ASHDOWN HOUSE

3am

Summer Writing Contest 2011

The Official Newsletter of the Ashdown Community

Message from the Editor

Dear Reader,

The first annual Ashdown summer writing contest was a success. Thank you to all who submitted ! The quality of the entries made for some difficult decisions, but the following three articles won fair and square.

Congratulation to Jane Chui, Lei Zhang and Jason Boggess for the clear summaries of their research, in layman's terms. It is always surprising and interesting to see what a wide range of projects students are working on.

I hope you'll enjoy these as much as I did !

Sincerely,

Anne-Raphaelle Aubry
Ashdown Newsletter Officer

In This Issue

- First place: 'Pores for $800, Alex', by **Jane Chui**
- Second Place: 'Need a flight ticket for your internet data package ?' by **Lei Zhang**
- Third Place: 'Eye care anywhere' by **Jason Boggess**

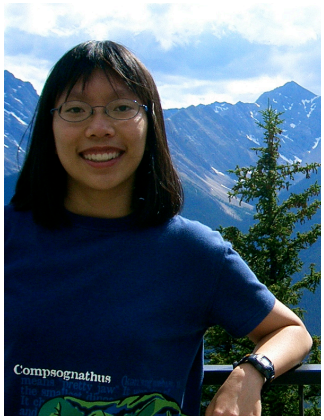
- Change in submission guidelines:

AMC Ticket or 10$ Amazon Gift Certificate for published submissions !

Contact the Editor

Please direct any comments or queries about "3am" to Anne-Raphaelle ("Anne") at aubry@mit.edu

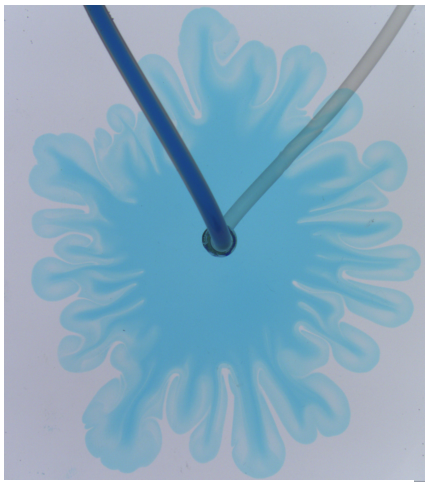
First Place: 'Pores for 800$, Alex' – Jane Chui



Jane Chui

Soil. Rocks. Decomposing matter. But what else do we know about the underground world that we've been living on top of? How exactly do fluids move through this underground world? How do they know where to go? We describe this lovely underground world as a "porous media" due to the spaces between the soil and rock grains, and those are some of the big questions being asked today. Turns out, we know a bit, not all, and definitely not enough of the answers to have facts that Alex Trebek can use for a category in a game of Jeopardy any time soon. But since I love Jeopardy and also Canadians, I decided at the end of last August to pack up and come to MIT to delve further into this magical world of the underground … yep, all for the love of a trivia game that's been around much longer than I've been alive.

The $200 and $400 questions tend to be easier, and we can answer those about porous media flows. Flow is driven mainly by gravity, as you might have guessed, and things like pressure and presence of pores and fractures influence this flow. Since pores and fractures are always filled with ***something*** (whether it be water, air, or some other liquid – it can't just be nothing!), flow is therefore a replacement of one fluid with another. There exists a myriad of factors that affect this replacement, and one of them is viscosity. The viscosity of a fluid can change drastically how this replacement can take place, and is therefore the focus of a growing field of research. A very well-documented and interesting phenomenon called "viscous fingering" occurs when a less viscous fluid invades a more viscous one. Instead of replacing the more viscous fluid in a uniform front, the fluid forms "fingers" that branch into the more viscous fluid (see figure to right).



A less viscous fluid (blue) invading a more viscous one (clear) is creating viscous fingers that change how flow and mixing occur in porous media like the earth's crust.

Yes, this phenomenon creates very fascinating pictures, but in fact, it is well-documented for rather serious reasons. One large reason is that oil companies often find themselves encountering this situation. Finding and then priming an oil reservoir for production is an expensive process, and so the goal is to always pump out as much oil as possible from a given reservoir. The most common (read cheapest and easiest) way to increase production is to pump gas or water into the reservoir, so that more oil can be pushed out … and therein lies the problem: both water and gas (usually carbon dioxide) are much less viscous than oil, and so viscous fingering happens. Valuable oil is therefore left in between these fingers, lowering the efficiency of these methods. Thus, even with using these methods for enhanced oil recovery, the best that companies can currently do is 40-60% recovery of all oil in a given reservoir [1]. In this day and age of the global energy crunch, imagine the possibilities of increasing that efficiency.

Although well-documented, this viscous fingering phenomenon is not well understood. The exact pattern, number of fingers, and size of fingers that the less viscous fluid will create when invading the more viscous fluid is still a mystery, and depends on variables such as flow speed, relative viscosity differences, and pore size. A characterization of exactly how these dependences interplay and change these finger patterns will be most useful; for example, companies can then ensure that although viscous fingering occurs, the fingers are so large and so dense that there is not much space left in between the fingers, sweeping out more of the oil. Many a simulation has been done in recreating these situations that oil companies encounter underground and calculating dependencies, but at the end of the day, no one has ever seen what happens in that reservoir first hand and cannot verify whether these simulations are correct. Part of my work, therefore, is to characterize the conditions that change these fingering patterns experimentally by building apparatus that simulate porous media and then injecting less viscous fluids as in an oil reservoir.

I say **part** of my work, and that's because it would be much too straight forward if that was it. Things get much more interesting when the two fluids are miscible, because as one can imagine, there would be mixing involved when one fluid is pushed into the other. An example of this would be in bioremediation, a growing method of remediating groundwater and soil. In some cases, bacteria solutions are injected into contaminated aquifers where there are contaminants creating a more viscous environment (just think toxic sludge). As we know, viscous fingering will happen, and in addition to the aforementioned preference to have as little "missed" area as possible to increase the effectiveness of remediation, the presence of fingers (versus just a solid circular front of fluid moving outwards) likely will change mixing efficiency of the miscible fluids. This efficiency is important because it will affect directly how well the bacteria is distributed to begin the process of "eating" the contaminants. And that, Alex, is the $800 question I'm working on right now – how do these fingers change mixing efficiency in porous media and by how much?

Injecting things underground with only a general idea of where it's going to go and how it's going to get there may be the best option we have right now, but I for one intend to be a little more precise; I truly believe that being so will change both the remediation and oil recovery worlds drastically. Bring it on, Alex.

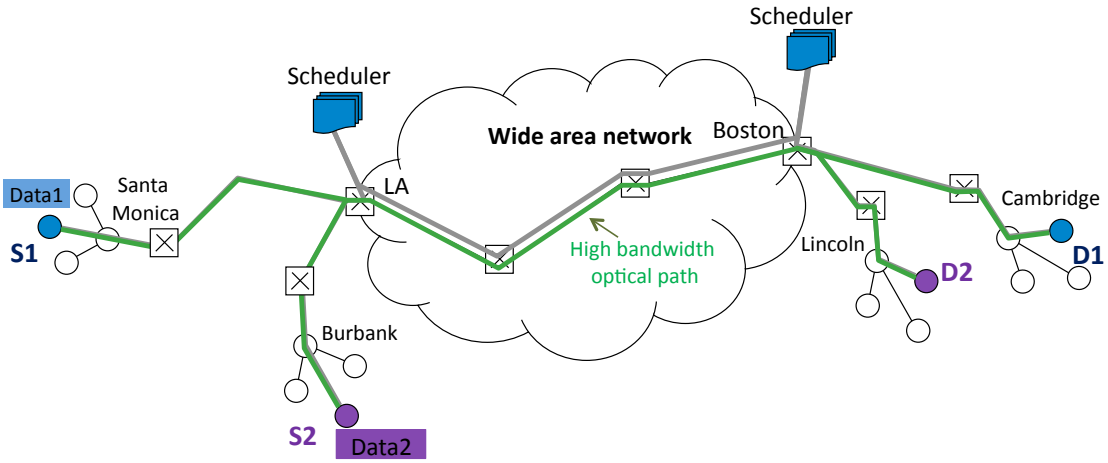
[1] U.S. Department of Energy, "Enhanced Oil Recovery," accessed via internet August 15, 2011. <http://www.fossil.energy.gov/programs/oilgas/eor/index.html>

Second Place - Lei Zhang
'Need a flight ticket for your Internet data package ?'

Lei Zhang

Ever wish to watch the Super Bowl or the Olympic games in 3D? You can buy a 3D TV from a Japanese manufacturer now. The technologies needed for devices on the user side are ready. However, the networks to carry and distribute the programs are not; at least not ready to provide such services to a big public at a low price.

Why aren't the networks ready? Well, the reason could be traced back to the 1970s when the Internet was first born. In the early stage of the Internet, it was designed to provide a robust network to allow multiple users to transmit data at the same time. The medium used to carry the traffic was wired copper cables which have a very narrow bandwidth. If we think of the optical fibers used today as information airways, then those copper cables were like alleys. To get the most out of those narrow alleys, the Internet was designed to work in the following way.



S1 wants to send Data1 to D1
S2 wants to send Data2 to D2

1. S1 and S2 send their corresponding requests to Scheduler at LA
2. Scheduler at LA negotiates with Scheduler at Boston to set up two paths for S1/D1 and S2/D2
3. S1 and S2 send their data through the provided paths at the scheduled time.
4. Paths S1/D1 and S2/D2 are released for others' use after the completions of the data delivery.

When a user wants to make a transmission, its data package is first chopped into small packets with labels indicating the source and destination addresses, and their sequence numbers. Then these packets are dumped into the Internet one by one. Each packet travels through the Internet independently. When it arrives at a router, which is like the crossing point in the transportation network, the router reads the packet's destination address, looks it up in its table of routes, and directs the packet to the best route it knows. The best route may not be the actual best one because there is always delay before the router gets the latest traffic situation. Thus, when all data packets finally arrive at the destination, they may arrive out of sequence. However, the data package can still be reconstructed with the sequence number of each packet. When one packet of a sequence number is lost, the receiver at the destination can sent a request to the sender, asking for a retransmission of this specific packet. This particular protocol that ensures reliability in transmission is the famous TCP/IP protocol, and the switching method is the so-called packet-switching.

TCP/IP and packet-switching were so successful that they are still being used to ensure reliable transmission in today's Internet. However, the current networks are much better equipped than those of forty years ago. Fiber cables are used across the globe in the backbone networks. In some countries, fiber cables are even deployed to end-users' houses. In the near future, we might plug a fiber cable directly into our laptops and go surfing the Internet. On the other hand, protocol-wise, we are still using TCP/IP, which chops every data package into small packets and make them travel independently.

Imagine you are trying to watch a high definition TV. You press the button on your remote control and start to download a one Gigabyte movie from your subscriber. This movie is chopped into millions of small packets of one Kilobyte and these packets are dumped into a highway network. These millions of packets are like a huge line of taxis, each carrying three passengers, running on the highway. Each one of them stops at every crossing point, asking for the directions, even though they are all heading to the same destination. The unnecessary processing power and inefficient use of the resources doom an expensive service to watch either Super Bowl or Olympic games in 3D.
Now think, what if you can buy a flight ticket for your large data package? You check with the airline agents, schedule a flight, consign your package. Bingo! Your package is shipped all at once. It is prompt; it is cheaper than hiring millions of taxis; and it doesn't cause traffic jams, a good deed for the whole Internet community!

Optical Flow Switching (OFS) provides such an end-to-end all-optical transmission service to users with large data packages. It was designed in our research group and has been studied for more than ten years. OFS employs an additional layer on top of the current network architecture, which acts like airline agents to take in user orders of use of service. When a user wants to make a large transmission, it talks to Scheduler A at its side of the network. Scheduler A then talks to Scheduler B at the destination side. A and B then negotiate with each other to work out a time slot and an end-to-end connection route that work for both sides, and proceed with the reservations of the necessary resources. When the designated transmission comes, the fiber channels connecting the sender and receiver are already connected, and the transmission takes at most a few seconds. After the transmission is completed, the resources are released for others to use.

With OFS, the situation is like this: you press the button on your remote control, wait for three seconds, and then there go your HD TV or 3D movies or games. And what's better? You still have your money in your pocket!

Third Place: 'Eye Care Anywhere' – Jason Boggess

I am a research assistant in the Camera Culture Group of the MIT Media lab where I design and code software to run on mobile platforms. But unlike most of the apps floating around there in the app store, my code is not for social interactions with friends or maintaining farms.
Well…. at least not directly…

Jason Boggess

The World Heath Organization estimates that a few billion people go without proper healthcare each year. Poor access to healthcare facilities in developing nations; incomplete education on conditions and treatments available; and diminished mobility options for disabled elderly leave hundreds of millions sick with preventable and treatable illnesses.

Last year it was estimated that somewhere around 1.7 billion people currently live with uncorrected optical refractive error (i.e. have need for eye glasses, but do not have them). Many of these people suffer from a common condition called astigmatism (non-spherical shape of the lens) which is impossible to detect with a standard eye chart or lens kit. Other eye ailments such as cataracts (cloudiness in the eye), colorblindness, presbyopia (age-related condition), and more go undetected and untreated despite being easily prevented and/or corrected.

NETRA

Our lab has developed a hardware/software solution to measure refractive error, astigmatism, and cataracts on a cellphone. NETRA—or Near Eye Tool for Refractive Assessment—will cost less than a dollar to produce and clip to any Android or iPhone mobile device. Once attached, the user simply has to align the device with their eye, look down the eyepiece, and follow the instructions to measure their refractive error.

The test is simple: align two circles so that they are barely touching—perfectly tangent to one another. If you have no refractive error, you should see the circles touching when you start the test. If you have refractive error (are near-sighted or far-slighted) the circles will either appear to overlap or be further apart from one another. By measuring the distance you move the circles, we can determine your eye prescription within a quarter of a diopter.

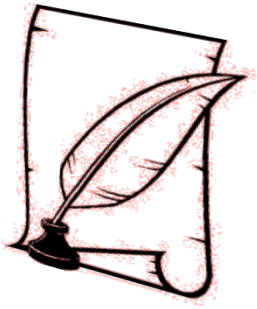
CATRA is the second generation of eye imaging tools on the mobile platform. Look through the device and have it scan your lens for cloudiness. If the test appears to remain constant, you're done. However, if you see flashing lights during the test, that could be an indication of a cataract. Continue the test to pinpoint the exact location on your eye of the cataract. When you are done, the test prints out a full opacity map of your lens.

The surprise to me was that while most people in developing countries lack full computers, most do have cell phones. Being on a mobile platform, both NETRA and CATRA can record data over time to track eye health and upload it to a central database. This is perfect for the elderly who have limited mobility or for friends trying making sure the other has done his daily test.

Refractive error may seem like a mundane health condition, but in many places of the world (including here in the United States) seeing clearly could mean the difference between getting a job, driving a car, seeing your loved ones clearly, and fully understanding conversations between friends. So in a way, our apps are like most apps out there—lets you talk to your friends and harvest your cabbage—just in a more intimate and non-digital way.

Citizen's Corner: Submission Guidelines

NEW: AMC Ticket or 10$ Amazon Gift Certificate for published submissions !



Do you have a flair for writing?

Do you have an experience you would love to share? A cause you want to speak out for? An event you would like publicized and reported?

The ears of Ashdown are thirsting to hear your story!

The "Citizen's Corner" is a section of "3am" aimed at reflecting the lives and perspectives of Ashdown residents. All Ashdown residents are invited to contribute, and all kinds of material are welcome. In the past, we have received everything from overseas exchange program stories to essays about environmentalism. We are especially keen on the views of international students comparing the way of life (in terms of culture, atmosphere, education system etc.) here to the ones they were used to.

<u>Guidelines in a nutshell:</u>

- Submissions should be between 100 and 1500 words.
- No politically sensitive, religiously sensitive or pornographic material.
- Pictures to accompany text are welcome.
- Email title: "3AM SUB: <title of submission>".
- Email Anne-Raphaelle Aubry ("Anne") at aubry@mit.edu.