
An Attempt to Generalize AI

Part 16: Speculation on

Autism

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24 July 2010

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This is the sixteenth in a series of articles attempting an overview of how minds may work and how similar systems could be implemented in computers. The cognitive model and approach to artificial intelligence uses a probabilistic hierarchy based on *patterns*. A pattern has a specification describing a set, or population, of *pattern instances*, distributed throughout a hierarchy containing the pattern instances of all the patterns. The hierarchy needs processing to provide *relevance*, with useful pattern instances being featured in the hierarchy, and used as a basis for exploratory extension of the hierarchy, while less useful pattern instances are removed, so that the hierarchy “grows” into high-relevancy regions, and this is achieved by a back-propagation *relevance measurement process* and a process to assign relevance values to pattern instances. Restrictive and repetitive behavior in autistic spectrum conditions could be explained in terms of a problem with the processing to provide relevance in the hierarchy. If the rate of turnover of pattern instances – the rate at which low-relevance pattern instances are removed and new ones are added – is reduced, the ability of the hierarchy to adapt its structure in response to occurrence of external inputs/outputs will be affected; however, the availability of “old” pattern instances in the hierarchy could also make otherwise inaccessible regions of the hierarchy accessible. Other characteristics of autism might be explained by other causes, though there could be an overall, ultimate cause, but they might also be explained in terms of the general limitation in modeling described here. The cognitive model treats the “self” as just part of the model, so any limitation in modeling ability which affects representation of other people might affect representation of the “self”.

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List of Abbreviations

AI	artificial intelligence
BERP	basic, exploratory relevance process
ERP	exploratory relevance process
PDD-NOS	Pervasive Developmental Disorder-Not Otherwise Specified
RMP	relevance measurement process

1 Introduction

This article is the sixteenth in a series intended to develop a model of human cognition which could be used for producing artificial intelligence (AI). For anyone who has not read all the previous articles to date, I suggest going to the article immediately before this one: *An Attempt to Generalize AI – Part 15: A Complete Description*, available at <http://www.paul-almond.com/AI15.pdf>.¹ This article is an ideal starting point, because it gives a complete description of the cognitive model that has been developed so far.

The previous articles have been used to develop a model of cognition, and approach to AI, and discuss some general philosophical issues that relate to this.

The cognitive model involves a hierarchy based on *patterns*, which are sets of *pattern instances*.² The system is not there just to model the world: It needs to plan actions. Planning is provided by the *action selection process*, which involves using the modeling system to model the system itself to plan its behavior.³

The hierarchy needs to be *relevant*, which means including the pattern instances that represent those features of the world which are most useful in planning actions and excluding others. This requires a way of measuring the relevance of pattern instances, and this is provided by the relevance measurement process (RMP).⁴ The RMP starts with particular pattern instances, used in the action selection process and corresponding to future inputs, being assigned relevance and this relevance is then back-propagated so that other pattern instances are assigned relevance. The relevance values are used in a

¹ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>.

² Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.10-31.

Almond, P., 2010. *An Attempt to Generalize AI - Part 1: The Modeling System*. [Online] paul-almond.com. <http://www.paul-almond.com/AI01.pdf> or <http://www.paul-almond.com/AI01.doc>.

Almond, P., 2010. *An Attempt to Generalize AI - Part 5: A Completely Probabilistic Hierarchy*. [Online] paul-almond.com. <http://www.paul-almond.com/AI05.pdf> or <http://www.paul-almond.com/AI05.doc>. pp.8-29. (Part 5 supersedes the description in Part 1, which referred to the (now obsolete) concept of "fixing".

³ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.32-41.

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⁴ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.53-56.

Almond, P., 2010. *An Attempt to Generalize AI - Part 6: Measuring Relevance*. [Online] paul-almond.com. <http://www.paul-almond.com/AI06.pdf> or <http://www.paul-almond.com/AI06.doc>.

basic, exploratory relevance process (BERP), which involves continual removal of low-relevance pattern instances while the hierarchy is extended from the pattern instances that remain.⁵ “Forgetting” – the removal of obsolete pattern instances – is also provided by the BERP.⁶

There are various ways in which the sophistication of the BERP might be increased, giving an improved exploratory relevance process (ERP).⁷

Relevance can also be provided by *reflexive outputs*: special outputs which, while made in the same way as other outputs, are directed inwards, acting on the hierarchy itself.⁸

The view of planning of actions taken in this series has implications for our view of the “self”.⁹ In this view, there is no separate system, outside the hierarchical model, that is planning all the actions. Planning is something that is done mainly within the model. The system has no special “self-modeling” process. Instead, what we think of as the “self” is part of the model within the hierarchy, generated in much the same way as the parts of

⁵ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.57-64.

Almond, P., 2010. *An Attempt to Generalize AI - Part 7: A Basic, Exploratory Relevance Process*. [Online] paul-almond.com. <http://www.paul-almond.com/AI07.pdf> or <http://www.paul-almond.com/AI07.doc>.

⁶ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.77-85.

Almond, P., 2010. *An Attempt to Generalize AI – Part 8: Forgetting as Part of the Exploratory Relevance Process*. [Online] paul-almond.com. <http://www.paul-almond.com/AI08.pdf> or <http://www.paul-almond.com/AI08.doc>.

⁷ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.70-76.

Almond, P., 2010. *An Attempt to Generalize AI - Part 9: Improving the Exploratory Relevance Process*. [Online] paul-almond.com. <http://www.paul-almond.com/AI09.pdf> or <http://www.paul-almond.com/AI09.doc>.

⁸ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.85-90.

Almond, P., 2010. *An Attempt to Generalize AI - Part 13: Reflexive Outputs*. [Online] paul-almond.com. <http://www.paul-almond.com/AI13.pdf> or <http://www.paul-almond.com/AI13.doc>.

⁹ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.53-56.

Almond, P., 2010. *An Attempt to Generalize AI - Part 2: Planning and Actions*. [Online] paul-almond.com. <http://www.paul-almond.com/AI02.pdf> or <http://www.paul-almond.com/AI02.doc>. pp.23-24.

the model that deal with any other aspects of reality. A view of cognition in which the “self” is part of the model has been described by Thomas Metzinger.¹⁰

As well as attempting to develop a model of cognition and approach to AI, I have taken a wider view in discussing some issues relating to cognition within the context of this model. It was suggested in *An Attempt to Generalize AI – Part 11: Explaining Dreaming* that dreaming might be explained in terms of a partially functioning hierarchy, the idea being that waking experience is a special case of a dream which happens to be caused by a particularly highly functional hierarchy which is particularly strongly influenced by the external world.¹¹ *An Attempt to Generalize AI – Part 14: Mind Control Speculation* suggested that the cognitive model suggests a mechanism for mind control, in which the brain is “lied to” about outputs that it has made, so that the “self” generated in the model is based on misleading records of previous behavior.¹²

This article will take a similarly wide view. It will attempt to explain some of the features of *autism* within the context of the proposed cognitive model. What will be said about autism in this article could also apply to the two conditions regarded as related to autism, or as forms of it: *Asperger syndrome* and *Pervasive Developmental Disorder-Not Otherwise Specified* (PDD-NOS).

¹⁰ Metzinger, T. (2003). *Being No One: The Self-Model Theory of Subjectivity*. Cambridge, MA: MIT Press.
Metzinger, T. (2009). *The EGO Tunnel: The Science of the Mind and the Myth of the Self*. New York: Basic Books.

¹¹ Almond, P., 2010. *An Attempt to Generalize AI - Part 11: Explaining Dreaming*. [Online] paul-almond.com. <http://www.paul-almond.com/AI11.pdf> or <http://www.paul-almond.com/AI11.doc>.

¹² Almond, P., 2010. *An Attempt to Generalize AI - Part 14: Mind Control Speculation*. [Online] paul-almond.com. <http://www.paul-almond.com/AI14.pdf> or <http://www.paul-almond.com/AI14.doc>.

2 Autism

Autism is a neurological disorder characterized by impaired social ability, impaired communication and restrictive or repetitive behavior. In this article, I will be focusing on restrictive and repetitive behavior and I will not be going into the other characteristics in detail.

Restrictive and repetitive behavior typically includes ritualistic/sameness behavior, stereotypical behavior, self-injurious behavior, compulsive behavior and restricted interests.¹³ This is suggestive of autism involving *a reduced ability to cope with change in the environment or to change behavior*. Subjects with Asperger syndrome tend to be intolerant of unpredictability and have difficulty in transitioning between tasks.¹⁴ This is also suggestive of problems coping with change or changing behavior.

In this article, I will be describing how difficulty in dealing with change or changing behavior could occur within the context of the cognitive model developed in this series. This still leaves the other main characteristics of impaired social ability and impaired communication. One answer to these could be that humans are particularly dynamic, and any condition which causes problems in dealing with change is going to cause problems in dealing with humans. Another answer could be that separate mechanisms, beyond the scope of this article, may be involved for these, although they may ultimately have some common cause.

¹³ Williams, D.L., Goldstein, G. & Minshew, N.J., 2006. Neuropsychologic functioning in children with autism: further evidence for disordered complex information-processing. *Child Neuropsychology*, 12(4-5), pp.279-298.

¹⁴ Dubin, N., 2009. *Asperger Syndrome and Anxiety*. London and Philadelphia: Jessica King Publishers. pp.48-49.

3 Autism within the Context of the Cognitive Model

3.1 Relevant Features of the Cognitive Model

The cognitive model developed in this series of articles is based on a hierarchy of *pattern instances*, the state of each pattern instance only being represented probabilistically in a real computer or brain.¹⁵ Each pattern instance is dependent, directly or indirectly, on external inputs/outputs occurring at specific times.

There is a *turnover* of pattern instances in the hierarchy and this is performed by the basic exploratory relevance process (BERP) or some other exploratory relevance process (ERP).¹⁶ Low-relevance pattern instances are continually removed, while new pattern instances are added. There would probably be a statistical element to this process, with the relevance of a pattern instance determining the *likelihood* that it is permitted to remain in the hierarchy at any time.

The number of pattern instances in the hierarchy at any time should depend approximately on the available computing power. As this should remain about the same over time, the number of pattern instances should also remain about the same – allowing for an initial period during which the hierarchy is set up. All the time, pattern instances are being removed from the hierarchy, with the chance of any particular pattern being selected for removal at any time depending on its relevance, while new pattern instances are being added to replace them.

3.2 A Possible Cause of Restrictive and Repetitive Behavior in Autism

I suggest that restrictive and repetitive behavior can be explained by the structure of the hierarchy not adapting rapidly enough to change. This can be explained in terms of a reduced rate of turnover of pattern instances: The rate at which low-relevance pattern instances are being removed from the hierarchy, and replaced by new pattern instances, is reduced.

There is no need for concern about whether the problem is a reduction in the rate of removal of pattern instances or a reduction in the rate of addition of new ones: Both

¹⁵ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.10-31.

¹⁶ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.47-69.

rates will tend to be the same. Pattern instances cannot be added at a greater rate than that at which they are removed for any great length of time, because the limit imposed by available computing resources would soon be reached. Pattern instances cannot be added at a rate *less* than that at which they are removed for any great length of time, because this would depopulate the hierarchy completely.

With reduced pattern instance turnover rate, the structure of the hierarchy will not adapt as quickly as it otherwise would to the occurrence of external inputs/outputs.

It should be noted that this is only the *structure* of the hierarchy not adapting quickly enough. The hierarchy will still adapt in as much that the occurrence of external inputs/outputs will alter bottom-level probability values, with probabilistic information propagating through the hierarchy, but this is not the structure adapting. The probabilities computed in the hierarchy will be “correct”, in the sense that they would have been produced by a sound process, but the reduced pattern instance turnover rate will mean that the structure of the hierarchy is not optimized for doing this computation *efficiently* and with full use of recently acquired information.

With reduced pattern instance turnover rate, the structure of the hierarchy will tend to be more suitable for representing things as they once were. With older pattern instances being around for longer, it is more likely that new pattern instances will be connected to them, causing the hierarchy to be “deeper” than it would otherwise be with a higher turnover of pattern instances. It is not necessarily the case that this would just be causing low-relevance pattern instances to be in the hierarchy: Pattern instances that would normally have been removed might act as a “bridge” to potentially high-relevance regions of the hierarchy that would be inaccessible with more efficient “housekeeping”. This might explain why subjects with autistic spectrum conditions sometimes display enhanced abilities in some areas. New pattern instances *will* be added which relate strongly to ongoing inputs/outputs, but these parts of the hierarchy will tend to be shallower than older parts of the hierarchy.

The explanation I have given here is quite short, but it is intended to be within the context of the more detailed cognitive model described in previous articles. Anyone who has read *An Attempt to Generalize AI - Part 15: A Complete Description* should see *exactly* what I am suggesting.¹⁷

¹⁷ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>.

3.3 Impairment Beyond that of Restrictive and Repetitive Behavior

3.3.1 Impaired Social Ability and Communication

As I said previously, in Section 2: Autism, on page 7, the explanation given here works more obviously for restrictive and repetitive behavior than for impaired social ability and communication. One possibility is that impaired social ability and communication might have different causes than the one described here, though there might ultimately be a single cause. Another possibility is that impairment in social ability and communication may just be *specific* results of modeling being *generally* compromised by reduced pattern instance turnover. Social abilities would require the modeling system to represent other people, and people are particularly complex and dynamic: We might expect a modeling system with limited ability to respond to change to have problems with this.

3.3.2 Impaired Representation of the “Self”

If social abilities *are* compromised by some general limitation on modeling, such as the one described here, then in the context of the cognitive model proposed in this series of articles, this has implications for the “self” as well. In the cognitive model developed in this series, there is no special “self-modeling” feature. Instead, the “self” is just another object in the model and it is not qualitatively different from representations of *other people*.¹⁸ Metzinger has previously proposed this kind of view of the “self”.¹⁹ We should therefore expect the “self” to be compromised by any general limitation in modeling that compromises representation of other people. This might conceivably manifest itself as a subject having *reduced self-knowledge*.

¹⁸ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.53-56.

¹⁹ Metzinger, T. (2003). *Being No One: The Self-Model Theory of Subjectivity*. Cambridge, MA: MIT Press. Metzinger, T. (2009). *The EGO Tunnel: The Science of the Mind and the Myth of the Self*. New York: Basic Books.

4 Conclusion

Autism is characterized by impaired social ability, impaired communication and restrictive or repetitive behavior. An explanation for restrictive or repetitive behavior has been suggested within the context of the cognitive model proposed in this series of articles.

Restrictive or repetitive behavior could be caused by a reduction in the rate of turnover of pattern instances in the hierarchy: the rate at which pattern instances are removed and new ones are added. The hierarchy would still be getting updated with information about external inputs/outputs as they occur, and the related propagation of probabilistic information through the hierarchy would be functioning normally. The reduction in the rate of pattern instance turnover, however, would limit the ability of the hierarchy to modify its *structure* to take account of recent inputs/outputs and make probabilistic predictions efficiently and with recent information.

A reduction in pattern instance turnover rate need not affect the hierarchy in negative ways only. It could cause the hierarchy to be “deeper” than it would otherwise be, and could make parts of the hierarchy accessible that would otherwise be inaccessible. Some of these parts of the hierarchy could have high relevance.

Reduced pattern instance turnover works more obviously as an explanation for restrictive or repetitive behavior than it does for impaired social ability and communication. These might be explained by other causes, though there could be a single ultimate cause behind all this. Alternatively, impaired social ability and communication might be explained as *specific* results of the *general* limitation in modeling described in this article: People are particularly complex and dynamic, so maybe it should not be surprising if a compromised modeling system has problems representing them.

The cognitive model developed in this series of articles views the “self” as merely another object in the model, so that your brain is representing “you” in fundamentally the same way that it represents other people.²⁰ If this is the case, and if representation of other people is being compromised by some general limitation in modeling, this suggests that the “self” should be similarly compromised, which may result in an autistic subject having reduced self-knowledge.

²⁰ Almond, P., 2010. *An Attempt to Generalize AI - Part 15: A Complete Description*. [Online] paul-almond.com. <http://www.paul-almond.com/AI15.pdf> or <http://www.paul-almond.com/AI15.doc>. pp.53-56.

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Ibid. pp.23-24.

Almond, P., 2010. *An Attempt to Generalize AI - Part 3: Forgetting*. [Online] paul-almond.com. Available at: <http://www.paul-almond.com/AI03.pdf> or <http://www.paul-almond.com/AI03.doc> [Accessed 24 July 2010].

Almond, P., 2010. *An Attempt to Generalize AI - Part 4: Modeling Efficiency*. [Online] paul-almond.com. Available at: <http://www.paul-almond.com/AI04.pdf> or <http://www.paul-almond.com/AI04.doc> [Accessed 24 July 2010].

Almond, P., 2010. *An Attempt to Generalize AI - Part 5: A Completely Probabilistic Hierarchy*. [Online] paul-almond.com. Available at: <http://www.paul-almond.com/AI05.pdf> or <http://www.paul-almond.com/AI05.doc> [Accessed 24 July 2010].

Ibid. pp.8-29.

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