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Genetics Mystery 6,026 🖔 9 🌣 ∨ George Dvorsky Filed to: COMPUTATIONAL BIOLOGY 6/08/15 9:20am

Scientists Use AI To Solve A Long-standing

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University has reverse-engineered the regeneration mechanism of planaria. It's the first time a nonhuman intelligence has been set with the challenge of investigating the complex regulatory networks required for this extraordinary and mysterious biological feat. The results of the study,

which can now be found at PLOS Computational Biology, represents the most comprehensive

For well over 100 years, scientists have wondered how planarians perform their regenerative

parlor trick. Prior to this study, biologists had identified the basic genetic components required

model of planarian regeneration found to date.

shape."

by planarians to reproduce missing body parts, but they struggled to understand how these replacement parts were able to appear in the correct size, shape, and orientation. So while they understood how planarians produced new tissue, they were at a loss to explain how this tissue morphs into perfectly formed body parts. "Most regenerative models today derived from genetic experiments are arrow diagrams, showing which gene regulates which other gene," noted lead author Michael Levin in a statement. "That's fine, but it doesn't tell you what the ultimate shape will be. You cannot tell if

the outcome of many genetic pathway models will look like a tree, an octopus or a human." Levin says that most models show some requirements for the process to happen, but not the sufficient dynamics required to produce the precise shape of body parts in a coherent step-by-step manner. "What we need are algorithmic or constructive models, which you could follow precisely and

Writing in Wired, Katie Collins summarizes how the researchers got their AI to produce the model: ...Levin and Lobo programmed the computer to crunch through the big data gathered

from the many studies performed in this area. It simulated the network formed by a

experiments. Every time it managed to match the results, the computer modified the

random genetic network it had created in line with the results and kept honing it until

it created a core genetic network that matched the results of all the studies. This took

Over the course of the experiment, this evolutionary approach allowed the scientists to reconcile

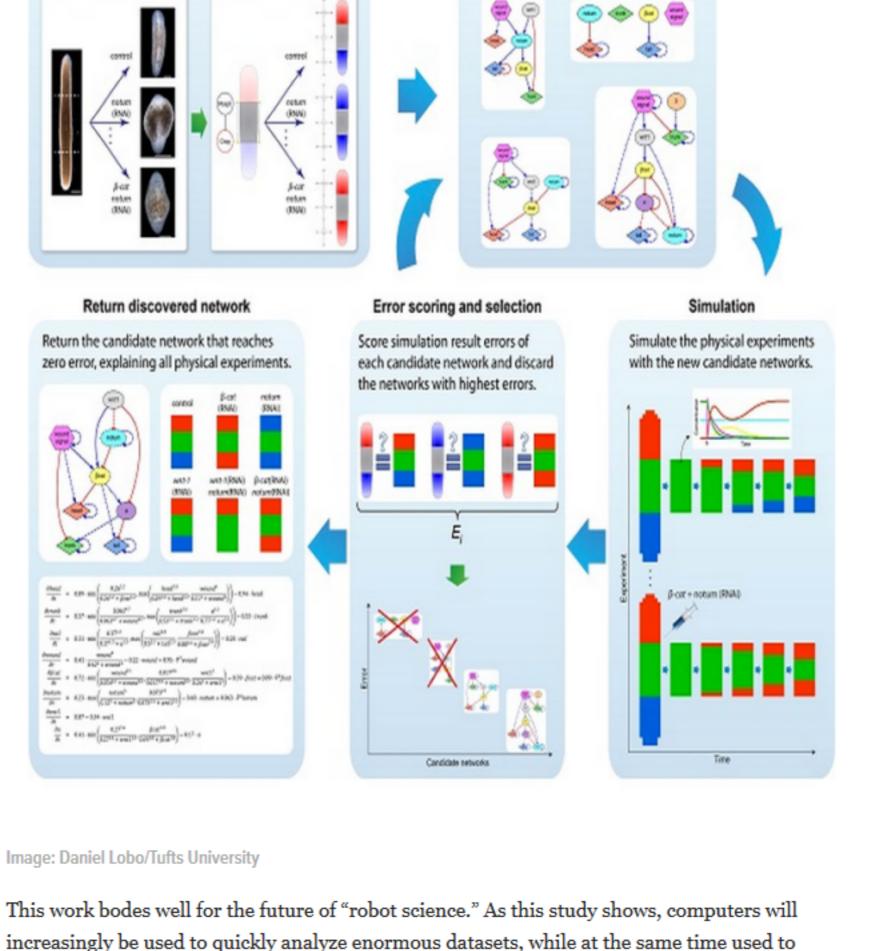
three days of trial and error guessing and tweaking — an approach that would be

worm's genes many times over until its results matched those from real-life

unfathomably inefficient if it were implemented by humans.

there would be no mystery or uncertainty," says Levin. "You follow the recipe and out comes the

the existing literature as it pertained to head vs. tail regeneration. Physical experiments Candidate regulatory networks Perform physical experiments and formalize them in a Generate candidate networks: random functional dataset based on a mathematical ontology. first, then cross and mutate existing ones.



Method Reverse-Engineers Planarian Regeneration". [Wired | Tufts University]

Contact the author at **george@io9.com** and **@dvorsky**. Top image by I, Science

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Gulld_Navigator > George Dvorsky

FrankN.SteIn > Guild_Navigator

Sitting in huge thanks of spice melange?;)

had been shot in the head the previous issue).

6/08/15 9:49am

we must scream).

Bantaro > George Dvorsky

plants shaped like Neurons.

that THOUGHT it was a man.

and it was one of the things that led to his fame.

If didn't exist Jim Henson would have had to invent me.

the programs as "intelligent" and drop the AI moniker.

the network is, which requires even more guessing and checking.

one. It is creativity on the part of the programmers alone.

InerringApproximation > George Dvorsky

6/08/15 11:54am

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only data mining but also inference of meaning of the data.

While the artificial intelligence in this project did have to do a whole lot of

computations, the outcome is a theory of what the worm is doing, and coming up with

theories of what's going on in nature is pretty much the most creative, intuitive aspect

of the scientist's job. One of the most remarkable aspects of the project was that the

model it found was not a hopelessly-tangled network that no human could actually

understand, but a reasonably simple model that people can readily comprehend. All

Read the entire study at PLOS Computational Biology: "Inferring Regulatory

Networks from Experimental Morphological Phenotypes: A Computational

this suggests to me that artificial intelligence can help with every aspect of science, not

expose the meaning in the data. As Levin explains:

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An experiment someone conducted is mentioned: the experimenters had taught a planarian worm to run a maze. Said 'educated' worm was chopped up and fed to other planarian worms, and after eating the 'educated' worm, the other planarian worms could run the maze on the first try.

This implied that intelligence or knowledge could be passed on via food. This had terrible

implications for Swamp Thing. Then it turned out his 'lungs' were too rough to exchange

oxygen into the 'bloodstream', and his brain didn't really have neurons that worked, just

Swamp Thing had been written since day 1 as a man who ran into the swamp, covered

with experimental plant goo and was changed into Swamp Thing. "The Anatomy Lesson"

completely reversed the character. He wasn't a man who became a plant. He was a plant

Great stuff, and it brought serious horror comics back to DC. Alan Moore was the writer

Lorewise, planarian worms are important to DC Comics Swamp Thing. In "The Anatomy

Lesson", a supervillian is called in to perform a private autopsy on Swamp Thing (who

First is planaries, then its traffic patters of the lemmings and then we have no mouths (and

America's Wang > George Dvorsky

tool, but it is an extension of the programmer. It's a fantastic paper to my eyes, but not some harbinger of artificial sentience. To be pedantic, yes, machine learning is often considered a subset of AI, but AI is such a

nebulous and misleading term as to be useless. As I've heard before, anything we don't

know how to do on a computer yet takes AI, but once we figure it out it we hardly think of

Genetic regulation networks are very finicky things. For most networks, it is impossible to

network first. Even more important is that it isn't always apparent what the real shape of

The method used in this paper was to mathematically describe all of the possible ways the

unknown network could be connected (as well as which components could be connected),

try some, compare the behavior to the actual observed data, and then try alterations on

the ones that matched best. All of these behaviors occur within patterns described by the

predict their behavior without going through and simulating all of the steps of the

Calling this artificial intelligence is misleading in my opinion (not ragging on you George,

the authors of the paper also call it AI). The technique is usually called machine learning

existing techniques. The big advancement here is really the availability of sufficient data

to perform such an analysis with, a clever pseudo-genetic algorithm to save computation

time, and using a very thorough simulation and comparison scheme. ML is a fantastic

(which is really just a kind of applied statistics), and it's mostly a clever application of

programmers alone. It cannot handle anything that was not expected by the programmer. It cannot make new associations that it hasn't been told to do beforehand. The program has no intelligence, unless you believe the Google search engine, spam filters, and voice recognition programs are intelligent. It is simply following a predefined set of operations. Even the "theory" developed by the ML algorithm was defined by the programmers as

well. They knew what shape it would have (it had to be some subset of the allowable

network shapes they initially defined), and they developed an algorithm to pick the best

It is similar to writing a program to pick the three best stocks to purchase based on their

gains in one day. You don't know which stocks your program will pick yet (but you know

how it decides it), but you know you will get three stocks as an output. It isn't a surprise;

you wrote it that way! In the case of this paper, it's more similar to which stocks are most

related and last week's stock price data. The result is now the predicted links between the

likely to increase or decrease in sync based on your ideas of how they could possibly be

stocks, which is arguably a theory of how those stocks change in price (based on your

initial assumptions of the possible ways they are linked). Not really the results of an intelligence other than yours alone, though. There is a good chance the regulation network that was produced in the end is wrong simply because nobody was aware of an additional interaction between some of the components (wouldn't be the first time). Or maybe some of the components don't actually interact but were thought to. There are many degrees of freedom in these regulation networks which, in addition to making the creation of a network model very computationally intensive, sometimes allows you to overfit your model to the data. Machine learning is an awesome technique, but it is only an extension of the

Sorry for the rant. I have done some computational biology with machine learning algorithms and the results are hardly AI except in the most generous of definitions. Programs are as dumb as their programmers and never as smart. Incredibly useful and powerful when done properly, but still just calculators crunching lots of numbers mindlessly. 5 🔆 Reply

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Computational biology continues to get better and better. This may have spinoff effects in other areas of computer science.

synthozolc > George Dvorsky 6/08/15 10:04am Hmph. Nothing really insightful to say here. I'm not a biology expert. You May Like

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programmer's creativity and algorithms. Certain kinds of machine learning are very easy to implement (decision trees, support vector machines once you grok the math), and R and python both have a lot of packages allowing the implementation of machine learning with minimal coding. I highly recommend trying to learn and implement one before fearing for the singularity.

> Ceyah > George Dvorsky Dey took r jorbs! I, for one, welcome our new robot science tools. And future overlords.

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