org/raceforthecure/>.
[18] Storm, Darlene. "Meet the Fastest, Most Powerful Science Machine in the World: Titan Supercomputer." *Computerworld*. Computer World, 01 Nov. 2012. Web. 07 May 2016.
[19] Elizabeth, Flock. "Susan G. Komen's Funding Cut to Planned Parenthood Only Latest in String of Controversies." *Washington Post*. The Washington Post, 1 Feb. 2012. Web. 07 May 2016.
[20] Ibid.
[21] "Charity Navigator - Historical Ratings for Susan G. Komen for the Cure." *Charity Navigator*. Charity Navigator, 1 May 2015. Web. 07 May 2016. <http://www.charitynavigator.org/index.cfm?bay=search.history&orgid=4509#.Vy4-evkrKhd>.
[22] "Annual Reports." *Annual Reports & Financial Statements*. Susan G. Komen, n.d. Web. 07 May 2016. <http://ww5.komen.org/AboutUs/FinancialInformation.html>.
[23] "Mammography." *SpringerReference* (n.d.): n. pag. Susan G. Komen. Web. <http://ww5.komen.org/uploadedFiles/_Komen/Content/About_Breast_Cancer/Tools_and_Resources/Fact_Sheets_and_Breast_Self_Awareness_Cards/Mammography.pdf>.
[24] "Annual Reports." *Annual Reports & Financial Statements*. Susan G. Komen, n.d. Web. 07 May 2016. <http://ww5.komen.org/AboutUs/FinancialInformation.html>.
[25] Zuckerman, Diana. "2016 Update: When Should Women Start Regular Mammograms? 40? 50? And How Often Is "regular"? - Stop Cancer Fund." *Stop Cancer Fund*. Cancer Prevention and Treatment Fund, 12 Jan. 2016. Web. 07 May 2016. <http://www.stopcancerfund.org/p-breast-cancer/update-when-should-women-start-regular-mammograms-40-50-and-how-often-is-regular/ >.
[26] "Charity Engine - How It Works." *Charity Engine*. Charity Engine, n.d. Web. 07 May 2016. <http://www.charityengine.com/about/how-it-works>.
[27] Mod.DE. "The New Credit System Explained." *Rosetta@Home Message Boards*. Rosetta@Home, 4 Sept. 2006. Web. 07 May 2016. <http://boinc.bakerlab.org/rosetta/forum_thread.php?id=2194>.
[28] "Awards and Recognition." *IBM Corporate Responsibility*. IBM, n.d. Web. 07 May 2016. <https://www.ibm.com/ibm/responsibility/awards_recognition.shtml>.

- *Opening photo by pixabay.com/qimono*
- *Screenshot photos by Eric He, courtesy of BOINC*

Eric He, class of 2019, is majoring in Mathematics and Data Science.