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Local News

Mould of transportation

By Peter Hendra/The Whig-Standard
Posted 1 day ago

If you ever find yourself in a fix over designing a transportation system, try turning to a lower form of life, such as slime mould.

That's right. Slime mould.

Selim Akl of Queen's University's school of computing, and a number of colleagues from around the globe, used slime mould to see if it would mimic Canada's network of roadways.

Ian MacAlpine The Whig-Standard Dr. Selim Akl, professor and director of the Queen's University School of Computing is conducting a study on complexity and slime-logic on motorways.

Using a topographical map of Canada, the researchers placed the slime mould in Toronto and rolled oats in major urban centres across the country.

"The slime mould has this ability to just look for the food, and so it sends these little protoplasmic tubes that find the food, consume it, and then move on from there to look for more food," Akl said.

"When it was done, we had a map of the highway system."

Canada's wasn't the first highway system the researchers experimented with — the Netherlands, Mexico, Japan and the United States were among them — but it was the most efficient of the lot.

The experiment was performed 23 times, Akl said.

"If a connection between two cities appeared fewer than eight times, we rejected it. And if it appeared more than eight times, we kept it," he explained.

"Interestingly, all the things that we threw away were going over large bodies of water, or through thick forests, or over mountains. So, once we got rid of those, the connections that the mould favoured matched the highway system except for one little connection in the West."

The reason for the slime mould mapmaking is to "prove that nature around us is computing all the time."

For example, Akl points to a leaf, which uses 99% of sunlight, whereas the most efficient of today's solar panels use 35%.

"If you want to design a communications system of any form — let it be a transportation system or a utility or if you want to find the best placement for a certain service — you may want to consider how nature does things," he offered.

"(Through) so many years of evolution, it found the best ways of doing things."

Akl, along with co-author Andrew Adamatzky of the University of the West of England, will have their research published in an upcoming edition of International Journal of Natural Computing Research.

The collection of colleagues are also writing a book about their experiments.

"We hope it will spark some interest," Akl said, "and we'll move on from there."

phendra@thewhig.com

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Tools

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Appropriate to use slime mould looking for food to create transportation systems because after all that is why we need transportation in the first place -to put food on the plate at the end of the day.

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The Slime oozing out of you TV set
http://www.youtube.com/ watch?v=AUFhHS-3sv8

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Fascinating. How much are we paying for this kind of research?

Reply | Report | Page Top — Post #3 By Elbonian, 1 day ago | 0 Votes | Vote:

Biomimicry is GREAT technology !! I saw something similar (30 years ago) using bubbles to find the shortest train routes.

Reply | Report | Page Top — Post #4 By greentechee, 23 hours ago | 0 Votes | Vote:

re-arrange the letters in selim and you get slime..coincidence???? oh ya man-about-town! you are the one who don't know what the L your talking about!!!!

Reply | Report | Page Top — Post #5 By road king, 21 hours ago | 0 Votes | Vote:

if I rearrange the letters of road king I get the french spelling for retard.

Reply | Report | Page Top — Post #6 By -Man-About-Town-, 19 hours ago | 0 Votes | Vote:

LOL LOL - dimwit greensnot, you must be the biggest bag of hammers I have yet met! LOL How do you find your own way home - or do you?

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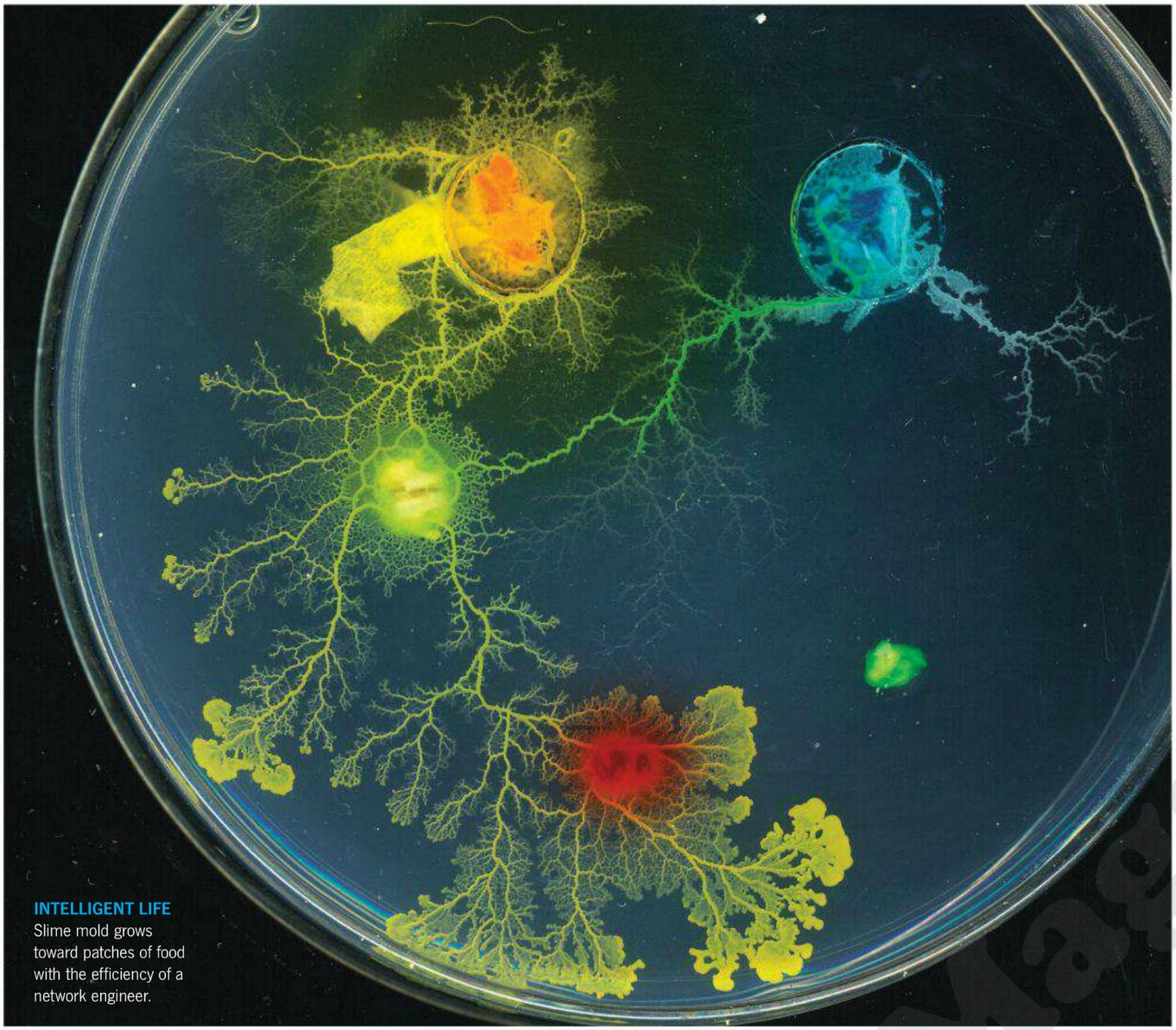


INTELLIGENT LIFE
Slime mold grows toward patches of food with the efficiency of a network engineer.

COURTESY ANDREW ADAMATZKY

Creature Computers

Why living cells are the future of data processing

STORY BY
Adam Baer

NOT ALL COMPUTERS are made of silicon. By definition, a computer is anything that processes data, performs calculations, or uses so-called logic gates to turn inputs (for example, 1s and 0s in binary code) into outputs. And now, a small international community of scientists is working to expand the realm of computers to include cells, animals, and other living organisms. Some of their experiments are highly theoretical; others represent the first steps toward usable biological computers. All are attempts to make life perform work now done by chips and circuit boards.

Last year, for example, a computer scientist at the University of the West of England named Andy Adamatzky and a team of Japanese researchers built logic gates that ran on soldier crabs. First they

H

constructed mazes that replicated the shape of the wires in a computer's logic gates. Then they chased two swarms of crabs (inputs) from one end of the gate to the other. When the swarms collided, they combined to form a new swarm (output), which often headed in the direction of the sum of their vectors, demonstrating that a living, somewhat random system can produce useful order.

If crabs are good at clustering together, a single-celled organism that resides in rotting trees—*Physarum polycephalum*, or slime mold—is surprisingly adept at making maps. Adamatzky and Selim Akl, a computer scientist at Queens University in Ontario, have spent the past few years using slime mold to map networks. In one experiment, they took a map of Canada, dropped oat flakes (slime-mold food) on the nation's major cities, and placed the mold on Toronto. It oozed forth to form the most efficient paths to the cities, creating networks of "roads" that almost perfectly mimicked the actual Canadian highway system.

Last April, biocomputers got even more impressive. Swiss bioengineers announced that they had programmed human cells to do binary addition or subtraction, which is how a computer does arithmetic. They genetically engineered the cells with an elaborate circuit of genes that turn one another on or off. The cells can process two inputs added to their dish (the molecules erythromycin and phloretin) and display an answer by producing red or green fluorescent proteins.

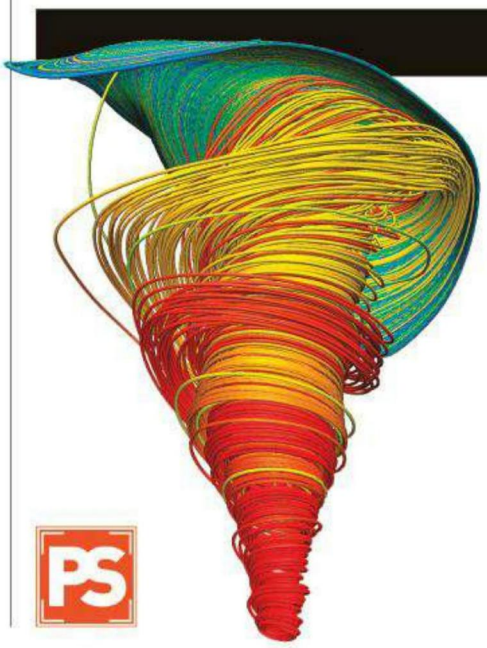
What's the point of all of this? Adamatzky says that slime mold's mapping abilities could design roads, wireless networks, and information-processing circuits better than today's computers. Combining slime mold with electronics could also yield benefits. Adamatzky is already making a computer chip that marries the speed of electrical communication with the learning capabilities of slime mold. The hybrid technology would process information less like a computer and more like a brain, learning and growing through experiences and trial and error, making it possible to solve problems in both neuroscience and computer science. "We envisage that the *Physarum*-based computing research will lead to a revolution in the bioelectronics and computer industry," he says.

POWER IN NUMBERS Soldier crabs live in flat lagoons and often move as a swarm, a trait that scientists have used to perform calculations.

Slime mold "will lead to a revolution in the bioelectronics and computer industry."

His colleague Akl says one advantage of biocomputers may be that they can function in places that conventional electronics can't. "Think about computing in harsh environments like the bottom of the ocean, the human body, or on another planet where our computers may not survive," he says. Life forms could thrive in settings where silicon chips might melt, freeze, or disintegrate.

But the biggest benefits could be in medicine, because cells are adept at interacting with other cells. Martin Fussenegger, a bioengineer at ETH Zurich and the lead researcher on the cell-calculator project, says cells could be programmed into "smart cell implants" that sense health problems in the human body and administer tailored therapies. For example, a patient with a high risk of breast cancer could receive an implant that would recognize cancer-indicating molecules and produce proteins to kill the cells making them. "A diseased cell is a program with a bug," Akl says. "Computer scientists are good at finding bugs and fixing them. I leave the rest to your imagination." PS



PS

Solar Cyclone

Using data from NASA's Solar Dynamics Observatory and the Swedish 1-meter Solar Telescope, a team of European researchers recently created 3-D simulations of the sun's spinning magnetic fields (such as this one) to determine why the star's upper atmosphere is hundreds of times as hot as its surface. They found that the magnetic twisters funnel hot, charged gases up from the sun into its atmosphere. About 11,000 tornadoes—some as wide as 900 miles—spin on the sun at any moment. *—Laura Geggel*

FROM TOP: COURTESY BENNY K.K. CHAN, BIODIVERSITY RESEARCH CENTER, ACADEMIA SINICA; COURTESY WEDEMEYER-BÖHM ET AL. (2012). IMAGE PRODUCED WITH VAPOR.

NEWS

Brainless slime able to trace map of Canada's highway system: study

Tristin Hopper Mar 26, 2012 – 11:35 PM ET

By using brainless yellow slime to trace a surprisingly accurate map of the Canadian highway system, Queen's University professor Selim Akl claims to have found evidence that the fungus can act a kind of natural computer.

On a map of Canada, Mr. Akl placed rolled oats over each of the country's major population centres, along with a dollop of slime mould over Toronto.

Over two to five days, the mold formed thin yellow tubes to reach out to the rolled oats, creating a fungal approximation of Canadian highways.

"In all experiments slime mould approximates all but Vancouver to Calgary links of Canadian highways networks," wrote Mr. Akl in a paper detailing the experiment, which is due to be published in the International Journal of Natural Computing Research.

"By showing species as low as slime mold can compute a network as complex as the Canadian highway system, we were able to provide some evidence that nature computes," said Mr. Akl in a Queen's University release.

In the future, said the study, slime mould could be used to help design highway and other transportation networks.

Previous studies have applied the slime mold method to transportation networks throughout Europe, Africa and South Asia. So far, Canada has emerged as one of the most accurate.

National Post

Posted in: Canada, News Tags: Nature, Selim Akl

TRISTIN HOPPER

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What do you think?

John Kohos

Is this new? I thought our roads were aready being designed by brainless slime.

2 hours ago Like

quaredunt

Makes perfect sense. Just the same as those night time satellite images of earth in which you see the lighted slimey tentacles of human spread across the planet, like a cancerous growth, tracing the lines of our transportation systems ... and (TOJack) all aided by people like Rob "Model T" Ford who continue to pander to the car.

19 hours ago 1 Like Like

TOJack

Maybe Rob Ford can use slime to build his subways.

1 day ago 2 Likes Like

Stoned Angel

Crazy stuff.

1 day ago Like

Longtooth

I have great respect for the fungal family for many reasons but I find this a bit dubious... all life follows the path of least resistance and when roads were constructed this principal was used except where major tunnels were used through mountains which would account for the deviation indicated for the route from Calgary to Vancouver. I think that it simply proves that this the fungus has a couple IQ points on the professor.

1 day ago 7 Likes Like

bchunter

I think the anti-Quebec prejudice shown by the fungus is obvious. I am appalled that an Anglo University is getting funding for this!

1 day ago 6 Likes Like

RK55

I don't know why people are being so snarky. It's a fascinating result. I love science when it makes your head explode like this one does. It's downright consciousness expanding. (Okay, I know, over the top;)

1 day ago 1 Like Like

Humanavatar

So does this mean we can do without city planners too?

1 day ago 6 Likes Like

Maggat

A dollop of slime was dumped on Toronto? OK.

2 days ago 5 Likes Like

JM Junior

Well, the slime told us to do it.....so let's go ahead and build that bridge across Hudson Bay we've all been dreaming about.

2 days ago 6 Likes Like

Torque Bomarc

Big deal.

This morning my bran flakes accidentally formed the equation for warp drive.

Government academic research grants will help expand my work to corn flakes, lucky charms, and, yes, even fruit loops.

2 days ago 14 Likes Like

Raynor

Need to watch the video. :-)

2 days ago Like

Morvin

You obviously didn't watch the video clip.

2 days ago in reply to Raynor Like

Raynor

Ya, you are right, I didn't, I read the narrative. I'm wrong aren't I. Video is fascinating.

2 days ago in reply to Morvin 1 Like Like

workman 1

oh pulleesse, are we to deduce that our road network designers are on a level with yellow, oops, multicultural, slime.

2 days ago 7 Likes Like

Slime mold mimics Canadian highway network (w/ video)

March 26, 2012

Queen's University professor Selim Akl has provided additional proof to the theory that nature computes.

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Moving forward, Dr. Akl would like to collect more examples to support his claim that nature computes. He explains, for example, that the leaf of a plant uses 99 per cent of the light it receives from the sun while the best engineered solar cells have an efficiency of only 35 per cent. Research into this area could lead to important practical applications.

Dr. Akl's study, co-authored by Andrew Adamatzky (University of the West of England, United Kingdom) is being published in the *International Journal of Natural Computing Research*.

Provided by Queen's University (news : web)

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hemitite
Mar 26, 2012

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Are they sure it wasn't the other way around?

report

David Santamaria
Mar 26, 2012

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Nobody can say anymore that since more than 3 billion years (LUCA), the centillions of cells that worked together to build life as you can see it now everywhere on earth, did it thank to a practically infinite chain of coincidences, because each time, each one of them, followed God's precise order to oneself instead of doing something stupid among the truly infinite stupid things each one of them could have have done, like who you know.
To affirm the contrary is just the pleasure to make suffer, perversion in is very definition.

report

Nathan_Henry
Mar 26, 2012

Rank: not rated yet

humans compute thus nature computes. In fact nature invents things that will compute for it. Like the computer. I'm surprised they look for proof in slime mold.

report

alfie_null
8 hours ago

Rank: not rated yet

> ...the leaf of a plant uses 99 per cent of the light it receives from the sun...

Where does this value come from? I read that photosynthesis efficiency is significantly less, ranging from three to six percent. Ref: http://en.wikiped...ficiency

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Tablet computers are being adopted by behavioural scientists at Norway's University of Stavanger (UiS) as a more efficient way of obtaining information from young children.

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Game Review: 'Ninja Gaiden 3' a letdown for fans

(AP) -- If you were playing video games in the 1980s, you probably remember flinging your Nintendo controller across the room after the original "Ninja Gaiden" sliced and diced you into mouth-frothing aggravation.

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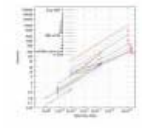

Surveying the wide range of parallel system architectures offered in the supercomputer market, an Ohio State University researcher recently sought to establish some side-by-side performance comparisons.

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(AP) -- Facebook CEO Mark Zuckerberg says Japan's massive tsunami inspired him to seek more ways for his social network to help people hit by natural disasters.

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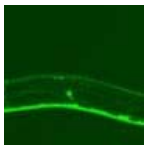

Certain genes and proteins that promote growth and development of embryos also play a surprising role in sending chemical signals that help adults learn, remember, forget and perhaps become addicted, University ...

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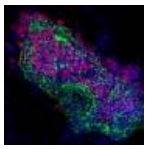

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Slime mold mimics Canadian highway network

posted on: march 26, 2012 - 4:30pm

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Source: **Queen's University**

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Slime mold mimics Canadian highway network in unusual experiment

2012-03-26

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Dr. Akl's study, co-authored by Andrew Adamatzky (University of the West of England, United Kingdom) is being published in the *International Journal of Natural Computing Research* and he is also serving on the program committee of a natural computing conference being held in Spain later this year.

Watch the YouTube video of the slime mold experiment.

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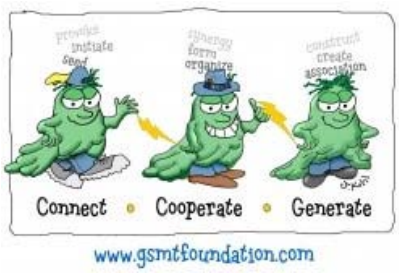
Slime Molds Compute



Many years ago, my High School biology teacher introduced me to slime molds in a lab class. I remember being fascinated by them, but I was fascinated by a lot of things back then, so they took a back seat to the girls in class. It wasn't until many years later that I became interested in them again. In fact, I developed a theory about them called The Green Slime Mold Theory. Slime molds come in all colors, and I like green.

What fascinates me about slime molds is their attributes. Although each individual cell is autonomous, they somehow communicate, and cooperate with other cells to reach a common purpose. They do it in the most efficient and expeditious way, without any one cell in charge. Can you image people working that way?

The Green Slim Mold Theory, hypothesizes, that based on the principals and attributes of green slime molds, people could work autonomously, with no one in charge, to reach a common goal in the most efficient and cost effective way. Later in the lens, I will reveal the project, and show the result. The cartoon characters in the image are my conception.
Drawn by Joe Khol

Cartoon Image Courtesy of GSMTF

CONTENTS AT A GLANCE

Amoeba Power

by jmchaconne

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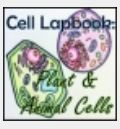

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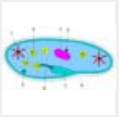
Protists: Paramecium, Amoebas, Algae, Diatoms, Euglena, and Others


Fungi Kingdom

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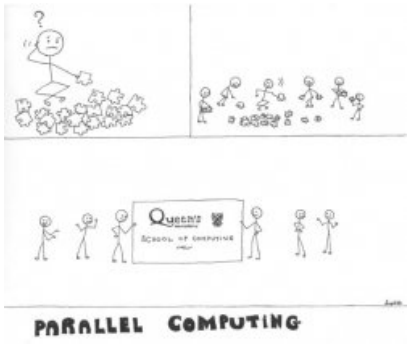
Computer Science and Slime Molds

My interest in slime molds led me to an article published by Selim G. Akl, a Professor, and Director at Queen's University School of Computing, Kingston Ontario, Canada. The Schools Motto Is

I Am Therefore I Compute

Speaking about the Motto, Professor Akl say's "Computing permeates the Universe and drives it: Every atom, every molecule, every cell, everything, everywhere, at every moment, is performing a computation. To be is to compute."
Drawing Courtesy of Queens University

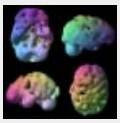


Slime molds and Computing

A retired helicopter pilot by profession, I was pleasantly surprised to someone else who shared my interest in slimy amoebas. Then I found a scientific article written by Professor Selim G. Akl, about his work with Slime molds. A professor at Queen's University in Canada, he leads the Parallel and Unconventional Computation Group at the School of Computing there. I found his email address and sent him a message.

When I learned that the good professor was researching the practical application of their unique attributes that got my attention. We began trading

Biology: Information, Videos, and Labs



Fight Toxic Mold By Going Green

Chaconne the Novel

Chaconne The Novel

by: Joseph C. Mastroianni
Amazon Price: $20.00 (as of 07/21/2012) BUY NOW

Johann Sebastian Bach's "Chaconne" the Partita in D minor for solo violin (BWV 1004) is my favorite piece of music. My father, a violinist, played it for me many times as a child. The music stuck with me, and inspired, and deeply affected my life. It is not known why Bach composed it. Since I love historical fiction, I took that as an opportunity to write a novel about it. It is two tales in one, the story of Bach's life and why he composed it, and the life story Milo, the protagonist, and how the music inspired his life. It was an eleven year writing journey, which I will always cherish, but never repeat! Squidoo now satisfies my creative writing urges.

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emails and I asked him if we could have a conversation about his work for this lens. He was kind enough to take time from his hectic schedule, for which I am grateful.

Director
Queens University School of Computing

A Conversation with Dr. Akl

I'm honored for the opportunity to have found you, and for this conversation. Your name, Akl, is unusual, as is mine, Mastroianni. In Italian it means master of the years. What does Akl mean?

My last name, Akl, means mind. (My first name, Selim, means sound, as in "safe and sound.

Interesting, many people think I'm out of my mind, most of the time! At this point, to explain the cartoon that appears here, what were your childhood dreams?

For a long time, I thought I wanted to be a journalist (a reporter, in particular), perhaps inspired by the comic book series Tintin.

I'm not familiar with it, except a rare cover was sold at an auction in Paris for 1.6 million! Tell me a little about your early family years, heritage and background: Something about your parents, and siblings, where you grew up, your wife, children?

I was born in Alexandria, Egypt, and grew up on the shores of the Mediterranean. I like to say that I played in the same sand where the great Euclid traced his geometric figures and proved his theorems. I came to Canada in my mid-twenties to study for the Ph.D. at McGill University in Montreal. Upon graduation I was hired by Queen's University in Kingston. I am married and have three children, a girl and two boys.

The universe placed you perfectly, on July 21 in fact, happy birthday! What is your earliest memory?

Thank you. My father worked for a financial institution, and I must have been three years old when he took me to his office to witness a huge safe being lifted by a crane and fitted through a third floor window. I may have developed an interest for engineering on that day!

Fortunately, for the banks it was engineering and not safe cracking! What kind of music do you enjoy, and fun books so you read for fun?

Classical, opera, jazz, French chansonniers. For fun, Popular science.

Who is your favorite author?

There are many. James Gleick is good (I am finishing his latest book The Information). Also, Charles Seife.

How about, childhood interests, sports, academics,?

The usual: I collected stamps, read comic books, French illustrated books, played basketball,

loved swimming (and generally hanging out at the beach), learned languages (I am more or less fluent in eight languages).

Eight! Amazing, so computer languages probably were very natural, when did you first get interested?

As a third year electrical engineering student, I had the opportunity to spend a summer as an intern with the French company SUD-AVIATION (later called Aerospatiale) located in Toulouse, France. They had just finished building the Concord, a magnificent airplane, now taking its first test flights in the neighboring Blagnac airport. When I arrived, they were working on their next project: the new AIRBUS airplane, still on the drawing board. The plan for me was to be assigned to the electronics department, but the latter was oversubscribed with interns, and so, as fate would have it, I was sent to the computer science department. In those days, computers had not made their way to engineering curriculum yet, so I knew nothing about computing. They said they'd teach me. And so I became part of the team that wrote the very first flight simulator for the AIRBUS. And it blew me away. Here we were, using software and hardware to create worlds that did not previously exist, but nonetheless worlds as real and as vibrant as our imagination could produce. I knew, right there and then, that this is what I wanted to do for the rest of my life. I went back home and convinced the EE department at my university to offer a specialization in computer science!

Aerospatiale, yes, as a helicopter pilot, I'm very familiar with, the company, and have flown their Alouette, a fine machine. How about your favorite scientist?

In computer science, Alan Turing, John von Neumann, and in recent times Donald Knuth.

Do you have a favorite historical figure?

Explorers, in general, and Columbus, in particular, for their vision and courage.

Do you believe life exists elsewhere in the universe?

Yes, I do. There is no overwhelming reason to believe otherwise.

Who or what inspired your interest in Science?

Without any doubt, it is the space race that began with Sputnik and ended with the Moon walk (43 years ago, today!) that inspired me. I collected pictures of rockets. I read every article I could find. I remember staying up all night, July 21, 1969, to listen to the live broadcast on my transistor radio (we had no TV) from the Voice of America station. My birthday was the next day. Incidentally, I find it sad that, when it comes to space research and travel, we have done nothing in over four decades that comes even close in significance.

I agree. I am encouraged by the private Space X project, and Virgin Galactic. Why did you choose teaching?

At a rather young age, I was given the opportunity to substitute for a middle school teacher for a few classes. I enjoyed it and I think the students liked me. Ever since, I never stopped teaching. I think I'm good at it, and strive to improve myself all the time. Over the years, I had good teachers and ones who obviously did not belong in the classroom; I try to emulate the former and avoid the mistakes of the latter. This, in a nutshell, is my theory of how to be a good teacher, that is, just emulate the masters.

That is about as good a teaching theory as I've heard expressed. As you know, I too have an interest in slime molds, green is my color. In fact, that is what brought us together. What prompted you to become interested in slime molds?

It was the most primitive species we could think of that satisfies:
Easy to obtain
Easy to grow
Easy to work with
Requires no elaborate equipment
Requires no skilled handlers
It is well behaved (does not run away)
Experiments are short (2 - 5 days)
No ethics approval is required!
(Queen's) NATURE COMPUTES

Somehow I don't think ethics would be a problem with any experimentation you are involved with. What do you find most interesting about them?

Recently, Andy Adamatzky and I have shown that slime mold (the plasmodium of Physarum polycephalum) can compute a map of the Canadian highway system fairly accurately. Andy, who is based in Bristol, U.K., is well known for his work with Nature-inspired unconventional computer models, such as reaction-diffusion computers and cellular automata. Does Nature compute? The proof is in the slime! Here's a creature with no brain, no nervous system, no eyes, no feet, no arms, capable of performing what one might call a complex information processing task.

Talk about handicapped, they are incredible creatures indeed. What practical applications to you foresee using their unique attributes?

Medicine: Slime mold may be bio-engineered to forage for cancerous cells (recall that penicillin is a fungus). Green' computing: No electricity required.

What conclusions have you reached about slime molds and computer science?

It's all about information: foraging for food means energy for survival, and this in turn means reproduction through copying of information. No brain required: simple biologic organisms do not require a central brain for cognitive behavior.

How do you envision the practical combination of computer science and biology, in relation to artificial intelligence?

Expressing the processes of nature as computations will have a transforming effect on all fields, from biology down to physics and beyond. I said this before: First, the biologists thought that they knew how the world works (cells); then came along the chemists and said that it is all chemistry (molecules); then the physicists claimed that at the very bottom, it is really all physics (atoms). Well, I contend that perhaps it is now the computer scientists' turn to show that, fundamentally, it is all information (bits). For a computer scientist there are four motivations for attempting to model nature's phenomena as computations:

(i) To better understand the processes of nature by expressing them as algorithms;
(ii) To seek inspiration from nature when natural algorithms are more effective and more efficient than conventional ones;
(iii) To use nature itself to perform the computations, when it substrates and processes are the most appropriate; and
(iv) To better understand what it means `to compute'.

A digital universe of sorts, if you will, what do you think is your most significant contribution to computer science?

I proved that the concept of universality in computing cannot be realized: Contrary to what is generally believed, it is in fact not true that a finite and fixed computer can execute, through

simulation, any computation that is possible on any other computer. If you are interested see
Courtesy of Queens University

What do you do to relax?

I go for a jog.

What would you like your epitaph to say?

I have not thought about one yet.

We appear to have the power of God, for good or evil. I wonder, is that statement blasphemy and arrogance, or our true purpose?

I believe that we do all these things out of curiosity, but also for survival. Furthermore, no research, with potentially dangerous or unethical applications, should be banned for political reasons. Remember, if we don't do it, someone else certainly will, and so we had better know as much as we possibly can about it, if we are to stop the bad guys from evildoing.

Thank you, Dr. Akl, for an interesting and informative conversation. I sincerely appreciate it, as will the readers I'm sure.

Questions by: Joseph C. Mastroianni
Answers by: Professor Selim G. Akl
July 21, 2012

Tintin Cowboy
Photo Courtesy of PGMCDN

Books by Professor Akl

- Parallel Sorting Algorithms (Academic Press, 1985)
- The Design and Analysis of Parallel Algorithms (Prentice Hall, 1989)
- Parallel Computation: Models and Methods (Prentice Hall, 1997)
- Parallel Computational Geometry (Prentice Hall, 1993)
- Adaptive Cryptographic Access Control (Springer, 2010)

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MycrowsoftSam Jul 22, 2012 @ 3:44 am

Thanks for the great read

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The voyage

My Bio

"Perfect meditation even the sound of silence cannot be heard" jmc
My life has been a fabulous journey. Every childhood dream has become a reality. So did some of my worst nightmares. Life is like that.

We do create our own reality either purposefully or on auto-mode. None of my dreams came true on auto-mode.

Two of them were to fly, and to ride a bicycle far as I could go. I've had an adventurous career as a professional helicopter pilot, and rode a bicycle across America.

Each day is an adventure; Music (classical guitarist) writing, including a published novel, a poetry edition, magazine articles, and essays, computer and business consulting, running, biking, chess, cooking, and just enjoying life.

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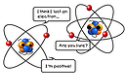

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SCIENCE SCIENCE THURSDAY -- **April 5, 2012 at 12:20 PM EDT**

Slime Molds: No Brains, No Feet, No Problem

BY: REBECCA JACOBSON

In a study released last week, computer scientist **Selim Akl** of Queens University demonstrated that slime mold is fantastically efficient at finding the quickest route to food. When he placed rolled oats over the country's population centers and a slime mold culture over Toronto, the organism grew its way across the Canadian map, sprouting tentacles that mimicked the Canadian highway system. It's an experiment that's been replicated globally several times now -- in Japan, the UK, and the United States -- all with a similar outcome.

So what is slime mold, and how does it do this?

Slime mold is not a plant or animal. It's not a fungus, though it sometimes resembles one. Slime mold, in fact, is a soil-dwelling amoeba, a brainless, single-celled organism, often containing multiple nuclei. View this slide show for some examples.

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Frederick Spiegel, a biology professor at the University of Arkansas and an expert on slime molds, first encountered them nearly 40 years ago. "I thought they were the most beautiful, sublime things I'd ever seen," he said. "I said, 'I've got to work with these.'"

They come in every color of the rainbow, except -- due to lacking chlorophyll -- a true green, according to **Steve Stephenson**, professor of biology at the University of Arkansas. They form strange and sophisticated shapes - some resemble honeycomb lattices, others blackberries. And then there's the slime mold known as "dog vomit," because it looks just like the stuff. Some remain microscopic, and others grow rogue, forming bulbous masses, as long as 10 to 13 feet. Yet humans largely ignore them.

"Very few have been consumed as food. You can't build a house with them. They escape our noses most of the time," Stephenson said.

Still, our world is crawling with them. More than 900 species of slime mold exist, Spiegel said, and they're found on every continent. Stephenson and his team -- the **Eumycetozoan Research Project** at University of Arkansas -- spent years trying to catalog all species of slime mold around the globe from the Arctic Circle to the tip of Chile. Slime molds are particularly fond of forest floors where they break down rotting vegetation, feeding on bacteria, yeast, and fungus.

When all is well, the slime mold thrives as a single-celled organism, but when food is scarce, it combines forces with its brethren, and grows. Starving amoebas work in tandem, signaling to each other to join and form a multicellular mass, like a "moving sausage," Spiegel said.

Then, once the mass is formed, the cells reconfigure, changing their shape and function to form stalks, which produce bulbs called fruiting bodies. The fruiting bodies contain millions of spores, which get picked up and transported by the wind, a passing insect or an animal. There, they start the process again as single-celled organisms. Meanwhile, the cells that formed the stalks die, **sacrificing themselves.**

For creatures without feet, they can travel incredible distances. Stephenson said one of his students identified slime molds in New Zealand that are genetically identical to groups found in the United States. How they got there is unknown.

Slime molds were likely an inspiration for the 1958 science-fiction film, "The Blob," scientists say. And it's in these plasmodial, "blob" states that they spread like highway networks and even solve mazes.

When ripped in half, the halves continue to grow independently and the

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nuclei in each half continue to divide and develop in sync. This makes the organism uniquely appealing to cancer drug research, said Jonatha Gott at Case Western University, because it provides researchers with multiple identical samples dividing at the same time.

Plus, unlike other organisms, the amoeba's genetic information makes an uncommonly large number of corrections during the RNA editing phase, Gott said. She compared it to a contractor continually making changes to an architect's plans.

"As it's making a copy of the DNA, it changes it," Gott said, "It's incredibly precise and incredibly accurate. If it doesn't do this, it dies. It's a really crazy way to express genes."

Computer scientists like Akl also study slime mold to better understand how **nature "computes."** The hope is that these amoebas will teach them how to develop better algorithms for delivering information.

The highway experiments, for example, show that slime mold is capable of computing optimal coverage of the map while using the least amount of energy, Akl said.

Nature, in this case, was able to compute an efficient network in less time than humans could. If we could harness the algorithm to do so, we could build more efficient systems, he added.

"We are always searching for the best way to connect people...yet here is this lowly species that can do it," Akl said.

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The Latest | March 31, 2012

Physarum polycephalum. Photo: Jerry Kirkhart via Wikimedia Commons

Regular readers of this blog (I flatter myself that such people exist) will know I'm keen on slime moulds, a form of life that defies easy description. So the publication this week of a paper that show how a particular type of slime mould can model transportation networks in Canada was simply too good to ignore. Not only does the research explore important questions about how nature performs computations, there's also a cool YouTube video showing a time-lapse of the cool/gross slime in action. What could be better?

The paper in question is published in the *International Journal of Natural Computing Research* by Andrew Adamtzky of the University of the West of England, and Selim Akl of Queen's University. Both are in the field of "unconventional computing." Akl describes it as follows:

> We talk about building different types of computers: quantum computers, chemical computers, biological computers. Part of this involves looking at nature. For example, there are evolutionary algorithms, genetic algorithms, neural network algorithms and swarm intelligence.

Adamtzky focuses on the slime mould *Physarum polycephalum*. Like many slime moulds, *P. polycephalum* has a lifestyle that smacks of science fiction. It starts out as spores which, on exposure to dark and moist conditions, germinate into amoeba-like swarm cells. These cells reproduce asexually, and can grow flagella for swimming if they need to. When enough of them are established, they switch to sexual reproduction and form a zygote, which in turn forms forms a giant cell with many nuclei, big enough to be seen without a microscope. This is called a *plasmodium*, and is the source of the slime mould's scientific name (roughly translated, *Physarum polycephalum* means "multi-headed slime")

The coolest thing about the plasmodium is how it forms a network of microtubules to search for and digest food. Adamatzky has long been interested in how these networks can be seen as a computer algorithm that solves a particular problem, namely constructing an efficient set of connections between various nodes (food sources). In previous work, he's compared *P. polycephalum* networks to road transportation in the UK and Mexico. But according to the latest paper written in collaboration with Akl, it's important to model as many countries as possible, and since Akl is Canadian, the natural choice was Canada.

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The setup was simple: a large petri dish was placed over a map of Canada and 16 nodes were created of top of major cities, as well as minor ones that are nonetheless major nodes in the Canadian transport system (e.g. Thompson, Man. or Wrigley, NWT). Each node consisted of a small pile of oatmeal wrapped in a paper towel, and kept moist with tap water. Would that my own graduate studies could have been conducted with such basic equipment. . .

23 times the mould was inoculated at Toronto, and after 2-5 days the network was complete. *P. polycephalum* never makes the same network twice, but certain connections were more common than others. For example, a connection between Thunder Bay and Winnipeg appeared in 22 of the 23 experiments, but that between Montreal and Radisson, Que. only appeared 8 times. The team applied various thresholds for the number of times a link would have to appear before it would be considered 'strong.' They then compared the networks thus generated to those of the actual transportation system in Canada, as well as networks generated by Akl using computer algorithms. In general, the mould imitated these very well, with few of the redundant links that one would expect to find if it was just branching out in random directions. "We would call it a computation; it's not a brute force coverage of the whole area," says Akl.

Just for fun, the team then simulated what would happen if the transport network was disrupted. They did this by sprinkling sea salt (toxic to *P. polycephalum*) at Tiverton, Ontario, site of the Bruce Nuclear Generating Station. According to the paper, the mould "migrates outside Canada, enhances the transport network outside the contaminated zone [and] sprouts indiscriminately from urban areas and transport links." I have no doubt that the folks at Bruce Power are operating their plant in a safe manner, but in the extremely unlikely event of a nuclear meltdown, I would probably respond in much the same way.

Fun and games aside, the research into how nature computes is as important as it is fascinating. I'll leave you with some inspirational quotes from Selim Akl himself:

> Since its inception, the paradigm of computation has been: you give me the data, I'll go and crunch the numbers, and give you the answer. There will come a time when this paradigm will change. The numbers that you are working on will change as you are working on them, and your algorithm will have to adapt to this. For example, it could be a robot roaming the surface of Mars, interacting with its environment and its environment affecting its computation.
>
> The philosopher in me says that nature is really performing a computation: it's computing the next state of the universe. Biologists had a description of how the world works, and then chemists came along and said it's at the molecular level. Then physicists said it's at the atomic level. We are saying that perhaps it's at the bit level, or the information level. A chemical reaction is really an exchange of information between two species. If you understand it this way, maybe we can capitalize on the knowledge that we have accumulated over the past 70 or so years in computer science, which I think is quite exciting.

You can see lots more cool videos from Andrew Adamatzky's other experiments here.

Also, in 2010 another group carried out a similar experiment with the Tokyo subway. You can see that video here.

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