DECLARATION OF ADRIAN BOWYER

I, Adrian Bowyer, being of sound mind, declare the following to be true to the best of my knowledge, information and recollection:

1. I am a retired Senior Lecturer, formerly employed in the Mechanical Engineering Department at Bath University.

2. I am the originator of the RepRap Project, which created the first general purpose self-replicating manufacturing machine using 3D printing. RepRap is short for "replicating rapid prototyper." RepRap is a community project to develop low-cost 3D printers that can print most of their own components. As open designs, all of the designs produced by the project are released under a free software license, the GNU General Public License.

3. In connection with the RepRap Project, I created RepRap.org, which I and other members of the Project administered from its inception in March 2005. I started to hand over my part of the work as an administrator to those other member of the project around 2018. I am still nominally an administrator, but others now run the site day to day. I originally bought, and still own, the domain reprap.org. I have personal knowledge about the operation of the website during my tenure as an administrator and through to present day, including how the website publishes content for public view and the operation of the website forum software.

4. Persons interested in 3D printing and rapid prototyping, both professionals and hobbyists, would have been aware of RepRap.org. RepRap.org hosts public forums in which community members can discuss topics relevant to the RepRap Project, and the 3D printing and rapid prototyping community, or anyone who visited the site, would have also known of the forums. From the origination of the project onward, the RepRap Project and the site, including the forums, were often discussed in various print and web media and on social media. I, and the

others involved in the project, actively worked to raise awareness of the project and site in the 3D printing community and beyond, because we believed that the project would benefit from active involvement by many interested persons. During my time as an administrator, RepRap.org had around 1,000 regular monthly users with many more users occasionally visiting or interacting with the website and public forums. Professionals, hobbyists and others would have known to, and did, visit the forums to interact with like-minded persons. The forums allowed (and still allow) people to pose questions, provide helpful suggestions, update others on new developments, and generally share knowledge and information regarding development of RepRap machines and 3D printing in general.

5. The forms were intentionally accessible to the public. No login was required to view these forums. Registered users can start, or "post," forum discussion threads and other registered users can post to those discussion threads. The forum software automatically appends a header to each post. The header includes the poster's user name, the thread title and the date and time the post was made. That date and time is persistent, remaining in the header of the post and unchangeable as long as the post is accessible on the site. All timings are registered in Eastern Standard Time, five hours behind Coordinated Universal Time (UTC). A user can edit his or her own post, but the original header remains unchanged. Instead, when a post is edited, the forum software appends information at the bottom of the post including a label indicating that the post was edited and the date and time the post was edited. If a post has been edited more than once, the form software displays the date and time of the last edit and indicates the number of times the post was edited.

6. The RepRap forums were (and still are) linked from the main page of RepRap.org with discussion threads organized into various different forums, organized by subject, allowing

users to browse based on general topics of interest. A notation at the top of each discussion thread identifies the forum that it was posted into. Additionally, the forums were (and still are) fully keyword searchable, allowing users to search for and readily identify relevant discussion threads. The search functionality allowed users to search for posts based on the author, the headings and the content of the posts.

7. Exhibit A is a true and correct copy of a discussion thread on the RepRap.org forum titled "Genetic Algorithms." I have personally accessed the discussion thread at https://reprap.org/forum/read.php?1,20208,page=1 and confirmed that it matches Exhibit A. The first eight posts in this thread have been publicly available, in the form they appear in Exhibit A, since January 11, 2009. The last post in this thread has been publicly available, in the form it appears in Exhibit A, since January 15, 2009. Interested members of the public would have been able to locate the discussion thread by clicking through to the relevant forum or through keyword searching based on the relevant terms that appear in this thread. In the relevant time, we had many regular readers who would have seen, and likely read, the discussion thread when it was posted and as additional posts were added.

8. Exhibits B-1 to B-4 are true and correct copies from Wayback Machine during December, 2008. I have personally accessed the records at https://web.archive.org/web/20081216112729/http://www.reprap.org/bin/view/Main/WebHome and confirmed that the records match Exhibits B1 to B4. Together, Exhibits B1 to B4 demonstrate an example of how one would navigate from RepRap.org to a post in a forum that would have contained the thread from Exhibit A. As annotated below, a user can click the "User Forums" link on the left panel of Exhibit B-1 (main page) to enter the listing of available forums.

The Wayback Machine - https://web.archive.org/web/20081216112729/http://www.reprap.org:80/bin/view/Main/...

RepRap "Wealth without money..." Jump:

RepRap Home
What can it make?
One page description
Future Plans
Main Blog

Documentation
Make your own RepRap
Using your RepRap
Software
Obtaining Parts
RepStrap machines
Videos / Movies

Community
User Forums
Builder's Wiki
Builder's Blog
Object Library
The People
World RepRap map
Related Sites

Background
Press
Philosophy
Acknowledgments
T-shirts, mugs etc.
GPL Licence

Support this project

Edit Attach Printable Main.WebHome r1.161 - 12 Dec 2008 - 16:12 - AdrianBowyer topic end

RepRap machine makes beer! See the main and builders' blogs for more news.

sale of replicated machine

Wade Bortz writes: Thanks to all the awesome work of the entire RepRap team, I sold my first set of second generation RepRap parts today, for the grand sum of one case of Upper Canada Dark Ale! Here's the shot - the proud new owners of the RepRap parts are (left to right) Liav Koren and Michael Bartosik, of Toronto, Ontario, Canada. I'm on the right, proudly clutching my well earned case of beer!
30 November 2008

"Think of RepRap as a China on your desktop."
- Chris DiBona, Open Source Programs Manager, Google Inc., 8 April 2008.

"The promise of advanced fabrication technology that can copy itself is a truly remarkable concept with far reaching implications."
- Sir James Dyson, 17 April 2007.

"[RepRap] has been called the invention that will bring down global capitalism, start a second industrial revolution and save the environment..."
- The front page of The Guardian, November 25, 2006.

Exhibit B-1 (main page cropped)

9. Exhibit B-2 shows the listing of all forums after the clicking on the "User Forums" link in Exhibit B-1. For each forum, the listing identifies the number of threads in each forum (in the "Threads" column), the number of posts in each forum (in the "Posts" column) and a date identifying the latest post in the forum (in the "Last Post" column). This information was automatically populated by the forum software, so it was automatically kept up to date. The "RSS" link under each forum allowed users to subscribe to push feeds of the new posts using the Really Simple Syndication web feed format that was popular in this timeframe. The interface also provides a search button on the top panel to allow the user to search. The user can choose a

specific forum by clicking on the corresponding link. For example, a user can click the "Mechanics" forum, as annotated below.

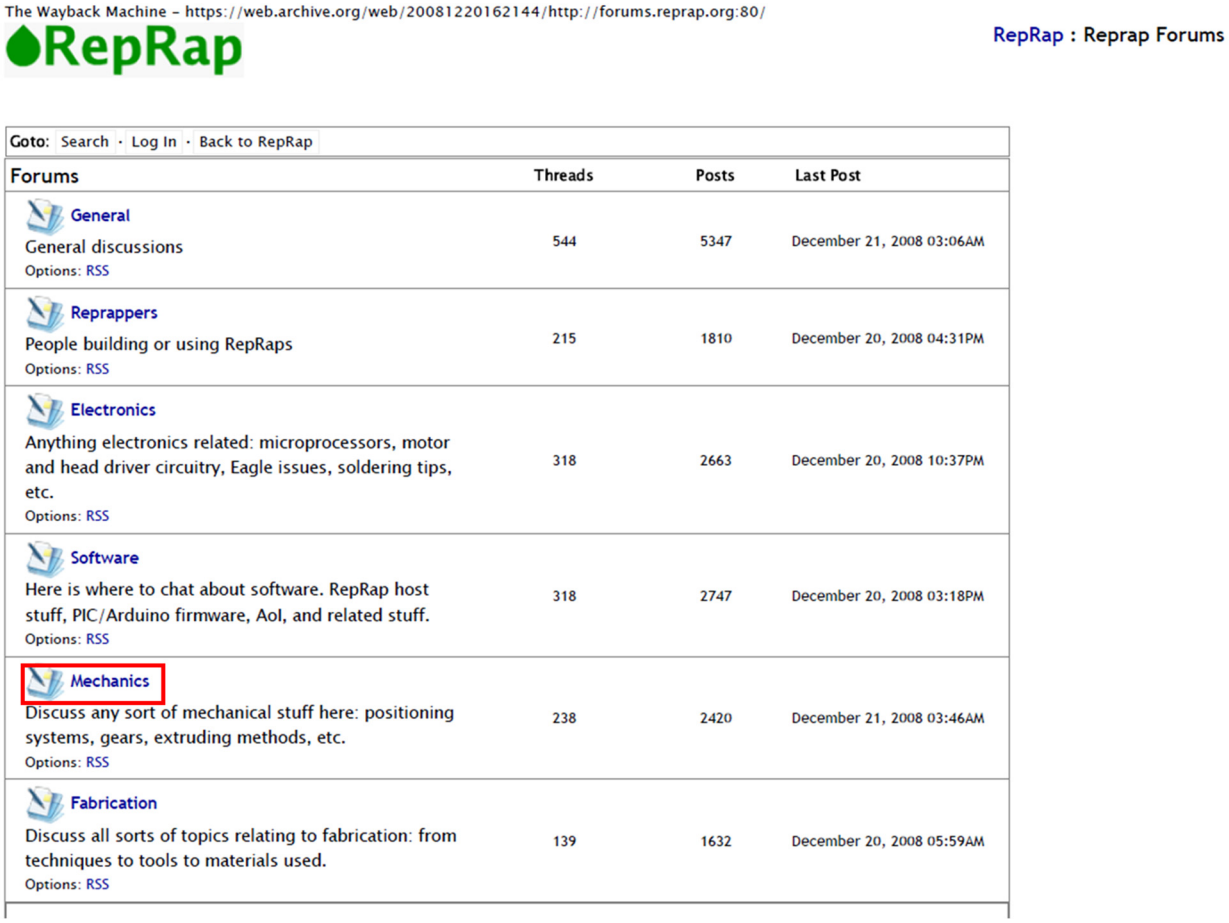


Exhibit B-2 (forums with search button)

10. Exhibit B-3 shows the listing of all discussion threads after clicking on the "Mechanics" forum in Exhibit B-2. At the time of this Wayback Machine crawl, there were multiple pages of discussion threads in the Mechanics and other forums that one could click through to access and read. The forum software automatically listed the discussion threads within a forum by thread title and ordered them in chronological order based on the last post in each discussion thread. The forum software would have listed the thread in Exhibit A first in its specific forum both when the thread was initially posted and each time a post was posted to the

thread. By automatically promoting active threads, interested users and members of the public had multiple opportunities to see, read and potentially post to each discussion thread. Although Exhibit B-3 shows the Mechanics forum, the forum software works the same for the other forums. Thus, they are similarly organized.

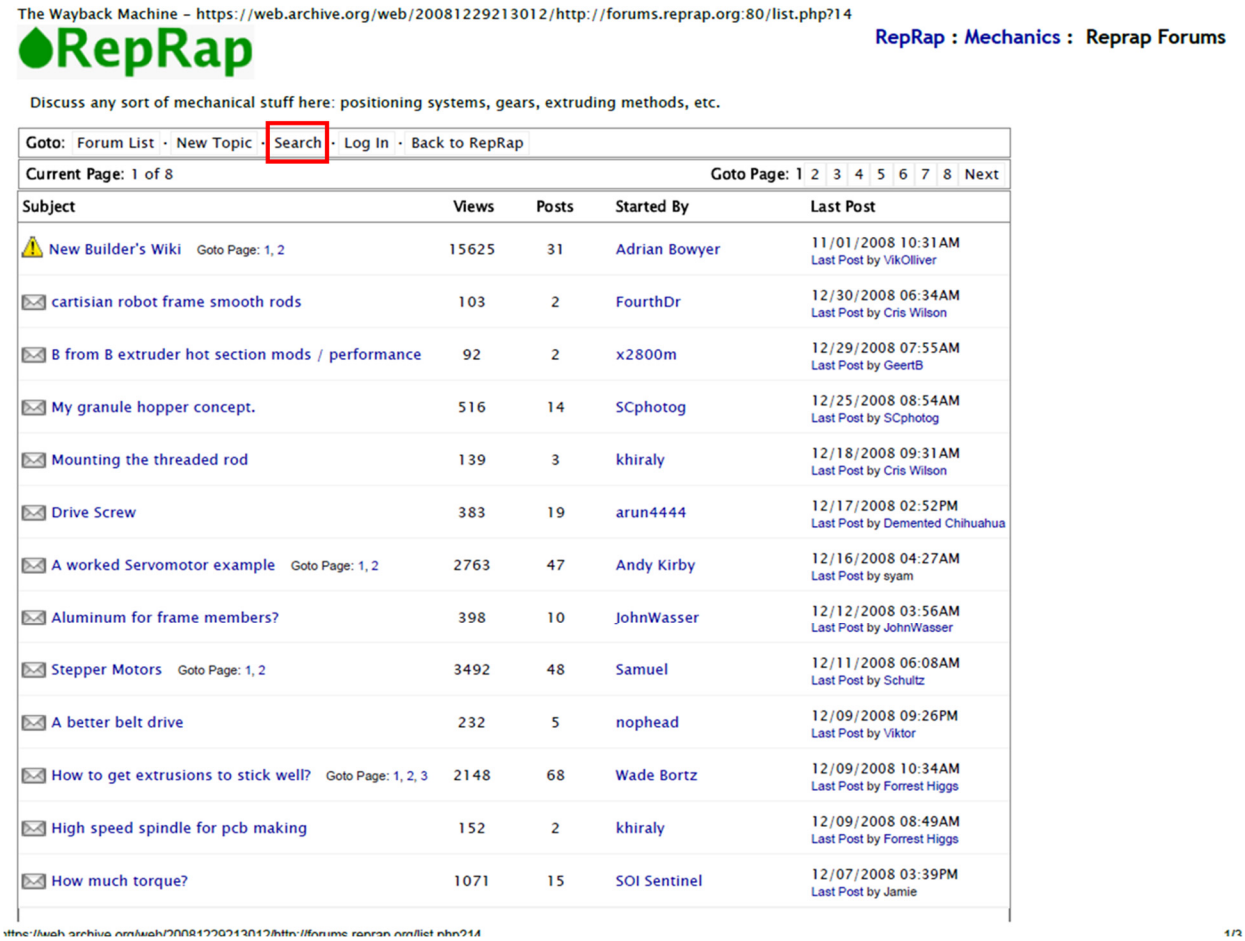


Exhibit B-3 (the "Mechanics" forum with search button)

11. As shown above, the interface from Exhibit B-3 also provides a search button on the top panel. This search button exists for each forum in the same location. When a user clicks the search button, the user will see the search interface of Exhibit 4. As shown below, a user can click the search button and then search all forums or specific forums based on keywords and author's user name. This search function was available to registered users and unregistered users

alike. The forum software automatically indexed, for searching, the entire text of the posts and user names contemporaneously with the postings. Thus, a post to a forum would be searchable within a day.

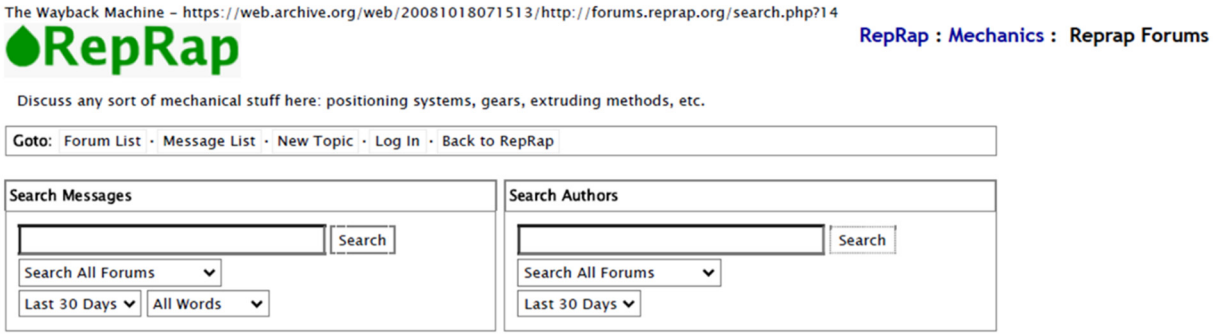


Exhibit B-4 (the search interface)

12. In this manner, each discussion thread, such as the one shown in Exhibit A, can be searched and accessed.

13. I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code.

By: */Adrian Bowyer/*
Adrian Bowyer

Date: _6/1/25_____

Exhibit A

Welcome! Log In Create A New Profile

RepRap Wiki IRC Magazine

Home > General > Topic

Genetic Algorithms

Search
Advanced

Posted by vbgraphix

Forum List Message List New Topic

vbgraphix
Genetic Algorithms
January 11, 2009 04:35AM

Registered: 15 years ago
Posts: 8

I'm wondering what applications Genetic Algorithms could have in improving RepRap.

It shouldn't be too hard to use software-based optimizers that can improve our circuits, designs, etc.

Thoughts?

Reply Quote

nophead
Re: Genetic Algorithms
January 11, 2009 05:38AM

Admin
Registered: 17 years ago
Posts: 7,881

I doubt software could improve the design any better than 1000's of people making Repraps and tweaking the design as they go. That is really gathering momentum this year. It is like genetic evolution in so much as the best design aspects survive and the things that don't work get dropped but the mutations are not random, they are hopefully intelligent design.

[www.hydraraptor.blogspot.com]

Reply Quote

Forrest Higgs
Re: Genetic Algorithms
January 11, 2009 08:45AM

Admin
Registered: 17 years ago
Posts: 1,915

I've written genetic algorithms in my day job in years past. The question isn't one of whether they could improve outcomes. They definitely could. The question is more one of who wants to invest the man-hours to apply the method to these particular applications. It's not something I have time for.

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

nophead

Re: Genetic Algorithms
January 11, 2009 08:50AM

Admin
Registered: 17 years ago
Posts: 7,881

Plus somebody would have to be a slave to the genetic software, building and testing the variants, unless the software had a brilliant physics simulator in it. As most of the random mutations would be no hope dead ends it would be a lot of work, most of it pointless.

[www.hydraraptor.blogspot.com]

Reply Quote

Forrest Higgs

Re: Genetic Algorithms
January 11, 2009 08:54AM

Admin
Registered: 17 years ago
Posts: 1,915

>
>unless the software had a brilliant physics simulator in it.
>
Yeah, I should have mentioned that bit. Unless you have an evaluation function, you can't have genetic algorithms. I don't think that we have any that can be reduced to pseudocode.

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

Batist

Re: Genetic Algorithms
January 11, 2009 09:24AM

Registered: 16 years ago
Posts: 32

There are some brilliant physics simulators available...
For example [www.bulletphysics.com] (C++ & Java)
Or [www.ode.org] (C++)

However, it doesn't solve the evaluation function problem...

[www.coded.be]

Reply Quote

nophead

Re: Genetic Algorithms
January 11, 2009 09:34AM

Admin
Registered: 17 years ago
Posts: 7,881

They might be brilliant but I would be very surprised if you could input a 3D model including its materials and simulate the extruder building an object, predicting all the defects like stringing and warping and working out how long it would take for things to wear out. Sounds like science fiction to me.

[www.hydraraptor.blogspot.com]

Reply Quote

Forrest Higgs

Re: Genetic Algorithms
January 11, 2009 09:38AM

Admin
Registered: 17 years ago
Posts: 1,915

There have been some very science fictiony things done with genetic algorithms. I've done one or two. I fear, though, that the app proposed here is simply too fuzzily defined to yield useful results.

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

Samuel

Re: Genetic Algorithms
January 12, 2009 06:45PM

Registered: 17 years ago
Posts: 82

I'd be interested in hearing about your experiences with GA, Forrest. Unfortunately, it probably isn't related enough to reprap to post here. Got any better ideas?

On a more topic related note: Yes, the extruder physics stuff would be hard to do with GA, but the suggestion about circuit boards would be more approachable.

Maybe you could use it to come up with a better slicing/filling algorithm for the software, or use GA to design better corner brackets that use less material, but are just as strong. That should be possible to simulate without a fancy filament warping function.

Do you think any of those physics sims could tell us how far apart our fill threads can be without sagging too much? Saving on material and build time is certainly a worthy goal, even without achieving higher accuracy in model shape.

Reply Quote

VDX

Re: Genetic Algorithms
January 13, 2009 03:25AM

Admin
Registered: 17 years ago
Posts: 13,988

Hi Forrest,

actual working GA-samples would be interesting for me too.

20 years ago i made some 'traveling salesmen'-optimisation with a neural-network-chain for CNC-drilling PCB's on my Atari-ST and hoped to develop a 'self-trained' perfect 3D-CNC-controller, but then my diploma examinations went hot and i somehow lost contact ...

Viktor

Reply Quote

Forrest Higgs

Re: Genetic Algorithms
January 13, 2009 07:34AM

Admin
Registered: 17 years ago
Posts: 1,915

I doubt that my GA samples would be of much use to the effort contemplated. The major effort I undertook was to simulate heritable IQ drift over several centuries in traditionalRussian Jewish Shtetl and Nguni kraals.

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

VDX

Re: Genetic Algorithms
January 13, 2009 07:40AM

Admin
Registered: 17 years ago
Posts: 13,988

... aiii

By the way ... could you prove true the effect of IQ-multiplying when two long time separated genetic lines recombine?

Viktor

Reply Quote

Forrest Higgs

Re: Genetic Algorithms
January 13, 2009 10:19AM

Admin
Registered: 17 years ago
Posts: 1,915

VDX Wrote:

> ... aiii
>
> By the way ... could you prove true the effect of
> IQ-multiplying when two long time separated
> genetic lines recombine?
>
I'd need a clearer statement of the proposition that I think that you are making. Got any prior art or links you can point me at?

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

VDX

Re: Genetic Algorithms
January 13, 2009 10:49AM

Admin
Registered: 17 years ago
Posts: 13,988

Hi Forrest,

... no links ... i read this somewhere and was interested if it's true that crossbreeded animals (or people too) between long time separated genetic lines are significantly shrewder than their parents

Viktor

Reply Quote

Nil Einne

Re: Genetic Algorithms
January 13, 2009 11:08AM

Registered: 16 years ago
Posts: 84

Your thinking of hybrid vigour [en.wikipedia.org] . However it's not really applicable here since it's most evident when the parents are highly inbred, usually in artifical selection cases where people have been inbreeding the plants/animals for years. I doubt any of the RepRap stuff qualifies and in any case, to work you'd need to actually have some sort of genetic algorythm at work in the background which we don't. Taking the best features from each model out there is not the same thing (even if it may be a good strategy.)

Also whether it has any real application to humans is also quite controversial. Sure if you're talking about highly inbred populations outbreeding has clear advantages but it may not make so much difference with humans since despite what the KKK et al want us to believe humans are actually a (mostly) incredibly mixed population.

Edited 1 time(s). Last edit at 01/13/2009 11:09AM by Nil Einne.

Reply Quote

Forrest Higgs

Re: Genetic Algorithms
January 13, 2009 11:44AM

Admin
Registered: 17 years ago
Posts: 1,915

With generational genetic drift in a more or less homogeneous population you have some fairly well-understood statistical mechanisms. The most usual one you see says that the IQ of children of a couple will fall within a fairly narrow distribution curve the mean of which can be taken to be the average of the parents' respective IQ's.

I modeled two situations, the first was a Jewish Shtetl in which bright males were identified quite early in life and encouraged to undertake rabbinic studies. Socially, such males, on completing their studies were considered prized marriage material by the Shtetl and pretty much had their pick of eligible young women. The rabbi's family was also expected to be large and the children thereof were similarly considered to be prized marriage material.

The question that I posed was one of accepting this social mechanism for encouraging bright males to have large families who were married back into the community, how long would it take for the mean IQ of the Stetl to exhibit the 10 point IQ advantage that Jewish populations consistently show over other european populations. The answer came out to about 250 years. I ran about a dozen variations on the scenario and found that the time frame only deviated from 250 years by about +/-20 to 30 years.

Against that I modeled a the marriage and child rearing customs common in southern African Nguni kraal where families accumulate capital over generations and the family patriarch is able to purchase multiple wives which aid him in capital accumulation. My genetic models of that mechanism typically showed an extremely gentle downward drift of population IQ. The drift that I detected was so small that I wouldn't vouch for it even existing. The IQ drift for Jewish Shtetl, however, was very pronounced and much stronger than I would have guessed before the modeling exercise.

The problem with the crossbreeding, as it were, of human populations with respect to IQ is that most of the information that we have comes from the 20th century. During that period the Flynn Effect complicates separating out IQ drift resulting from other factors.

Someday, if I am spared for long enough, I hope to revisit that exploration and maybe get a handle on why the Flynn Effect set off the massive upwards IQ drift that it did in the 20th century in the industrialised world. Knowing the hows and whys of the Flynn Effect would be VERY interesting. ☺

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

Forrest Higgs

Re: Genetic Algorithms
January 13, 2009 11:54AM

Admin
Registered: 17 years ago
Posts: 1,915

Nil Einne Wrote:

>
> Also whether it has any real application to humans
> is also quite controversial. Sure if you're
> talking about highly inbred populations
> outbreeding has clear advantages but it may not
> make so much difference with humans since despite
> what the KKK et al want us to believe humans are
> actually a (mostly) incredibly mixed population.
>
DNA surveys consistently indicate that genetic variation amongst humans not originating from subSaharan Africa is extremely slight, less by several magnitudes for all five billion of us than what you'd encounter in the average Chimpanzee troop.

Not to put too fine a point on it, we're (the Euroasians amongst us, that is) are as inbred as a bunch of rough collies. That could go a long way towards explaining the average 30 point

difference between Euroasian and subsaharan African populations. Genetically, subSaharan Africans are humanity's root stock, to use a good horticultural term. Most of humanity's DNA variation is found amongst those who never left Africa. We should guard that treasure house of DNA very carefully. You never know when we might really, really need it.

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

Nil Einne

Re: Genetic Algorithms
January 13, 2009 03:29PM

Registered: 16 years ago
Posts: 84

Forrest Higgs Wrote:

> DNA surveys consistently indicate that genetic
> variation amongst humans not originating from
> subSaharan Africa is extremely slight, less by
> several magnitudes for all five billion of us than
> what you'd encounter in the average Chimpanzee
> troop.

But that's precisely my point. Given the low variation and the fact that what variation does exist has been shown to be not strongly linked to the concept of race, it doesn't make sense that hybrid vigiour would be observed. The simple fact is, as much as certain groups would like to claim otherwise, there is no such thing (generally speaking) as all these pure races that shouldn't mix. In fact, most of what we think as races don't really exist on a genetic level. So it's unlikely your going to get hybrid vigour and mixing or not doesn't really matter since by and large, humans are already mixed.

> Not to put too fine a point on it, we're (the
> Euroasians amongst us, that is) are as inbred as a
> bunch of rough collies. That could go a long way
> towards explaining the average 30 point difference
> between Euroasian and subsaharan African
> populations. Genetically, subSaharan Africans are
> humanity's root stock, to use a good horticultural
> term. Most of humanity's DNA variation is found
> amongst those who never left Africa. We should
> guard that treasure house of DNA very carefully.
> You never know when we might really, really need
> it.

Reply Quote

Nil Einne

Re: Genetic Algorithms
January 13, 2009 04:13PM

Registered: 16 years ago
Posts: 84

Forrest Higgs Wrote:

> With generational genetic drift in a more or less
> homogeneous population you have some fairly
> well-understood statistical mechanisms. The most
> usual one you see says that the IQ of children of
> a couple will fall within a fairly narrow
> distribution curve the mean of which can be taken
> to be the average of the parents' respective
> IQ's.
>
> I modeled two situations, the first was a Jewish
> Shtetl in which bright males were identified quite
> early in life and encouraged to undertake rabbinic
> studies. Socially, such males, on completing
> their studies were considered prized marriage
> material by the Shtetl and pretty much had their
> pick of eligible young women. The rabbi's family
> was also expected to be large and the children
> thereof were similarly considered to be prized
> marriage material.
>
> The question that I posed was one of accepting
> this social mechanism for encouraging bright males
> to have large families who were married back into
> the community, how long would it take for the mean
> IQ of the Stetl to exhibit the 10 point IQ
> advantage that Jewish populations consistently
> show over other european populations. The answer
> came out to about 250 years. I ran about a dozen
> variations on the scenario and found that the time
> frame only deviated from 250 years by about +/-20
> to 30 years.

I would like to know how you came out with those figures. The genetic basis for IQ is rather poorly understood. There is definitely an inherited component but how large it is remains an open question. Even if it's true "IQ of children of a couple will fall within a fairly narrow distribution curve the mean of which can be taken to be the average of the parents' respective IQ's" which I'm somewhat doubtful (most studies I've seen suggest the correlation with parental IQ is far from clear) this doesn't prove a genetic basis since amongst other things contrary to what some people claim, IQ isn't purely inate. Of course, if the correlation is there, it's possible/likely? it would increase whatever the cause but I would suggest that's far from certain.

For that matter, IQ is poorly understood. All it actually measures is your ability to do IQ tests. There appears to be some correlation with what we call 'intelligence' but it's at best only a loose one.

Also it doesn't sound to me like you study considered the IQ of the female partner. The fact that the male had the pick doesn't mean they choose the ones with the higher IQ. It's easily possible to imagine that they choose the ones with the IQ 10 points lower on average therefore likely cancelling out any advantage their higher IQ had presuming your theory of IQs holds true. Also, even though their children could may have been high up in the social scale, having large families means you can afford to devote less attention/resources to the children you have. For humans, having large families is not necessarily the most effective evolutionary strategy. It could easily lead to a lower IQ of the children and a lower chance of evolutionary success of the children which the social (and genetic?) advantage they have due to their parents may not be enough to make up for.

Indeed there are other factors to consider. Just because the parents are encouraged to have more children doesn't mean they do or are able to. It may be that the high IQ is correlated with other factors which reduce evolutionary success. For example, if the Father is more likely to die young. Or for that matter beyond having more children is less able to raise the children effectively. Indeed even social factors could come into play. Does the increase pressure on the father to perform according to societal expectations lead to a lower median age at death or negatively effect the way they raise their children?

Bringing the female into it again, regardless of the fact the father has the pick of the crop or the IQ of the female they select, there's no guarantee they will select the most evolutionarily successful females. Given the societal factors at play, it's possible that the females they pick are not the best choice. Perhaps for example, the females are more prone to infidelity (whose effect is going to be even more difficult to quantify) or has similar problems to those I raise for the father.

Of course sexual selection will likely come into play. The fact that they choose the females and they had the pick of the crop means that whatever the traits they must be those considered most important amongst their community and therefore whatever inherited component of these traits that's passed to the children would give them an advantage even if they paradoxically also give them a disadvantage. (The same of course for the father.) This of course plays back into the societal edge the children have. But again, rather extra fitness component they have must be weighed against any negative effect on fitness it may also have.

BTW, I would avoid the term 'drift' when talking about evolution. Drift usually refers to genetic drift which is random and doesn't seem to be what you're referring to. It does have to be considered in any calculation of evolutionary rates though.

P.S. A bit tired so apologise if any of that didn't make sense. I think I covered the basics though. Since this is OT and not really something of great interest to me, I'll probably stop there. I have some background in biology so know calculating evolutionary rates is an extremely complicated thing. And working out how a trait will change in a certain situation even more so given the near infinite number of variables many of which can have a fairly large effect. Particularly in a beast as complicated as humans. If you haven't already, I suggest you consult an evolutionary biologist (which I'm guessing your not) preferbly one with a background in statistics/biometry who could advise you further on your calculations. I think you may not have quite understood the complexity of the calculations.
P.P.S. In case I was wrong about how far you went, were any of those calculations published in a peer-reviewed journal?

Edited 2 time(s). Last edit at 01/13/2009 04:21PM by Nil Einne.

Reply Quote

VDX

Re: Genetic Algorithms
January 13, 2009 04:32PM

Admin
Registered: 17 years ago
Posts: 13,988

... now, that's the real spirit

I found some similarities with breeding pets, cultural/social relationships between long time separated folks (eg. eastern and western europeans after breakdown of the Sowjet Union) and developing repraps/repstraps with different strategies ...

Maybe there are some significant patterns we can use for faster 'rep-volution'?

Viktor

Reply Quote

Forrest Higgs

Re: Genetic Algorithms
January 13, 2009 05:21PM

Admin
Registered: 17 years ago
Posts: 1,915

Nil Einne Wrote:

>
> There is definitely an inherited component but how large it is remains an
> open question.
>

Mostly it's a politically explosive question the possible answers to which fly in the face of a half-century of social orthodoxy.

Thank you for your review of the genetic programming project I undertook.

I mentioned the content of what I did mostly in reply to Viktor's query, not from any desire to spark a debate about IQ or the vexed IQ vs race question. After I got my PhD in 1990 I undertook a number of explorations using various techniques mostly to satisfy my own curiosity and relax. This was one of them. One of the others was slowly, painfully working my way through the proofs of Kurt G

Edited 1 time(s). Last edit at 01/13/2009 05:30PM by Forrest Higgs.

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

Samuel

Re: Genetic Algorithms
January 13, 2009 07:47PM

Registered: 17 years ago
Posts: 82

Fascinating.

How were G

Reply Quote

Forrest Higgs

Re: Genetic Algorithms
January 13, 2009 07:58PM

Admin
Registered: 17 years ago
Posts: 1,915

I used the old Nagel and Newman explication of G

Edited 1 time(s). Last edit at 01/13/2009 11:41PM by Forrest Higgs.

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

Colecoman1982

Re: Genetic Algorithms
January 14, 2009 01:47PM

Hi,

On the topic of applying GA (or, more generally, self-learning iterative algorithms) to reprap, my suggestion is that is might be more feasible than you think. You don

Reply Quote

Forrest Higgs

Admin

Re: Genetic Algorithms
January 14, 2009 02:53PM

Registered: 17 years ago
Posts: 1,915

Colecoman: The problem with that approach is that it presumes a very high rate of interactive dataflow between the PC and the reprap machine. That's not happening at the present time. Right now, reprap machines are either stand alone or more or less peripherals to your PC.

Hell, there are no rules here - we're trying to accomplish something.

Opportunity is missed by most people because it is dressed in overalls and looks like work.

Thomas A. Edison

Reply Quote

vbgraphix

Re: Genetic Algorithms
January 14, 2009 03:34PM

Registered: 15 years ago
Posts: 8

I really love the camera idea. Though, scanning may not require anything as complex as a camera. A camera might bring the cost up too much. A simple light detector or laser of some sort may do the trick.

As for data flow, it shouldn't be too hard to hack together a bunch of open source monitoring devices to record data like temperature, speed, vibration, etc. I think that would be a very constructive thing to do.

Reply Quote

Wade

Re: Genetic Algorithms
January 14, 2009 04:10PM

Registered: 16 years ago
Posts: 536

Hm, I don't look forward to trying to code up a vision system from scratch....

but, an accelerometer on the write head might be useful. Keep an eye on the RMS power of the vibration the head experiences; that might be able to detect the next time I have an all-night long series of head collisions due to a bad programming job.

A strain gauge on the extruder mount would do that as well, and it could do a few other things as well, like finding the bed height automatically. Could take some time though.

Wade

Reply Quote

Mr. Seeker

Re: Genetic Algorithms
January 14, 2009 05:02PM

Registered: 16 years ago
Posts: 96

Wade Wrote:

> but, an accelerometer on the write head might be
> useful. Keep an eye on the RMS power of the
> vibration the head experiences; that might be able
> to detect the next time I have an all-night long
> series of head collisions due to a bad programming
> job.

Why dont you get a shock absorber? Foam works pretty well for this kind of problems ☺

The accelerometer wont be very useful if you have lots of vibration because when you want to fill a gap quickly, the "vibrations" will shut the machine off. Try to look at [forums.parallax.com] from parallax, there is shown how their X-Y accelerator works.

Also thinking about the strain gauge... You could also use it to calibrate the Z-axis, but its also possible with IR or ultrasonic sensors... Or in the case of "money is not a problem" a webcam?

Edited 2 time(s). Last edit at 01/14/2009 05:15PM by Mr. Seeker.

Reply Quote

Wade

Re: Genetic Algorithms
January 14, 2009 05:29PM

Registered: 16 years ago
Posts: 536

Well, I figured that the rms power of the vibration will be much higher for stuck head situation, where the stepper is jumping steps at high speed. It's certainly noisy as hell when it happens! Should be easy to set a limit that will pass a zig zag path, but fail multiple head collisions. A single head collision would be more difficult to detect without a strain gauge.

I prefer the Analog Devices ADXL series, but I haven't used them for a few years. Even so, my webcam only cost me $10 new; I'd be hard pressed to put together an accelerometer monitoring system for less than that. Still, it could be fun.

I wonder, does anyone make a sort of instrumented bolt for a reasonable price? The extruder mount could use a pair of bolts with strain gauges, and you could watch the change in bolt tension when you run into something. Probably cost as much as the RepRap. ☺

Wade

edit - the neat thing about strain gauge vs optical measurements is that the strain gauge will tell you how much your extruder has elongated due to heating, warping, or in my special case, catastrophic failure.

Edited 1 time(s). Last edit at 01/14/2009 05:31PM by Wade Bortz.

Reply Quote

VDX

Re: Genetic Algorithms
January 15, 2009 03:30AM

Admin
Registered: 17 years ago
Posts: 13,988

... the camera could do a better scanning job when treating with photogrammetry - take two picrures from different positions and calculate the displacement of some relevant edges or previous placed colour-dots ...

Even GA or NeuralNetwork-simulation could help a lot - i knew someone who built high-speed-3D-scanners with two cameras that acts like the human brain with image-recognition ... extremely fast, super precise but extremely expensive too

Maybe an open source approach and some clever people can do the same?

Viktor

Reply Quote

Newer Topic Older Topic Page 1 of 2 **Pages: 1 2**

Print View RSS

Sorry, only registered users may post in this forum.

Click here to login

This forum is powered by Phorum.

Welcome! Log In Create A New Profile

RepRap Wiki IRC Magazine

Home > General > Topic > Page 2

Genetic Algorithms

Search
Advanced

Posted by vbgraphix

Forum List Message List New Topic

Larry_Pfeffer

Re: Genetic Algorithms (now instrumented bolts/load cells)
January 15, 2009 07:37AM

Registered: 16 years ago
Posts: 251

Wade Wrote:

> I wonder, does anyone make a sort of instrumented
> bolt for a reasonable price? The extruder mount
> could use a pair of bolts with strain gauges, and
> you could watch the change in bolt tension when
> you run into something. Probably cost as much as
> the RepRap. ☺

Wade, et al,

If we had such a sensor (crash/no-crash), how would it be used? Stop everything and wait for help? Or is some more complicated, automatic recovery envisioned?

Generally, strain gauges (particularly applying them) is labor intensive (read fussy work) and in consequence usually not cheap. The signals from foil strain gauges are small, so one needs high amplification (with low time & thermal drift) to get a usable signal.

Metals have much lower failure strains (order of 1e-3) than plastics (10 -- 1000x as a WAG), so instrumenting a plastic "bolt" or other structure would be easier -- except that plastics are terrible heat conductors, and have much higher thermal coefficients of expansion, which makes it difficult to match coefficients, such that one can measure mechanically-induced strain, separately. Plastics generally creep, if you strain them long and hard. And some are virtually impossible to glue strain gauges (or anything else!) to them.

However, there may be a way to skin this cat.... I did some preliminary experiments (read, played around with) some conductive-plastic fiber I got a sample of, and it serves as a pretty good strain gage, and well matched to plastic, because it is plastic. Since it has high intrinsic resistance (compared to foil gauges), it develops a larger signal, with minimal resistive heating.
(The mfgr. didn't seem very interested in this aspect -- may have been too far out of their area of expertise....)

Typically, bolts aren't the best shape for instrumenting, even if one turns down the thread for a flat surface (and smaller section to increase the strain) because bolts are usually strained mainly in tension. Load-cell structures are typically designed to strain the instrumented areas in bending, torsion (or sometimes shear), to get us usably large strains. I don't have a darwin, and I'm a bit hazy on the attachment of the extruder to the cartBot. If you (or anybody else) can post some photos (or sketch w/dimensions) of the attachment, I might be able to come up with a mod that'd serve as a load-cell structure and try putting some of my "strain gauges" on it.

I know we'd *like* three forces and three moments, resolved about a common point, e.g. the extruder tip. However, a 6-DOF load cell is usually a complicated (hard to machine) structure, and usually needs 6 -- 8 pairs of gauges.
Can folks with extruding experience suggest what the minimum set of forces/torques would be?
And what part of the reprap usually hits things, the tip, or someplace else?

Larry Pfeffer,

My blog about building repstrap Cerberus:
[repstrap-cerberus.blogspot.com]

Reply Quote

freds

Registered: 16 years ago
Posts: 300

Re: Genetic Algorithms (force Sensor)
January 15, 2009 09:18AM

Here's a force sensor that should be fairly easy for use to use in our environment.

[www.hvwtech.com]

Reply Quote

Colecoman1982

Re: Genetic Algorithms
January 15, 2009 11:22AM

@Forrest: A high data rate between reprap and PC shouldn't be necessary. What I was envisioning was more of an auto-calibration process done as a pre-process before printing. Basically, the rerap would print a simple test pattern, use the imaging system to measure the accuracy of the pattern, modify it's print parameters based on the image information, and then repeat the process until calibrated. This would save the need for someone to hand-adjust the each reprap/repstrap for temperature, flow rate, and slop/backlash in the support frame/stepper motors. If done well, it could even prove to be more efficient at it than all but the best human operators (similar to how ABS breaks, in cars, can react better than is possible with human reflexes). This strikes me as an important feature to have in Reprap if the project is to ever allow for mass distribution as most people you are looking to distribute to won't have a fraction of the mechanical aptitude you guys have.

As for the 3d scanning feature, that might be slower due to direct control of the print head from the

computer but shouldn't be all that time consuming based on the DIY 3d scanning algorithms I've seen posted online.

@Wade: True, recreating a computer vision library from scratch would be difficult, but there might be some open source resources that might speed the process up such as the open source OpenCV library released by Intel and a similar library released by Nvidia (the name, of which, escapes me at the moment).

The primary advantage I see in a webcam, as opposed to accelerometers or strain gauges, is price. Cheap webcams can be had for as low as ~$10 (though I don't necessarily suggest going for the absolute cheapest ones). The resolution and color quality won't be the best, but moving the print head closer to the target can get around resolution and color quality doesn't matter as much since most computer vision calculation are done in black and white anyway.

-Shawn

Reply Quote

Larry_Pfeffer

Registered: 16 years ago
Posts: 251

Re: Genetic Algorithms
January 15, 2009 11:28AM

Wade Wrote:

>
> I wonder, does anyone make a sort of instrumented
> bolt for a reasonable price? The extruder mount
> could use a pair of bolts with strain gauges, and
> you could watch the change in bolt tension when
> you run into something. Probably cost as much as
> the RepRap. ☺

If all that's wanted is a (binary) crash sensor, then a simpler approach (than strain gauges or accelerometers) might be a springs & contacts approach, similar to what's commonly used (in a steering wheel) to sound the horn, no mater where you press on it.

Larry Pfeffer,

My blog about building repstrap Cerberus:
[repstrap-cerberus.blogspot.com]

Reply Quote

Wade

Registered: 16 years ago
Posts: 536

Re: Genetic Algorithms (now instrumented bolts/load cells)
January 15, 2009 10:32PM

I'm more interested in closing the loop on extruder height control - I'd like to know exactly how high my extruder head is above the bed, as height changes of 0.1 mm make significant differences in raft and part adhesion. My current method is on the crude side. The PTFE length changes with temperature, and time, and sometimes the frame itself warps over time, so I'd like to measure the important variable - nozzle to bed height - directly.

Collision detection is a nice side affect; I'd have the machine shut down and flag me if it happens, as opposed to breaking something. Right now I have the Arduino shut everything off, print an error message to the serial port and go into an infinite while loop when something really bad happens, like a thermocouple malfunction. That saved my machine once already.

That IESP-12 force sensor is priced right at $7, but I'm a little skittish about the "estimate" language in the datasheet. It doesn't sound like it works well over long periods of time under force though, which could be bad in our setup if it's always measuring the weight of the extruder.

A metal bar with some strain gauges could work too, but the heat flow from the extruder might mess with things.

In general, this sounds like a little more fun that I'm interested in at the moment. And no, this has nothing to do with genetic algorithms, sorry.

Wade

Edited 1 time(s). Last edit at 01/15/2009 10:38PM by Wade Bortz.

Reply Quote

freds

Re: Genetic Algorithms (now instrumented bolts/load cells)
January 15, 2009 11:42PM

Registered: 16 years ago
Posts: 300

Wade Wrote:

>
> That IESP-12 force sensor is priced right at $7,
> but I'm a little skittish about the "estimate"
> language in the datasheet. It doesn't sound like
> it works well over long periods of time under
> force though, which could be bad in our setup if
> it's always measuring the weight of the extruder.
>
> Wade

Hi Wade

My idea was that it would measure upwards pressure from a calibration touch down or abort if it had run into the bed.

It could also be used for a calibration cycle where you touch down on the four corners of the bed or the maximum build area to check for alignment or height of Z; which in IMHO is the measurement

that can be the most variable.

The other idea that I had was measuring contact force for a stencil cutting blade or drawing pen to get more uses out of the bot.

As a stencil cutter it could cut logos, labels, paper or PCB exposure or silk screen masks; other capabilitys to show off why we are into this 3D stuff.

Since it is variable resistance it could interface to one of the analog ports for the Sanguino in place of the second extruder which no one has really done yet.

Though if you still wanted to have a second extruder you could do away with the separate Z-enable (tie it to X & Y enable for a generic stepper motor/movement enable) and then devote that pin to Z contact pressure.

You know that

Edited 3 time(s). Last edit at 01/15/2009 11:48PM by freds.

Reply Quote

Wade

Re: Genetic Algorithms
January 16, 2009 12:04AM

Registered: 16 years ago
Posts: 536

The upward pressure is the same thing general idea, but if you've got it truly not touching the sensor (as that datasheet reccomends), then you've got a certain amount of backlash to take up before the sensor registers, which would prevent me from knowing exactly when the head touches, which is what I'm really interested in. There's fair amount of give in the entire system when you're looking at scales of less than a mm, so I was thinking a constant measurement of the force on the head (including it's weight) would be useful. That points more towards strain gauges.

Yeah, the 4 corners calibration was what I was thinking as well. It could also pick up on a tangled plastic filament feed, which has wrecked a few builds of mine in the past as well. That would probably just trigger the head collision detection, due to the upward force on the extruder.

Mostly I just squint at the webcam feed every few hours and try and deduce if something bad has happened. ☺

Wade

Reply Quote

Enrique

Re: Genetic Algorithms
January 16, 2009 02:44AM

Registered: 16 years ago
Posts: 213

A cheap bump sensor is described on instructables at:
[www.instructables.com]

Basically, stick a metal rod through a pipette extending out a bit, put a spring around the pipette extending also, and check for continuity. For the reprap, the spring & rod would be pointing upward, like a car antenna, and whenever the nozzle bumped into something, as long as the acceleration was high enough, the spring would then bend and bump into the rod. The continuity would trigger the switch circuit:
[www.instructables.com]

and a signal would be sent to the Arduino to shut down.

If the sensor trips in regular operation, the spring would be trimmed bit by bit, until it doesn't quite trigger during operation.

In that bump sensor, the red wire is connected to the middle of the spring, but I think it would be better to connect it at the base of the spring.

Reply Quote

Mr. Seeker

Registered: 16 years ago
Posts: 96

Re: Genetic Algorithms
January 16, 2009 03:59AM

What is also possible is just having a long thin rod in the middle of a tube. When the rod touches the tube, the IO goes zero...

Same principal, different layout.

Reply Quote

BeagleFury

Re: Genetic Algorithms
January 16, 2009 10:17AM

Another option to detecting height might be to use several hall effect sensors embedded at strategic locations in the print table, and a magnet on the print head?

Reply Quote

vbgraphix

Registered: 15 years ago
Posts: 8

Re: Genetic Algorithms
January 23, 2009 04:15PM

Found some cool resources:

[blog.makezine.com]

[www.cs.nyu.edu]

For those more technically inclined:

[www.cogs.susx.ac.uk]

Reply Quote

grael

Re: Genetic Algorithms
January 31, 2009 05:40PM

Registered: 15 years ago
Posts: 242

The Hybrid vigour side of GA is fascinating.
There's an interesting site:
[www.rdos.net]
Which goes over an alternative to the mitochondrial DNA evidence for the African "Eve" theory. Basically, it's saying that the "proof" was more along the lines of "absence of evidence", than "evidence of absence", and that the African emigration occured in waves. As a result, recombination of the partially specieated peoples, (probably the rape, pillage and plunder scenario), resulted in some interesting mixes in following generations. Certainly, the more competent level of inventiveness seems to have flourished from some 20,000 years back, and onward. The site points out various gene "defects" that do not appear as defects when the environment is altered to be more like some of the precursor environments. One of the interesting points made, was the speciation of kept beasts, away from the wild animals, and of the DNA changes over time that point to at least one separation/speciation period, which is far in excess of that proposed by the Out of Africa proponents.

On another site:
[www.evolutionpages.com]
is some interesting data on our critical difference from the other great apes, if I recall correctly, they have 23 chromosome pairs, and we have 22. one of our pairs appears to be a splice of two of theirs. I like to think of us as being like Win CE, the cut down version of windows.

Back on track though, I suspect GA are a little like fuzzy logic. Forest points out that to create the environment in which they would be fruitful, is a huge mission in itself. "Expert systems" are what most programs today can be defined as.

In the blood and bone world, "mother nature" practices the ultimate determinism, trialing solutions in the actual environment. In that scenario, successes are not always rewarded, and failures are not always culled.

In the reprap development environment, the determinism aspect is not so honest, with people watching the experiments, there is bound to be tampering with the results. However, sometimes people get lucky, and notice something that works, nurture it, and in time, we have a new feature, that has escaped a premature cull, for some other reason.

Tools continue to advance, and given another 10-50 years, it's certainly not inconceivable, that AI systems may have environmental sensing systems good enough to take deterministic modeling many significant steps forwards.

The human factor... As our tools advance, the disparity between their and our intelligences diminish, normally, the human race has needed people like Nicola Tesla, Leonardo Da Vinci to

lead the way. The Nicola Teslas aren't in every generation though, and so typically we've had, as a species to wait many generations for the next breakthrough/s. As our tools become more A.I like, the human factor in co-evolution is going to become more of a "flavour", than a control, you have only to look at technologies developing around us, to see the progression, and our place within the progression becoming less of masters, and more as symbionts with the machines we create.

Graham Daniel

Reply Quote

Newer Topic Older Topic Page 2 of 2 **Pages:** 1 **2**

Print View RSS

Sorry, only registered users may post in this forum.

Click here to login

This forum is powered by Phorum.

Exhibit B-1

www.reprap.org/bin/view/Main/WebHome Go NOV DEC JAN
758 captures
14 Jan 2007 - 20 Jan 2025
2007 16 2008 2010 About this capture

RepRap Home
What can I make?
One page description
Future Plans
Main Blog

Documentation
Make your own RepRap
Using your RepRap
Software
Obtaining Parts
RepStrap machines
Videos / Movies

Community
User Forums
Builder's Wiki
Builder's Blog
Object Library
The People
World RepRap map
Related Sites

Background
Press
Philosophy
Acknowledgments
T-shirts, mugs etc.
GPL Licence

Support this project

Edit Attach Printable Main.WebHome r1.161 - 12 Dec 2008 - 16:12 - AdrianBowyer topic end

RepRap machine makes beer! See the main and builders' blogs for more news.

sale of replicated machine

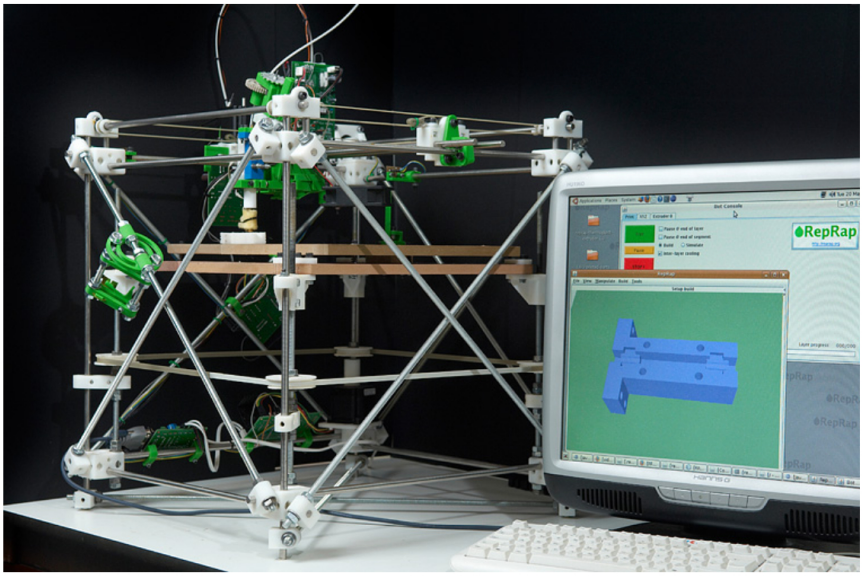
Wade Bortz writes: Thanks to all the awesome work of the entire RepRap team, I sold my first set of second generation RepRap parts today, for the grand sum of one case of Upper Canada Dark Ale! Here's the shot - the proud new owners of the RepRap parts are (left to right) Liav Koren and Michael Bartosik, of Toronto, Ontario, Canada. I'm on the right, proudly clutching my well earned case of beer!
30 November 2008

"Think of RepRap as a China on your desktop."
- Chris DiBona, Open Source Programs Manager, Google Inc., 8 April 2008.

"The promise of advanced fabrication technology that can copy itself is a truly remarkable concept with far reaching implications."
- Sir James Dyson, 17 April 2007.

"[RepRap] has been called the invention that will bring down global capitalism, start a second industrial revolution and save the environment..."
- The front page of The Guardian, November 25, 2006.

What is RepRap?



Look at your computer setup and imagine that you hooked up a 3D printer. Instead of printing on bits of paper this 3D printer makes real, robust, mechanical parts. To give you an idea of how robust, think Lego bricks and you're in the right area. You could make lots of useful stuff, but interestingly you could also make most of the parts to make another 3D printer. That would be a machine that could copy itself.

RepRap is short for Replicating Rapid-prototyper. It is the practical self-copying 3D printer shown on the right - a self-replicating machine. This 3D printer builds the parts up in layers of plastic. This technology already exists, but the cheapest commercial machine would cost you about €30,000. And it isn't even designed so that it can make itself. So what the RepRap team are doing is to develop and **to give away** the designs for a much cheaper machine with the novel capability of being able to self-copy (material costs are about €500). That way it's accessible to small communities in the developing world as well as individuals in the developed world. Following the principles of the Free Software Movement we are distributing the RepRap machine at no cost to everyone under the GNU General Public Licence. So, if you have a RepRap machine, you can use it to make another and give that one to a friend...

The RepRap project became widely known after a large press coverage in March 2005, though the idea goes back to a paper on the web written by Adrian Bowyer on 2 February 2004.

RepRap Version 1.0 "Darwin" can be built by anyone now - see the Make your own RepRap link there or on the left, and for ways to get the bits and pieces you need, see the Obtaining Parts link.

Main Web
Changes
Changes detailed
Topic list
Search

login

Replication

Adrian Bowyer (left) and Vik Olliver (right) complete replicated machine
with a parent RepRap machine, made on a conventional rapid prototyper, and the first complete working child RepRap machine, made by the RepRap on the left. The child machine made its first successful grandchild part at 14:00 hours UTC on 29 May 2008 at Bath University in the UK, a few minutes after it was assembled.

Not counting nuts and bolts RepRap can make 60% of its parts; the other parts are designed to be cheaply available everywhere. This is an interesting coincidence: we can make 60% of our proteins; the other parts are evolved to be cheaply available everywhere...

The primary goal of the RepRap project is to create and to give away a makes-useful-stuff machine that, among other things, allows its owner cheaply and easily to make another such machine for someone else.

To increase that 60%, the next version of RepRap will be able to make its own electric circuitry - a technology we have already proved experimentally - though not its electronic chips. After that we'll look to doing transistors with it, and so on...

Glossary

- RepRap - n. any free rapid prototyping machine that can manufacture a significant fraction of its own parts; v.t. (in lower case: *to reprap*) to make something in a RepRap machine.
- RepStrap - n. any free rapid prototyping machine that doesn't make its own parts, but is intended to make parts for a RepRap.
- reprapper - n. a person engaged in making or using RepRaps or RepStraps.
- reprapable - adj. capable of being made in a RepRap machine.

to top

I	Attachment	Action	Size	Date	Who	Comment
	FirstRepRapPartSale-1.jpg	manage	2701.1 K	30 Nov 2008 - 12:57	AdrianBowyer	wade sale
	FirstRepRapPartSale-1-small.jpg	manage	258.2 K	30 Nov 2008 - 12:59	AdrianBowyer	wade sale small

Edit | **Attach image or document** | **Printable version** | **Raw text** | **More topic actions**
Revisions: | r1.161 | **>** | **r1.160** | **>** | **r1.159** | **Total page history** | **Backlinks** | **Refresh**

You are here: Main > Design > WebHome

to top

Copyright © 1999-2008 by the contributing authors. All material on this collaboration platform is the property of the contributing authors.
Ideas, requests, problems regarding RepRap? Send feedback

Exhibit B-2

orums.reprap.org/ Go OCT DEC FEB
351 captures
29 Mar 2007 - 17 Jan 2025
2007 20 2008 2010 About this capture

RepRap

RepRap : Reprap Forums

Goto: Search · Log In · Back to RepRap

Forums	Threads	Posts	Last Post
General General discussions Options: RSS	544	5347	December 21, 2008 03:06AM
Reprappers People building or using RepRaps Options: RSS	215	1810	December 20, 2008 04:31PM
Electronics Anything electronics related: microprocessors, motor and head driver circuitry, Eagle issues, soldering tips, etc. Options: RSS	318	2663	December 20, 2008 10:37PM
Software Here is where to chat about software. RepRap host stuff, PIC/Arduino firmware, AoI, and related stuff. Options: RSS	318	2747	December 20, 2008 03:18PM
Mechanics Discuss any sort of mechanical stuff here: positioning systems, gears, extruding methods, etc. Options: RSS	238	2420	December 21, 2008 03:46AM
Fabrication Discuss all sorts of topics relating to fabrication: from techniques to tools to materials used. Options: RSS	139	1632	December 20, 2008 05:59AM
Developers Forum for core development team. (Current dev team discussion is not world-readable; the mailing list connection to this forum needs to be reactivated.) Options: RSS	268	985	March 27, 2008 09:06PM
Forum Administration Praise, questions, complaints, etc. go here. Options: RSS	25	76	December 12, 2008 07:53AM
RepRap Marketplace	**Threads**	**Posts**	**Last Post**
For Sale Options: RSS	15	112	December 20, 2008 04:00PM
Wanted Options: RSS	10	46	December 16, 2008 01:21PM
Objects Library	**Threads**	**Posts**	**Last Post**
Library Admistration and Announcements Spam on one of the pages? Ideas on how to organize files? Discuss it here. Options: RSS	6	42	November 08, 2008 09:42AM
Things to Print What do you want to build with your RepRap? Options: RSS	38	266	December 16, 2008 08:13PM
3D Design tools 3D Design tools, Art of Illusion, Blender, CAD tools, etc. What are you using? What are your favorite tutorials?	14	70	December 16, 2008 09:28AM

Options: RSS

RepRap User Groups	Threads	Posts	Last Post
Request a Local RepRap User Group If you don't see your town, request here and the admins will create a forum for you. Options: RSS	2	3	January 16, 2008 05:52PM
Australia, Brisbane RepRap User Group Options: RSS	3	16	December 21, 2008 03:21AM
Australia, Sydney RUG Options: RSS	2	17	August 22, 2008 03:10PM
Australia, Perth RepRap User Group (This forum is the hub for Australian RepRapping discussion in general, until we have enough activity to give Australia its own forum.) Options: RSS	3	10	December 05, 2008 07:21PM
Brazil, São Paulo RepRap User Group Options: RSS	1	8	November 28, 2008 10:09PM
Canada, Edmonton RepRap User Group Options: RSS	2	9	August 13, 2008 09:11AM
Canada, Montreal RUG Groupe d'Utilisateurs RepRap en Montréal / Montreal RepRap User Group Options: RSS	1	8	July 20, 2008 03:51PM
Canada, Ottawa-Gatineau RUG (aka "le Groupe des Utilisateur RepRap de Ottawa–Gatineau") Options: RSS	1	6	June 06, 2008 02:05AM
Canada, Toronto RepRap User Group Options: RSS	2	19	November 25, 2008 11:18AM
Canada, Vancouver RepRap User Group Options: RSS	3	24	November 25, 2008 11:39AM
Canada, Winnipeg RepRap User Group Options: RSS	1	7	December 20, 2008 04:47PM
Colombia RepRap User Group Grupo de Usuarios RepRap en Colombia Options: RSS	1	3	July 05, 2008 04:16AM
Dutch User Group (Nederlandse RepRap Gebruikersgroep) Options: RSS	3	24	December 04, 2008 10:52PM
Finnish RepRap User Group Options: RSS	3	21	October 30, 2008 07:24AM
RepRap Groupe d'Utilisateurs Francophone (RepRap en Français) Options: RSS	2	31	September 18, 2008 11:52AM
Germany RepRap User Group (Deutschland RepRap Benutzergruppe) Options: RSS	11	182	December 19, 2008 04:11AM
Hungary RepRap User Group Options: RSS	8	68	August 13, 2008 05:50AM
Israel, Tel Aviv RepRap User Group Options: RSS	1	5	October 08, 2008 09:44PM
Italy, Pisa RepRap User Group This forum may also be good for general RepRap in Italy			

This forum may also be good for general RepRap in Italy discussion until we have enough users in Italy to justify an all-of-Italy forum. Options: RSS	7	14	November 26, 2008 01:43AM
Japan, Tokyo RepRap User Group 東京都 RepRap ユーザグループ Options: RSS	1	4	December 21, 2008 12:47AM
New Zealand RepRap User Group Discussions on suppliers, meetups, and how to keep Keas from eating your extruder heads. Options: RSS	5	10	June 18, 2008 08:12PM
Serbia, Belgrade, RepRap User Group Options: RSS	1	2	October 19, 2008 12:08AM
South Africa, Cape Town RepRap User Group Options: RSS	2	6	November 27, 2008 12:28AM
Russia RepRap User Group Группа Пользователей RepRap Options: RSS	6	35	November 26, 2008 11:00PM
United Kingdom RepRap User Group Options: RSS	11	111	December 19, 2008 10:52PM
Baltimore/Wash. DC (and environs) RUG (This group is also for people within traveling distance of those two places. Annapolis, etc. etc.) Options: RSS	12	28	December 14, 2008 06:19PM
Arizona, Phoenix RepRap User Group Options: RSS	1	4	December 09, 2008 11:07AM
California, Los Angeles RUG Options: RSS	4	42	October 04, 2008 05:18PM
California, San Francisco Bay Area RUG Options: RSS	2	14	November 05, 2008 05:42AM
Colorado, Denver RepRap User Group Options: RSS	2	6	June 05, 2008 04:34AM
Florida, Orlando RepRap User Group Options: RSS	1	2	November 12, 2007 11:43AM
Illinois, Chicago RepRap User Group Options: RSS	3	12	December 16, 2008 11:31AM
Kansas City (Missouri/Kansas) RepRap Users Group Options: RSS	2	3	February 27, 2008 02:23AM
Massachusetts, Boston RepRap User Group Options: RSS	4	64	November 26, 2008 11:20PM
Michigan RepRap User Group Options: RSS	1	5	December 07, 2008 05:59PM
Minnesota Twin Cities RepRap User Group Options: RSS	4	22	November 13, 2008 11:19PM
Ohio, Dayton RepRap User Group Options: RSS	3	19	September 21, 2008 01:55AM
Oklahoma City RepRap User Group Options: RSS	2	2	October 28, 2008 04:27PM
Oregon, Klamath Falls RUG Options: RSS	3	15	November 27, 2007 07:17AM
New York City RepRap User Group	2	9	December 20, 2008 03:46AM

Options: RSS	2	9	December 20, 2008 03:46AM
New York, Potsdam RepRap User Group Options: RSS	2	5	December 05, 2008 10:36AM
North Carolina RepRap User Group Options: RSS	3	8	July 11, 2008 07:39AM
Rhode Island / New England RUG Options: RSS	5	31	November 27, 2008 04:55AM
Texas, Austin RepRap User Group Options: RSS	1	5	October 15, 2008 08:25AM
Texas, Dallas RepRap User Group Options: RSS	1	9	June 17, 2008 05:24PM
Texas, Houston RepRap User Group Options: RSS	18	82	October 31, 2008 01:02AM
Texas, San Antonio RepRap User Group Options: RSS	2	2	December 28, 2007 07:57AM
Utah, Salt Lake City RepRap User Group Options: RSS	3	10	November 04, 2008 07:56AM
Hampton Roads, Virginia RUG Includes Hampton, Newport News, Norfolk, Portsmouth, Virginia Beach, Chesapeake, Williamsburg and Suffolk. Options: RSS	1	2	November 27, 2008 07:33AM
Washington, Seattle RepRap User Group Options: RSS	5	24	December 01, 2008 11:05PM

Online Users (*Administrator*)

sid
Guests: 4

[Return to main RepRap site]

Exhibit B-3

orums.reprap.org/list.php?14 Go OCT DEC APR
66 captures
1 Jul 2007 - 11 Sep 2019
2007 29 2008 2010 About this capture

RepRap

RepRap : Mechanics : Reprap Forums

Discuss any sort of mechanical stuff here: positioning systems, gears, extruding methods, etc.

Goto: Forum List · New Topic · Search · Log In · Back to RepRap

Current Page: 1 of 8 Goto Page: 1 2 3 4 5 6 7 8 Next

Subject	Views	Posts	Started By	Last Post
New Builder's Wiki Goto Page: 1, 2	15625	31	Adrian Bowyer	11/01/2008 10:31AM Last Post by VikOlliver
cartisian robot frame smooth rods	103	2	FourthDr	12/30/2008 06:34AM Last Post by Cris Wilson
B from B extruder hot section mods / performance	92	2	x2800m	12/29/2008 07:55AM Last Post by GeertB
My granule hopper concept.	516	14	SCphotog	12/25/2008 08:54AM Last Post by SCphotog
Mounting the threaded rod	139	3	khiraly	12/18/2008 09:31AM Last Post by Cris Wilson
Drive Screw	383	19	arun4444	12/17/2008 02:52PM Last Post by Demented Chihuahua
A worked Servomotor example Goto Page: 1, 2	2763	47	Andy Kirby	12/16/2008 04:27AM Last Post by syam
Aluminum for frame members?	398	10	JohnWasser	12/12/2008 03:56AM Last Post by JohnWasser
Stepper Motors Goto Page: 1, 2	3492	48	Samuel	12/11/2008 06:08AM Last Post by Schultz
A better belt drive	232	5	nophead	12/09/2008 09:26PM Last Post by Viktor
How to get extrusions to stick well? Goto Page: 1, 2, 3	2148	68	Wade Bortz	12/09/2008 10:34AM Last Post by Forrest Higgs
High speed spindle for pcb making	152	2	khiraly	12/09/2008 08:49AM Last Post by Forrest Higgs
How much torque?	1071	15	SOI Sentinel	12/07/2008 03:39PM Last Post by Jamie
Heating problem	476	10	Mathias	12/05/2008 09:53PM Last Post by Mathias
Gear-driven Z-stage instead of Belt-driven	387	11	Lethosos	12/05/2008 07:37PM Last Post by Cris Wilson
Simple Dispenser	359	3	Viktor	11/26/2008 01:11PM Last Post by nophead
Foolproof extruder?	476	8	james glanville	11/24/2008 08:33PM Last Post by Ian Adkins
Laser Cut Parts (Bits from Bytes) Goto Page: 1, 2, 3	3304	83	spcmicro	11/20/2008 02:56PM Last Post by Wade Bortz
Open source stepper motor	372	2	KE5AFU	11/20/2008 10:58AM Last Post by Forrest Higgs
Newbie X-axis problem / Bits from Bytes kit	416	8	jkolhi	11/20/2008 08:22AM Last Post by jkolhi
Using digital caliper for positioning?	606	14	GeertB	11/19/2008 08:07AM Last Post by Sandy
Augers	379	5	Bruce Stewart	11/15/2008 03:06PM Last Post by peteredworthy
hello all	259	6	Yovavc	11/14/2008 06:27AM Last Post by Yovavc
linear magnetic encoder	1308	15	travel	11/02/2008 09:43AM Last Post by RBisping
Commercial Style Cartesian Bot	699	21	Pheobot	10/30/2008 04:25AM Last Post by Demented Chihuahua
New head design + PCB functionality (Concept)	908	11	Alycan	10/29/2008 01:32PM Last Post by Forrest Higgs
What size solder for the thread wrap	301	5	davidgoodenough	10/29/2008 11:35AM Last Post by Bodgelt

STL for toothed gear	378	5	Leav	10/25/2008 02:28PM Last Post by Wade Bortz
Just how easily should the axes move...	571	12	davidgoodenough	10/24/2008 03:56PM Last Post by stephen george
Alternatives to the toothed belt	447	8	zzorn	10/23/2008 12:51PM Last Post by zzorn
Cooky bed idea	407	2	Leav	10/12/2008 09:29PM Last Post by sid

Current Page: 1 of 8 **Goto Page:** 1 2 3 4 5 6 7 8 Next

Options:

[Return to main RepRap site]

Exhibit B-4

orums.reprap.org/search.php?14 Go DEC OCT APR
3 captures
17 Dec 2007 - 16 Apr 2016
2007 18 2008 2016 About this capture

RepRap

RepRap : Mechanics : Reprap Forums

Discuss any sort of mechanical stuff here: positioning systems, gears, extruding methods, etc.

Goto: Forum List • Message List • New Topic • Log In • Back to RepRap

Search Messages

Search

Search All Forums

Last 30 Days | All Words

Search Authors

Search

Search All Forums

Last 30 Days

[Return to main RepRap site]