fMRI - Random, stray thoughts

Bill Howell, 11Oct2013,

Following an interesting conversation at a dinner, I composed the following email just in case some points might be of interest to “Phils” wife, who was doing Post-Doc work on fMRI, with some link as I understand it to her main interest of neuro-psychology.

Although I have no expertise in fMRI, the subject is of some interest to me given that neural networks (and to a lesser extent evolutionary computation) have been, andremain, my priority “hobby interests” since ~1988 when I joined the INNS, (or at least started subscribing to *Neural Networks* journal. I have been attending the International Joint Conference on Neural Networks (IJCNN) since ~1992 Baltimore, at least when I have the money (out of pocket, after tax) to do so. It is one of two main vacations that I take, besides visiting family.

The “Table of Contents” on page 3 gives a rough guide to the contents of the email.

Status as of 11Oct2013 :

First posted to my website 13Oct2013
The original email has been slightly modified :

- The names and email addresses of correspondents have been removed for privacy.
- Topics or sections been formatted to be “Heading 1” to allow an easy generation of the Table of Contents
- My comments, and selected comments by others, to Asim Roy's Brain Representation SIG have been attached directly, whereas they were file attachments in the original email.

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Table of Contents

0. Introduction

-------- Original Message --------
Subject: Random, stray thoughts on fMRI
Date: Fri, 11 Oct 2013 02:03:16 -0600
From: Bill Howell. Retired from NRCan. now in Alberta Canada <Bill@BillHowell.ca>
To: Harriet
CC: Phil

Here's a quick set of ideas that come to mind about fMRI - from a very narrow non-expert perspective. Even though I doubt you'll want to read much of the following, if anything, it's worth throwing down ideas just in case SOMETHING perks some interest. Some of the ideas are zany and non-accepted, meaning that they may not have the same awareness as the more "mainstream" ideas.

WARNING : But first it's appropriate to direct your attention to my signature block, which is-but-isn't a joke. I don't always send it for casual, "empty" emails, but I will for anything with content, and still repeat it occasionally with long-time contacts, such as the Organizing Committee members for the IJCNN etc.

- I'm "Mr." Howell, because everyone kept calling me "Dr." or "Professor", and I'm neither. Many still address me that way even after they see my signature block (which they obviously don't pay attention to).
- It was consistently scaring me that experts in a field were sometimes taking what I was saying too literally. I'd far rather they ignore me, and think that I am a "bullshitter and heretic" than take me too seriously, fail to check on my rantings, and be misled in consequence. My self-designated titles must turn many off, which isn't good - but it's far better than the possibility of somehow misleading people. (Clearly this applies to both of you!) Not to say that there isn't more than an element of truth in the titles...

1. Directly related to fMRI :

Note that I look at issues like this primarily from the point of view of the Computational Intelligence mathematical/statistical toolsets that are used, not the psychology! But more and more I add to the little I know about the latter...

1.1 Blind-Source signal processing :

This area of mathematics was a 'hot topic" in neural networks in the early 2000's I guess (and before that in other fields) . I first saw it during a plenary lecture by Terry Sejnowski at the IJCNN 2001 Washington DC, if I remember it correctly. Terry started with an audio recording (very impressive to me!), and got into fMRI, extolling the huge long-term career opportunities then arising for grads & post-docs. I made a point of checking papers for a couple of years thereafter, then personally haven't really followed up since.

By the way, Terry just gave a special presentation about Obama's 40 M$ (initially) ?Human

Brain Initiative? (one of probably hundreds!) at IJCNN 2013 Dallas TX. Apparently he is chairing part of the preparations, involving hundreds of scientists and institutions. Apparently many organisations snuck into the initial by-invitation-only meetings, which slowed things down a bit, but at least it helped get the word out fast!. He didn't get into fMRI details, but did inspire me for an hour, in spite of my somewhat cynical expectations prior to his talk, thinking that it was a [low-commitment, high-tech, advanced, core human, sexy]-sounding soundboard for political positioning rather than a really significant issue. Unfortunately, several colleagues prick my balloon when I brought it up during the conference, pointing out that only three universities that they new of (including their own) have just received collectively far more funding than the initial 40 M$ Brian initiative (oh well - I guess I wasn't the most cynical person!).

1.2 Olaf Sporn's IJCNN 2013 Dallas plenary talk "Neural Models of the Human Brain"

This was very inspiring and provocative talk, regarding sort of a general networking within the brain that seem to fit like a glove long-standing concepts and discussions regarding complexity, energy, and computational capacity of neural networks. See the abstract of his talk below my signature block. I've also attached below my own comments taken from long-unfinished notes on what I saw at IJCNN 2013 (including my expectation that the "Rich Club" phrase will become fashionable lingo).

1.3 The Perils of fMRI

It struck me at the time that I saw Sejnowski's presentation in 2001, that there would be tremendous potential with the technical and the mathematical, statistical, experimental] tools used in its analysis. But (based on many, many other fields of science), that it was also the ideal paltform for the penultimate [biorhythms, palm reading] etc, the sort of things that have plagued psychology and other sciences in the past. Like [quantum mechanics, relativity, climate models], toolsets that approach "small-world universal function approximators" would be used to prove whatever scientific belief system was on hand. Sure enough, during Olaf Sporn's plenary talk at IJCNN 2013 (and on one or two other occasions), this exact subject came up, and there was a fair amount of laughter at some of the many boondoggles that have come up. Already this is affecting the credibility of the area, apparently. But this should not impede, nor much delay, the ultimate successes to come.

2. Indirectly related to fMRI?

2.1 Cause-and-effect studies of the brain :

2.1.1 Trans-cranial Magnetic Stimulation & fMRI?

I introduced ?Mitsu Kawato?, one of 3 chief editors of Neural Networks journal for a decade or two (or three?) when he gave a plenary talk at IJCNN 2005 Montreal (he retired 3 to 5 years ago). Unfortunately, his topic as provided - cause effect studies involving TMS, was NOT the talk he gave! (I still don't know if I believe what I saw his robot doing - playing air hockey against

humans and beating them, with movements that completely revolutionized my concept of "how robots can move!) This was the first that I ran into the cause-effect theme, but I should have anticipated it. I don't have any of Kawato's papers on TMS.

Co-incidentally, Isabel Guyon is (or has just finished) running an international competition of CI techniques for assessing cause-effect, which I think is an extremely important theme - kind of like statistics on steroids, trying to circumvent unavoidable human belief systems. One of her earlier competitions "Agnostic versus Prior learning" was also fascinating!

> IJCNN 2013 Cause-effect pairs challenge March 28 - July 19, 2013
>
> http://www.causality.inf.ethz.ch/cause-effect.php

2.1.2 Opto-genetics

This caught me by surprise when I happened to meet ?Dave Johnston? at the "Last Chance Saloon" just outside of Drumheller. Unfortunately, I lost his business card and obviously didn't remmber his name properly, as I can't find that name on the Uof Calgary website. I have provided below a separate contact, Deissroth, who obviously is involved in optiogenetics - but Harriet, you must knowa lot of these people anyways. I really don't know anything about this, but it is reminiscent of the Vancouver company (I forget the name) that was famous 5 or 10 years ago who had a technique for optical treatment for the eyes. But as I understand it, genetic modifications allow for specific activation of neurons, but I am not yet aware of the degree of specificity with respect to the volume of the region, temporal coverage (I assume this to be easily controllable) and type of neuron.

> Dr. Karl Deisseroth | Hotchkiss Brain Institute
> Karl Deisseroth has developed optogenetics, a technology that uses lightto control millisecond-precision activity patterns in genetically defined cell types within ...
> www.hbi.ucalgary.ca/gairdner/deisseroth

Note that an earlier technique was neuron-type-specific color staining, but off-hand I forget the name of the scientist in the USA who developed this (and others involved). A friend of mine in Ottawa, Jean-Phillippe Thivierge did post-doc work in that lab, and is now at the University of Ottawa. (He did fascinating work on modeling ontogeny of parts of the sensory system or brain if I remember correctly (maybe the retinotopic mapping - involving pre-natal "activity waves" to help coarse tune retinal cells and/or signals), and 3 or 4 years ago when I lasted talked to him he was really excited about modeling the damage-recovery characteristics of complex networks (not actual neurons). I don't think that this staining would be directly applicable to fMRI experiments, except perhaps as pre-and-post fMRI observation and testing (perhaps for brain tissue slice, for example)?

2.2 Hybrid experimental techniques

This is very recent, so I've simply attached the link to the blog comment by Aureli Soria-Frisch (which came through the LinkedIn IEEE-CIS group), but my comment andhisresponse (both fairly empty) are pasted below my signature block. The theme of combined stimulation (here mostly variants of transcranial current stimulation) to enhance subsequent readings is very interesting (to me). Obviously, Mitsu Kawato's TMS plenary (as above) falls into this category as well, but with a greater emphasis on cause-effect. Aureli's emphasis is EEG reading - can this be done with fMRI?

> http://blog.neuroelectrics.com/blog/bid/311416/What-can-electrical-brain-stimulation-do-for-Brain-Computer-Interfaces?goback=.gde_75152_member_268053603#!

2.3 The Jenifer Aniston neuron

Does this prove that "concept cells" and single-cell symbolic representations exist? Asim Roy of Arizona State University organized a workshop following IJCNN 2013 on this theme, and even had ?name? fly in from New York University for the morning to present, before flying back to NY! That particular presenter does experiments with single-electro arrays on severe epileptic patients who need the arrays to help define volumes of the brain that must be removed to potentially save the patient's life. Naturally, you can't choose the brain region or electrodes, as that is done only for the surgeons. There are apparently 4 main groups in the USA, with many more coming on stream.

This theme evokes powerful emotions and discussions as it violates the core "connectionist" dogma. I prefer to force on myself a "multiple conflicting hypothesis" mindset, so I am less susceptible to becoming a [believer, disciple] of a concept or theory, rather than theories being tools for me. I like to pretend that I can accommodate ALL of the perspectives (Hah, but at least I try!). Perhaps more importantly, it helps to keep an open mind when you stick your foot in your mouth as often as I). A "Brain Representation SIG" blog was set p following the IJCNN, and Asim is lookingfor authors to contribute to a Special Session on this theme for IJCNN 2014 Beijing (as of bout a month ago, he had 4 contributors, and may get enough for two sessions).

Anyways, rather than get into details, I've attack a file with my comments on a post-workshop blog (listed below), which includes a few comments by others related to mine. There is an archive of all blog comments.

> Asim Roy's Brain Representation SIG : blog started Aug2013
> http://erlars.org/mailman/listinfo/brain-representation-sig_erlars.org
> Howells comments - BrainRep SIG 131011.txt

2.4 Walter Freeman's "stochastic chaos", EEG, and the brain

Walter Freeman has long developed beautiful experimental result, mathematics and theories

from his EEG and olfactory work that is the penultimate of "connectionist" thinking and chaos theory for the brain. I bought the most recent book he co-authored, but haven't had a chance to read it yet. He had been a key contributor to Asim Roy's blog on concept cells (Brain Representation SIG). Whether or not you like the idea, I think his work is fantastic, and worth being aware of. I doubt that the temporal scale of fMRI readings could adequately reflect the results and implications of Freeman's theories.

> Walter J. Freeman, Rodrigo Quian Quiroga 2013 Imaging brain function wth EEG: Advanced temporal and spatial analysis of electroencephalographic signals www.Springer.com 248pp ISBN 978-1-4614-4983-6

3. Off-topic, but possibly pertinent? :

3.1 Epigentics - chemical changes to mimic environmental influences on behaviour

I had forgotten to put this in until I re-checked Phil's initial email below. Basically, as I understand it, the effects of environmental stress on the nurturing behaviour of a mother rat during the first week of a young rat's life are an important factor affecting the young rat's response to stress for the rest of it's life. Meaney was able to a) identify a single-epigenetic-site that seemed to change with the stress-response behaviour, and b) induce the same behavioural changes via methylation (or remove via de-methylation, if that is the term).

But something that still really intrigues me is that, apparently, some epigentic modfications have a reasonable chance of being reflected (weakly) in subsequent generations. To me, if that is the case, then is this a mechanism for Lamarkian, versus Mendelian heredity? There are a whole host of downstream implications of this that fascinate me, and relate as well to my "MindCode" interests ("3.4 MindCode" below).

What s really embarassing, is that I never in a thousand years would have even dereamed of a next step that I saw in a Globe & Mail article several years ago: Meaney was getting funding for looking at the possibility of relating this to children from difficult family situations! I assume that this is a mega-long term blue sky project, but it is still fascinating. I haven't checked up on progress or even whether this project actually went ahead, but I certainly will.

I can't think how this relates to fMRI, but perhaps CONTROLLED behaviours offer a fantastic opportunity to find specific fMRI correlates, bridging the micro and macro scales?

> M.J. Meaney, M. Szyf, "Maternal care as a model for experience-dependent chromatin plasticity?". Trends in Neurosciences, Vol.28 No.9 September 2005.

3.2 Neurotransmitters

Off on a tangent again, but inspired by the item above "2.1.1 Trans-cranial Magnetic Stimulation & fMRI?", Mitsu Kawato was replaced as one of 3 Chief editors Of Neural Networks journal by Kenji Doya, who did a paper describing the effects of 4 basic neurotransmitters in kind of an engineering-like fashion (this is probably erroneous, clouded by fading memory, but I have the paper on file somewhere...) :

- dopamine - as setting the "reward" level (I am forgetting - a bit like reinforcement learning, if not temporal-difference learning, but maybe accommodating both?)
- serotonin - the discount factor for time (net present value) for
- acetocholine - the rapidity of updates (hyper-timefor urgent, stressful situations is perhaps a distorted view of this)
- nor-adrenaline - a randomness factor, which is the most unusual and inventive of the three roles, and extremely reminiscent of control theory, and the core essential role of randomness with many CI techniques

I really liked this paper, possibly because I don't understand the neurotransmitters, and it is somewhat like an engineering control paper.

> K. Doja, "Metalearning and neuromodulation" in Doja, Dayan, Hassselmo, Neural Networks, 2002, pp495-506

3.3 BOLD and "Exclusion Zone" (EZ) water?

I just can't get this EZ theme out of my mind - right across a HUGE swath of topics, especially in biology! Rather than get into details, I've attached a short somewhat descriptive email, and will simply say that EZ water is a modern extension by Gerald Pollack of ?Washington long-standing work by ?Gerald Ling? and others. The basic idea is that water near hydrophilic surfaces, with energy input especially in the IR (perhaps I'm mistaken and it's UV) range, forms a separate gel-like phase comprised of proton-deficient hexagons of water molecules. That structure is very simlar to that of ice, and replaces "hydrogen-bonded cahins of water molecules" which was the basis of earlier concepts like Gerald Ling's. Soviet workers are part of the long tradition, and famous chemist ?Boris Derjagin? was accused of fraud and incompetence by Western scientists. After a small bit of reading, I suspect there was fraud - but not by Boris, instead by Western scientists, and that continues. I could be wrong though - I'm used to that. Incidentally, Pollack's concepts are far from accepted or mainstream, but he does have some basis for his concepts.

Does EZ relate to fMRI? Perhaps not, because as with Blood Oxygen Level Dependent measures [fMRI, PET, and others I forget!], it is the changes in measures related to neuron activity that must be picked out. Furthermore, even if EZ water changes do occur and do affect fMRI readings, for example, they will already have influenced results and are already accounted for in the analysis, which to some degree are somewhat "high level" and independent on the exact nature of the things being measured. On the other hand, maybe, just maybe, there is a big role of EZ water, and understanding how it works might lead to

big fMRI breakthroughs.

I was intending to jointly email Walter Freeman and Gerald Pollack after I draft a note regarding possible "conceptual bridges" between their respective work. Phase transitions are a huge part of both.

As a last EZ comment, EZ batteries (which come out ofPollacks's work) are the best candidate I've ever seen for a simple, automatic source of electrical energy that may have been one of the key mechanisms for the origins of life. Two other concepts I remember were part of Stuart Kauffman's theoretical work on theorigins of life (colloids to provide a semi-isolate environment of concentrated diverse-complex chemicals, and autocatalytic networks leading to the edge of chaos). While he became famous at the San Diego Institute for his basic concepts and applications regarding complexity (complex systems in biology, economics, and on and on), Stuart did spend several years heading an Institute at the Unversity of Calgary. I missed a chance to see on of his public presentations at the UofC, but I did barge into his office and got a chance to talk to him for about 4 minutes.

> Gerald H. Pollack 2013 "The Fourth phase of water: beyond solid, liquid, vapor" Ebner & Sons, Seattle, WA www.ebnerandsons.com 357pp
> Gerald H. Pollack 2001 "Cells, Gels and the Engines of Life: a new, unifying approach to cell function" Ebner & Sons, Seattle, WA www.ebnerandsons.com 357pp305

3.4 MindCode

This is waaaayyy off track, but it is one of my own greatest interests in the neural network area. Simply put, instinct shows a level of "pre-programming" at all levels of [data, function, etc etc] in the brain, and the plateauing advances of NNs may reflect the emphasis on learning and evolution, without taking advantage of 570 My of evolutionary power that is already there! This is reflected in some of my comments to Asim Roy's "Brain Represntation SIG". I prefer to refer to the draft version of a concept paper I did for IJCNN 2006 Vancouver. In spite of its [spelling, grammar, structure, incompleteness] as compared to the final reviewed and published version, it is broader and deeper in some key areas :

> William Neil Howell 2006 "Genetic specification of recurrent neural networks: Draft - with errors and incomplete, not peer reviewed, unpublished" http://www.billhowell.ca/Neural%20nets/Howell%202006%20-%20Genetic%20specification%20of%20neural%20networks,%20draft%20concepts%20and%20implications.pdf

There are many other concepts that should be mentioned, but for now that's a good sample of things "somewhat related to fMRI" that excite me (plus I can't remember them now - maybe with time). Additionally, fMRI is not an area that I focus on, but it's obviously critically important to many themes I do follow much more closely.

I doubt that any of this will be of particular use for your work, but as I said at the start, just maybe something might be of general interest, or spark a thought.

Mr. Bill Howell
Bullshitter & Heretic (...I enjoy crazy ideas, & I am NOT an expert in anything!)
IJCNN 2014 Beijing, China 6-11 July, Technical Program Chair (paper reviews for a topic)
IJCNN 2013 Dallas Texas, Publicity Chair, August www.ijcnn2013.org
CISDA 2012 Ottawa, help John Verdon with Social Media Special Session, http://ieee-cisda.org
member$ - Friends of Science Society www.friendsofscience.org
"supporter$" - Electric Universe www.thunderbolts.info
member - Natural Philosophy Alliance www.worldsci.org/php/index.php?tab0=Home
member$ - International Neural Network Society www.inns.org
member$ - IEEE Computational Intelligence Society www.ieee-cis.org
member$ - Principia Scientific International http://www.principia-scientific.org
"supporter$" - Free Thinking Film Society www.freethinkingfilmfest.ca
Retired: Science Research Manager (SE-REM-01) at Natural Resources Canada, CanmetMINING, Ottawa
see Steven Yaskell's book "Grand Phases on the Sun" on www.amazon.com & facebook
- the historical charts came from a project by my father and I
(my thinking has now shifted from that, to focus on bigger events possibly driven by major astronomical events)
1-587-707-2027 Bill@BillHowell.ca www.BillHowell.ca
P.O. Box 299, Post Office, Hussar, Alberta, T0J1S0

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Appendix 1. Olaf Sporns "Neural Models of the Human Brain"

IJCNN 2013 Dallas TX plenary talk - Abstract (retyped with errors)

Recent advances in network science have greatly increased our understanding of the structure and function of many networked systems, ranging from transportation networks, to social networks, the internet, ecosystems, and biochemical and gene transcription pathways. Network approaches are also increasingly applied to the brain, at several levels of scale from cells to entire brain systems. We now know that brain networks exhibit a number of characteristic topological features, including small-world attributes, modularity and hubs. I will review recent work on how complex brain networks are organized, and how their structural topology constrains and shapes their capacity to process and integrate information. will place particular emphasis on models of the large-scale structure and neural dynamics of the human brain.

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from Howell's notes on IJCNN 2013 Dallas TX :

Appendix 2. Plenary - Olaf Sporns “Network models of the brain”

(OR - How is your “Rich Club” working for you?)

For some time there have been results and/or conjecture from several areas of complex systems that suggest advantages to having “hubs” that have “short-distance” connections with local nodes (communities) and “long-distance” connections with other hubs, including neuronal “short-range correlation versus long-range “ connections. Examples include :
Transportation systems “especially for airline routes for which the “hub and spoke” arrangement has long been a feature, although in recent decades there has been a trend to smaller aircraft flying reasonably long distances directly between secondary destinations. Presumably that trend has been driven by high costs and delays at the major hubs (for example in the USA - Chicago, Atlanta, Washington, Houston, Los Angeles, etc), plus the value of reducing high-value customer travel time by avoiding transfer points.
Internet connections - Perhaps 20 years ago, IBM had put forward (perhaps based on earlier work by other groups) a “hubs, experts, and community” concept for viewing how information flows in the internet.

After years of watching this theme, it was fascinating to see Sporns presentation of fMRI analysis by his group and by several independent, high-quality labs that suggest not only “hub” locations in the brain, but some statistics showing the percentage of energy, mean connection distance, and huge interconnectivity of the hubs, relative to the rest of the brain. The “Rich Club” provides a rich set of regions of connections and possibly of processing to link and leverage off of all regions of the brain. If I remember correctly, the Rich Club (RC) regions all interconnect with one another. Sporns used transportation networks as a real-world example of a similar structure, but many other examples exist. I did not catch all of the implications that Sporns suggested, but the implications for [confirming, rejecting, improving., building] past models for cognition and consciousness seem huge, as is the

implication for the application of "abductive" logic (simile, metaphor " to pervert the formal definition) to use results (mathematics, relationships etc) from other concept domains to accelerate the development of the "Rich Club" work.

In what follows, I offer my apologies to Olaf Sporns for trivializing a great, thought provoking presentation based on solid research based on solid use of functional Magnetic Resonance Imaging (fMRI). However, I just couldn't help it...

Fashionable Jargon - In the areas of clothing, management, architecture, literature, art, science, and other areas of human intellectual effort, it is clear that "fashions become cults become religions", usually built on "religious terms and jargon" specific to the "in-crowd of disciples of the new religion". There is a tendency especially for concepts and jargon that are successful in the "hard sciences" areas of physics, chemistry etc, to be enthusiastically attempted in the "vastly harder, practically impossible" areas of psychology, sociology, etc. While I think the envy is horribly mis-placed, it makes it fairly easy to anticipate at least some of "... the next things ...". And at times the transformative potential for the jargon seems particularly explosive.

Such is my impression of the "Rich Club" terminology of Sporns and colleagues. While justified by the scientific value and implications of their work, it seems to me nearly inevitable that it will be pushed beyond reasonable limits by fashion-centric scientists (as has happened with fMRI itself). So you should expect "Rich Club" jargon, like "Black Holes", "Resonance", and many other concepts of the past, to become a fashionable trend in (as above) "... clothing, management, architecture, literature, art, science, and other areas of human intellectual effort ...". But that is to be expected, as we are all human, and we like to be seen as part of a fashionable trend.

However, one should NOT pass the opportunity to look more closely at Sporns' work, which is impressive and seems to extend and confirm long-standing concepts and suspicions in brain and NN research. Somewhere there is probably a link to the stochastic chaos of Walter Freeman and Robert Kozma. The real conceptual potential of Sporns work vastly exceeds its huge "fashion" potential, and promises to help channel focus and energies of some researchers, but hopefully not all! - as we need the diversity of many other concepts as well.

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Neuroscience and EEG blog

Appendix 3. What can electrical brain stimulation do for Brain-Computer Interfaces

Posted by Aureli Soria-Frisch on Fri, Aug 23, 2013 @ 01:49 AM
http://blog.neuroelectrics.com/blog/bid/311416/What-can-electrical-brain-stimulation-do-for-Brain-Computer-Interfaces?goback=.gde_75152_member_268053603#!

LinkedIn IEEE-CIS group
Last Neuroelectrics'blog post
Program Manager and Senior Research Engineer at Starlab S.L.

My last post on Neuroelectrics' blog deals with the combination of transcranial current stimulation (tCS) and Brain-Computer Interfaces (BCI) as discussed in the last BCI meeting I attended.

What can electrical brain stimulation do for Brain-Computer Interfaces

blog.neuroelectrics.com

I attended the International BCI Meeting and one of the most interesting topics discussed there was the combined utilization of electrical brain stimulation and BCI.

Bill Howell

www.BillHowell.ca - interested in neural networks, evolutionary computing

Very interesting blog, that I will follow, albeit I am no expert in this area. I'm just starting to go through Walter Freeman & Rodrigo Quian Quiroga's 2013 book "Imaging brain function with EEG" as part of an occasional attempt to be aware of some of the concepts in this area. I get a sense from that book that stimulation approaches far beyond simple frequencies and simple locations might be needed, but I'm guessing at this point.

Is there any chance of patient-controlled real-time feedback to direct the hybrid approach? Perhaps that might be possible if the patient can SOMEHOW sense for themselves higher "... external brain stimulation as priming of the internal motor cortex activation ...", combined with some (even crude) manner for them to direct and modulate the stimulation (frequency, spiking-like waveform etc). But I suppose that if patients did get a feeling like that, researchers would alreadty be working with it.

As for your blog question : "... if tACS favors the activation of oscillatory rhythms, it would be better suited for the SSVEP and the motor imagery priming ... I am not aware of any work in the literature describing such an approach. ? ..." - neither am I aware...

Aureli

Aureli Soria-Frisch

Program Manager and Senior Research Engineer at Starlab S.L.

Thanks a lot for your comment and interest in the blog.

What you describe in the second paragraph is denoted in Brain-Computer Interfaces as "close-loop" systems. This has been a hot research topic for some time. However I am not aware of important advances in the field.

/home/bill/Neural_Nets/Brain representation SIG/Howells comments - BrainRep SIG.txt
Asim Roy's Brain Representation SIG
www.BillHowell.ca
blog started Aug2013 http://erlars.org/mailman/listinfo/brain-representation-sig_erlars.org

Appendix 4. Howells comments - Asm Roy's IEEE-CIS Brain Representation SIG

------- Original Message --------

Subject: Learning on the order of seconds, instinct

Date: Tue, 08 Oct 2013 09:42:44 -0600
From: Bill Howell. Retired from NRCan. now in Alberta Canada <Bill@BillHowell.ca>
To: brain-representation-sig@erlars.org <brain-representation-sig@erlars.org>

Below is a re-posting of my comment from Saturday 03Oct2013. The original message was too large, so I removed most of the earlier postings from this message.

In relation to this BrainRep SIG's focus on "concept cells", a key question buried in the middle of my 03Oct2013 comment was : "... Concept cells could be one of many key features ..." related to "pre-programming" of [data, functions, operators (transformers), modules, processes, architectures, ... all the way to [multiple, conflicting & complimentary) [behaviours, personalities, strategies] (whether through DNA, epigenetics, other molecules or structures, or whatever). This is not to ignore powerful [growth, learning, evolution] of [neurons, ensembles, brain regions etc], and the critical importance of new environmental challenges and new concepts.

So, assuming that the concept of "concept cells" is valid, my questions are :

is the concept cell CAPABILITY built in through inheritance, and not just emergent (both could be the case!)?
are some, if not many, very specific concepts "built into" concept cells at different stages of development (pre-and-post natal, eg at adolescence) by inheritance (either specific or generic concepts)?

is it possible to identify concept cells in lower life forms for which experimentation is much easier? (eg reactions to specific smells, sounds, movements, tastes, whatever to which an organism has not yet been exposed)

do concept cells arise as-needed (say in the hippocampus, pulling material/context from other regions like the cortex)? almost-instantly (using rich prewiring prehaps) giving a capability like variable-function-operator-system? (Ben Goertzel 30Sep2013 referred to something like functional capabilities).

Bill Howell

-------- Original Message --------

Subject: Re: [Brain-Representation-SIG] Learning on the order of seconds

Date: Thu, 03 Oct 2013 23:35:19 -0600

From: Bill Howell. home email. Ottawa <Bill@BillHowell.ca>
To: Brad , Allan , "brain-representation-sig@erlars.org" <brain-representation-sig@erlars.org>

Brad, Allan,

Does quick "learning" or "representation" necessarily require biological [synaptic, neuronal, network, .. maybe regional] modification, at least initially? It seems to me that instinct shows that there is already a huge genetic-and- nonGenetic "programming" ["chemical" (eg DNA, epigenetics) or other] source for [data, functions, operators (transformers), modules, processes, architectures, ... all the way to [multiple, conflicting & complimentary) [behaviours, personalities, strategies]. This is augmented by [fine-tuning, learning, evolution] through environmental challenge-responses, which "should" also be available.

"Novelty-reaction learning" might possibly take place "very quickly or even one-step" with what is already there, even if it is sub-optimal and relatively slow compared to a well-learned response. Perhaps the brain at this stage needs to mull over the challenge and try many possible routes - reminding me of Walter Freeman's concepts, for example. But if a "need" recurs, more and more [specific, tuned, evolved] biological modifications (synaptic changes and perhaps many others I am less familiar with) might lead to much [faster, more accurate, powerful] "semi-hard-wired" processing and results. Concept cells could be one of many key features for this. Earlier comments on this SIG did suggest that concept cells could be of great advantage to certain forms of processing. One doesn't need "either/or", both approaches may always be involved.

As simple abstract examples :

I've often thought that there must be enough DNA coding (3.2 Giga base pairs, if I remember correctly for humans, with less than 1 or 2% being "genetic", is the naive impression I have) to provide an extremely rich source of code at various levels of abstraction, to be able to "quickly [pick, assemble,

architect]" almost any general purpose (Turing or super-Turing) system. Why wouldn't biology take advantage of this - one might speculate that higher-order epigenetic processes might make this possible. John Mattick's group at the university of Queensland seemed to be looking at issues like this 10 years or so ago, but more for "normal biology" as opposed to neurons and the brain (Mattick's description of non-genetic DNA and micro-RNA as being an explanation of the Cambrian explosion ~600 My ago was a nice conjecture). (Note that Gary Marcus' "The Birth of the Mind" discusses the inherent power of a relatively small number of genes to do their work with very compact, powerful coding and capabilities).

Bernie Widrow's 2009 IJCNN Atlanta plenary presentation "Memory Molecules" (and many MUCH earlier papers along this line) argued that long-term memory may require some form of stable molecular form, rather than relying on ever-changing synapsis, but even if that concept area doesn't work, instinct (greatly under-appreciated and under0discussed in my humble opinion) begs explanation. As I understand it, there really isn't an experimental basis for this, but ...

Jonathan Edward's examples from immunology may provide another potential example of this (I really enjoy his perspective in this SIG) - evolution with [existing, random changes, selection, iterations] allow the immune system to become very good at dealing with specific pathogens, but there is likely at least some initial capability to handle new pathogens via the "primitive, general" immune system (I forget the name for capabilities such as inflammatory responses and others response that I also forget), and the ?killer -cell? "targeted, specific" actions.

Michael Meany's work at McGill University and Douglas hospital on epigenetics and behaviour may be another potential platform for this, wherein behavioural changes in response to the environment could be reproduced by methylation of epigenetic sites.

If the brain already has systems that make for a wide range of specialized "applications" of general capabilities such as Approximate Dynamic Programming and symbolic capabilities together with concept neurons (perhaps not just objects and classes, but functions, processes etc as listed above), then these might also be quickly adapted to a new challenge with little of no requirement for "hard" biological changes.

It seems to me that incredible "brain power" is likely always available to deal with challenges. Biological changes may not be required for a "quick and reasonable answer". Many more processes are available for the"biological" modifications to approach optimality and to provide a more-or-less permanent capability for a new challenge.

Bill Howell

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01Sep2013 Howell's own posting Initial comments

I am enjoying the comments and discussions of this Brain Representation SIG, which has so far put forward ideas from electrode probe based tests, EEG results, logic and symbols, information theoretics, chaos, category theory, and other areas. I tend to look at all of the ideas discussed so far as being complimentary, and even if they conflict, it is best for me to retain ideas for future use, given the very sketchy understanding we have at present, and to avoid becoming trapped in any specific concept.

A. Robert Hecht-Nielsen's Confabulation Theory [1]

This SIG has reminded me of Hecht-Nieslen's Confabulation Theory for mammalian cognition (thought)- not for planning, executive or other functions if I remember correctly). The reminder started with respect to comments on the number of neurons required for concepts etc in this SI and Quiroga etal [2]. Hecht-Nielsen made many rough estimates along those lines, to quote from aquick note I did a couple of years ago for a social media project at work [3]:
"... As a gross overview, Confabulation Theory assumes that information is held within “attribute classes” in roughly 4,000 thalamocortical modules (~45 mm^2 each cortial patch, carrying information about “mental object attributes”) and roughly 40,000 cortical knowledge bases (establishing “meaningful co-occurrences” between thalamocortical modules). All vertebrates (and even invertebrates such as bees and octopi) are postulated to possess functionally analogous structures, albeit in smaller quantities. Confabulation is a “winner-takeall” process for coming to a conclusion (intermediate or final) , and is the only information-processing operation used in cognition. Confabulation DIFFERS from Bayes theorem in statistics, and these simple differences make confabulation a superior form of reasoning for the real world, where information is often incomplete, erroneous, or event misleading (predator – prey). It is even proposed that many supposed successes of Bayesian statistics are the result of extreme
simplifications which mean that it is actually Confabulation that is being applied, without the statisticians and scientists even being aware of this important distinction! ..."

Confabulation Theory was not well received by many when presented at WCCI 2002 Hawaii, or later at IJCNN 2007 Orlando (I hope I got the dates right). But I was intrigued, like the mathematics, and was stunned by the results of his "third plausible sentence" exercise. I have not heard anything since 2007, but I have met one or two others who are still interested in the idea. IBM Watson's defeat of the Jeopardy plyer a few years back also reminded me of confabulation, but although it seemed similar in some ways, as I understand it Watson is not based formerly on Confabulation. However, it may have heavily used the naive Bayesian technique, which is apparently closely related to Confabulation Theory rather than being a proper form of Bayes Theorem.

In any case, Confabulation Theory has been applied to several impressive problems (eg. awesome machine sentence construction without the need for formal grammar - I did an informal survey to see if people could pick out the machine from human respondents - they couldn't), requires massive inputs from much of the brain (like Walter Freeman's chaos concepts), and provides for cognition in a real-world robust and reasonable manner.

B. Questions related to the concept neuron itself:

How PERSISTENT over time is the "Jennifer Aniston" neuron? Can we check a couple of months or so later to see if the neuron or the whole
hippocampal population, has changed "duties", or is this prevented by glial cell passivation of electrodes and other difficulties of sustaining stable, long-term probes?

Can a neuron of local group of neurons rapidly "change jobs" to assume a different a completely different context (i.e forget Jennifer Aniston and instead primarily focus on making cookies or something)? If themes do "wander" or swap in and out of long term memory, how does this change the concept of a concept cell, and how fast can a local "context" (duties) change?

Consciousness and imagination - Presumably concept neurons can be used to "imagine" many possible future events and scenarios. As per John Taylor's theory of consciousness [4], a sense of self, and what the expected results of one's actions should be, are critical to learning a model of the external environment (including collaborators, competitors, etc), and to evolve/adapt behaviours and plans accordingly ("control strategies" in the terms of Paul Werbos' Approximate Dynamic Programming ideas). While I've seen models of learning (eg temporal difference learning) and control theory (Approximate Dynamic Programming (ADP) community especially) and creativity (Ali Minai), I haven't followed neural network based symbolic systems, other than Hecht-Nielson's.

C. How are concept neurons used?

Walter Freeman (Sun, August 25, 2013 4:32 pm) I like his contrasting perspectives on Freeman-K-set model as a finite state automaton using thermodynamics and random graph theory versus his complementary description using thermodynamics and quantum field theory (Note 1).

How are [functions, processes, dynamics] built and run, as distinct from how data is constructed? Are there "concept" neurons for processes? If so, do they use similar mechanisms? Several SIG comments touch on this, but I haven't listed them here.

Recurrent connections may be required for a symbolic / conceptual system - I liked this point in the SIG:
Ben Goertzel (Mon, 26 Aug 2013 07:55:08 +0900) and Michael Healy (Thursday, August 29, 2013 3:48 PM) My impression from Michael's comments in particular is that "relationships" (morphisms) between symbols are well-handled and preserved in Category Theory, and this requires back-connections (functors) between representations. "... this approach involves reciprocal pairs of connections, so feedforward networks are unlikely to be able to handle ...".
Tsvi Achler's (Fri, 30 Aug 2013 09:01:09 -0700) "functional" perspective of does NOT seem to include [functions, processes, dynamics], but instead contrasts recognition versus symbolic descriptions.

D. Structure and function:

I'm very interested in this theme, but perhaps it's too far off topic forthis SIG, although I suspect it would be come important when addressing mechanisms. Walter Freeman's concepts do provide for some ofthis, but not to the detail I hope to see some day (as he says on this SIG - a tenfold increase

over current resolutions will help progress).

NOTES:
1) Although I purchased the Freeman-Quiroga book [5] in early August at IJCNN2013 Dallas, I have yet to read that or the links provided by Walter in this SIG. I have followed several of Walter's past papers, and would have to go through those again to jog my memory. I don't find the ideas easy, but they are very stimulating and powerful, as well as being fun.

REFERENCES:
[1] Robert Hecht-Nielsen 2007 “Confabulation Theory: The mechanism of thought” www.springer.com 245pp plus DVD with videos ISBN 978-3-540-49603-8
[2] R. Quian Quiroga, I. Fried, C. Koch 2013 "Brain Cells for Grandmother"
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[3] Bill Howell 2011 "Confabulation Theory - “Plausible next sentence” survey"
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[4] John Taylor 2006 “The Mind: A users manual” John Wiley & Sons, Chechester, West Sussex 286pp
[5] Walter J. Freeman, Rodrigo Quian Quiroga 2013 “Imaging brain function wth EEG: Advanced temporal and spatial analysis of electroencephalographic signals” www.Springer.com 248pp ISBN 978-1-4614-4983-6

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Appendix 4. Selected comments by Others - Asm Roy's IEEE-CIS Brain Representation SIG

Comments by others - used as background to my 03Oct2013 email :

-------- Original Message --------

Subject: Re: [Brain-Representation-SIG] Genes, God and the roulette wheel

Date: Fri, 4 Oct 2013 11:34:14 +1000
From: Allan
To: Brad, "brain-representation-sig@erlars.org" <brain-representation-sig@erlars.org>

Brad,
"but there would not be much opportunity for iterated learning mechanisms to control that process"
Possibly the point to be made here is that you are confusing a computationally implemented model with the actual physiology. Something that modellers and engineers/physicists often do.
Just because current methods of digital computation require iteration to achieve their result does not mean that neurophysiology must follow suite. ;-D
ADC

-------- Original Message --------
Subject: Re: [Brain-Representation-SIG] Genes, God and the roulette wheel
Date: Thu, 3 Oct 2013 18:03:04 -0400
From: Brad
To: Juyang
CC: brain-representation-sig@erlars.org <brain-representation-sig@erlars.org>

John,
I am not entirely sure what you are suggesting here, but if the implication is that synapses can form in 300ms, I would say that this has not been demonstrated empirically to the best of my knowledge, nor does it seem feasible given what is typically observed in cultured neurons. I think that in this passage, the authors were using the term "immediately" in the context of a developmental time course (i.e. months) and did not mean to imply a time course of less than a second, which is my meaning of "immediate"
Now it's true that synapses can grow surprisingly fast. I recall seeing evidence that this can occur within a few minutes, but even that is not fast enough to support our ability to form mental representations of novel objects on-the-fly (which should be taken to mean within several hundred milliseconds).
-Brad

-------- Original Message --------
Subject: Re: [Brain-Representation-SIG] Genes, God and the roulette wheel
Date: Thu, 03 Oct 2013 17:27:27 -0400
From: Juyang
To: Brad
CC: brain-representation-sig@erlars.org <brain-representation-sig@erlars.org>

I quote from http://www.jsmf.org/about/j/neural_connections.htm

"The process by which axons reach their dendritic targets is not an arbitrary, random one. The brain has to form the correct contacts and circuits between axons and dendrites. Sometimes, the axons must traverse relatively vast distances - on an axonal scale, distances equivalent to our making a coast-to-coast U.S. trip - to find their appropriate target cells. Genetic mechanisms guide this neural mass migration. Following a trail blazed by physical, mechanical, and chemical markers, axons reach and identify their appropriate target cells. They even find the appropriate sites on the target cells' dendrites. In humans, the migration begins about four months before birth and ends shortly after birth. Once the axons and target cells recognize each other, synapses begin to form almost immediately."

How fast is that immediately? That is close to our input signal based initialization for neuron's initial weight.

-John

-------- Original Message --------
Subject: Re: [Brain-Representation-SIG] Genes, God and the roulette wheel
Date: Thu, 3 Oct 2013 16:05:35 -0400

From: Brad
To: Juyang
CC: brain-representation-sig@erlars.org <brain-representation-sig@erlars.org>

Hi John,
Well that's the tough question: does synaptic modification occur on a sufficiently rapid time scale to allow these competitive dynamics to emerge and resolve within about 200-300 ms? I tend to assume that the brain is not sufficiently plastic to be modified so quickly, and therefore it seems useful to assume that there is a mechanism for representing a novel stimulus immediately.
-Brad

-------- Original Message --------

> ***Subject: Re: [Brain-Representation-SIG] What evidence do we need to show that the brain is a symbol system?***

Date: Mon, 30 Sep 2013 17:21:05 +0800
From: Ben
To: Rodrigo
CC: brain-representation-sig@erlars.org <brain-representation-sig@erlars.org>

Thanks Rodrigo, I will read your paper carefully... I have read a few of your prior papers but not this one.

I am very curious about how concept cells and distributed representations might interact. Suppose that we have two concepts F and G, and each has both a distributed and a localized (concept cell) representation: F_dist, F_local, G_dist, G_local ...

I wonder if somehow: The feeding of G_local as an "input" to F_dist, could serve as a neural implementation of what we would mathematically depict as F(G)
i.e. F taking G as an argument....

That is, I am wondering if neurally

F(G) = F_dist (G_local)

This notion intrigues me because of the way mathematical formalisms like combinatory avoid use of variables via using higher-order functions (functions that take functions as arguments). I wonder if the brain might do something similar (though certainly with many differences and peculiarities)...

So for instance if
F = kick
G= cat

then perhaps the notion of "kick a cat" would be associated with a dynamic such as
kick_dist(cat_local)

i.e. the concept neurons for "cat" stimulating global activity in the distributed representation for "kick" ...

I realize this sort of hypothesis may go beyond what we can measure reliably now, but I'm still curious for others' relevant thoughts and intuitions

thx

Ben Goertzel

-------- Original Message --------
Subject: Re: [Brain-Representation-SIG] What evidence do we need to show that the brain is a symbol system?
Date: Mon, 30 Sep 2013 10:13:57 +0100
From: Rodrigo
To: Ben
CC: brain-representation-sig@erlars.org <brain-representation-sig@erlars.org>

Dear Ben et al,

I agree that if a model contradits the data, then the model, rather than the data, should be revisited. I think the evidence about concept cells is too strong to be ignored.

I said this in previous posts, so I won't make any long arguments, but I wanted to point out that concept cells are far from epiphenomena, I believe they are actually the key neural substrate for the formation of episodic memories. They are also necessary computationally: without such a representation the brain wouldn't be able to quickly create new links, which is the mechanism needed for episodic memory formation.

I don't like to be self-promoting my own papers, but these are actually the main points of my NRN 2012 article http://www2.le.ac.uk/departments/engineering/research/bioengineering/neuroengineering-lab/Publications/NRN_RQQ_2012.pdf and I don't know papers by others making such claims about concept cells.

The idea of the function of concept cells comes from a convergent set of findings described there and from evidence from HM and other lesions studies of the MTL (see reviews by Squires and many others). The computational aspect comes from models of McClelland et al 1995 (complementary learning systems) following earlier work by Marr 1971.

Cheers,

Rodrigo

enddoc