An Attempt to Generalize AI Part 12: Pattern Relevance

By Paul Almond

15 June 2010

Website: http://www.paul-almond.com
E-mail: info@paul-almond.com

This is the twelfth in a series of articles attempting an overview of how minds may work and how similar systems could be implemented in computers. Previous articles described 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. Each pattern's set of pattern instances is used to obtain statistical information for probabilistic predictions. Each pattern's population of pattern instances is to be described in a very general way, to provide a very general ontology. An *exploratory relevance process* has been previously described, the purpose of which is to ensure that the pattern instances included in the hierarchy are those which are relevant to the predictions of future evaluation function score values required in the system's action selection process. This is done by assigning relevance values to pattern instances in a back-propagation process. The issue of selecting the patterns themselves that will be involved in this has had little discussion, and this article remedies this by discussing the inclusion of pattern selection into an exploratory relevance process. A general view of the exploratory relevance process is also given: Although the exploratory relevance process involves trial and error, modifications to the hierarchy build on what already exists, and the hierarchy also directs its own future development.

Table of Contents

1 Introduction 4
2 The Existing Approach to Relevance 7
3 Dealing with Patterns 9
3.1 The General Idea 9
3.2 More Sophisticated Versions 10
4 A General View of the Exploratory Relevance Process 12
4.1 The ERP is exploratory 12
4.2 The ERP is *Directed* by the Hierarchy 12
4.3 High relevance is not everything 14
5 Conclusion 16
6 Bibliography 17

List of Abbreviations

AI	artificial intelligence
BERP	basic, exploratory relevance process
EFS	evaluation function score
ERP	exploratory relevance process
RMP	relevance measurement process

1 Introduction

This article is the twelfth in a series about artificial intelligence (AI) and how our own minds might work. The first article, *An Attempt to Generalize AI - Part 1: The Modeling System*, is available at http://www.paul-almond.com/AI01.pdf.[1] The second article, *An Attempt to Generalize AI - Part 2: Planning and Actions*, is at http://www/paul-almond.com/AI02.pdf.[2] The third article, *An Attempt to Generalize AI - Part 3: Forgetting*, is at http://www.paul-almond.com/AI03.pdf.[3]

These three articles described a hierarchy based on *patterns*, which are sets of *pattern instances*, and were intended to give an idea of how humans may model the world, plan actions and discard information from the model when it is no longer useful. The fourth article, *An Attempt to Generalize AI - Part 4: Modeling Efficiency*, which is at http://www.paul-almond.com/AI04.pdf, suggested that pattern instances should be allowed to have *incompletely specified pattern inputs*, so that it would be practical for the hierarchy to be "pruned" by some process seeking to maximize its relevance.[4] This required a *completely* probabilistic hierarchy, an issue dealt with in the fifth article of this series, *An Attempt to Generalize AI - Part 5: A Completely Probabilistic Hierarchy*, which is at http://www.paul-almond.com/AI05.pdf.[5]

That made a process to provide relevance in the hierarchy feasible. The sixth article, *An Attempt to Generalize AI – Part 6: Measuring Relevance*, which is at http://www.paul-almond.com/AI06.pdf, described a back-propagation process for measuring relevance in the hierarchy.[6] The problem is made tractable by the way in which the *action selection process*, described in the second article, *An Attempt to Generalize AI – Part 2: Planning and Actions*, works. The seventh article, *An Attempt to Generalize AI – Part 7: A Basic, Exploratory Relevance Process*, which is at http://www.paul-almond.com/AI07.pdf, described the *basic exploratory relevance process* (BERP), which uses this measuring process to direct the growth and pruning of the hierarchy.[7]

---

[1] 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.

[2] 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.

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

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

[5] 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.

[6] 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.

[7] Almond, P., 2010. *An Attempt to Generalize AI - Part 7: A Basic, Exploratory Relevance Process.*

The eighth article, *An Attempt to Generalize AI – Part 8: Forgetting as Part of the Exploratory Relevance Process*, which is at http://www.paul-almond.com/AI08.pdf, removed the need for the forgetting process in the third article, instead incorporating forgetting into the BERP, or any other exploratory relevance process (ERP).[8] This was done by modifying the relevance measurement process (RMP) to take account of obsolescence. This article also introduced *ghost pattern instances*. A ghost pattern instance is one that persists temporarily, after "removal" by the ERP, as a simple probability value, while it is still needed as a pattern input by other pattern instances. The incompletely specified pattern inputs introduced earlier are now ghost pattern instances. The ninth article, *An Attempt to Generalize AI – Part 9: Improving the Exploratory Relevance Process*, which is at http://www.paul-almond.com/AI09.pdf, discussed ways in which the sophistication of the BERP might be increased, giving an improved ERP.[9]

Functioning of the system requires pattern instances to be placed in the hierarchy on an ongoing basis, and pattern instances need to belong to patterns. A way in which this could work had been described in the first article, *An Attempt to Generalize AI - Part 1: The Modeling System*.[10] Other approaches, conforming to the same general idea, were discussed in *An Attempt to Generalize AI – Part 10: Alternatives for Pattern Instance Construction*, which is at http://www.paul-almond.com/AI10.pdf.[11]

The view of cognition in this series was related to dreaming in humans, with a suggestion for how it occurs in *An Attempt to Generalize AI – Part 11: Explaining Dreaming*, which is at http://www.paul-almond.com/AI11.pdf.[12]

This article will clarify an issue about relevance. Previous articles discussed how the ERP will achieve relevance by controlling the insertion and removal of pattern instances in the hierarchy, but the actual patterns have not been mentioned much since the start of

---

[Online] paul-almond.com. http://www.paul-almond.com/AI07.pdf or http://www.paul-almond.com/AI07.doc.

[8] 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.

[9] 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.

[10] 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.

[11] Almond, P., 2010. *An Attempt to Generalize AI - Part 10: Alternatives for Pattern Instance Construction*. [Online] paul-almond.com. http://www.paul-almond.com/AI0.pdf or http://www.paul-almond.com/AI10.doc.

[12] 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.

the series. This article will make it clear that *patterns themselves* will also be subject to the ERP. There will also be a general discussion about the hierarchy and relevance.

2 The Existing Approach to Relevance

Two forms of the hierarchy can be considered.

- The **conceptual hierarchy** is the hierarchy of all pattern instances. The conceptual hierarchy could never be represented in a computer, as it is infinite.
- The **actual hierarchy** is that part of the conceptual hierarchy which is represented in a computer. It consists of a selection of pattern instances.

Because the states of some of the pattern instances in the actual hierarchy are dependent on inputs/outputs that have yet to occur, they can only be known about probabilistically. This is achieved by propagating probabilistic information through the hierarchy in logic application and statistics application.

The existing approach to relevance assumes that there is a set of patterns which are to be used, and it deals with how to connect pattern instances of those patterns into the hierarchy. The idea is to represent only relevant parts of the conceptual hierarchy in the actual hierarchy.

A *basic exploratory relevance process* (BERP) has been described in *An Attempt to Generalize AI – Part 7: A Basic, Exploratory Relevance Process*,[13] though more sophisticated kinds of *exploratory relevance process* (ERP) could also be used. In the BERP, each pattern instance is assigned a relevance value. Pattern instances are continually added to the actual hierarchy, and they need to be connected to the ones that are already there. Pattern instances are also continually removed from the hierarchy, and the chance that a pattern instance avoids being removed at any time depends on its relevance: Low-relevance pattern instances are likely to be removed more quickly. The result will be an actual hierarchy that becomes denser where it has high-relevance, growing into high-relevance regions, and less dense where it has low-relevance.

The BERP, and other ERPs, require a way of assigning relevance values to all the pattern instances. This is done by the *relevance measurement process* (RMP), a relevance back-propagation process described in *An Attempt to Generalize AI – Part 6: Measuring Relevance*.[14] This starts by assigning relevance externally to particular, important, bottom-level pattern instances corresponding to future inputs, and then back-propagating this relevance through the hierarchy according to the degree of effect that pattern instances are having on pattern instances with already known relevance values.

---

[13] 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.

[14] 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.

The particular, important, bottom-level pattern instances get their importance from the way in which the system's actions are planned: the *action selection process* described in *An Attempt to Generalize AI - Part 2: Planning and Actions*.[15] The action selection process involves selecting an output value, when one is required, by trying the different possibilities and propagating probabilistic information through the hierarchy in each case, as if the output had occurred with the relevant output value. An evaluation function score (EFS) is continually computed from recent inputs, and encoded as bottom-level pattern instances, and the desirability of a particular output value can be determined by looking at the prediction for the pattern instances that will be used for future input of the EFS. It is these pattern instances which are the particular, important, bottom-level ones which are assigned relevance externally, and from where relevance is back-propagated, in the RMP.

This approach deals with pattern *instances*, but no mention has been made of selecting the *patterns* to be used. Pattern instances are associated with patterns, and some way is needed of selecting the patterns that are to be used.

[15] 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.

3 Dealing with Patterns

3.1 The General Idea

The way that ERPs work, as previously described, deals with putting pattern instances into the hierarchy and removing them, so that the hierarchy grows into the regions where it should be most dense, but pattern instances are grouped into sets known as patterns, and there is also the issue of deciding what patterns to use.

In the first article, it was assumed that patterns would be "constructive", in the sense that each pattern would control the connection of new pattern instances belonging to it into the hierarchy. With patterns working like this, when pattern instances are added in the ERP, they would have to be added by patterns. The issue then is: *which* patterns, out of the infinite set of possible patterns, get to add pattern instances in the ERP?

The method used to generate the patterns will be involved with this. In the first article, *An Attempt to Generalize AI - Part 1: The Modeling System*, the following was stated about generation of pattern specifications.

"This article has not discussed how the pattern specifications are generated. From where do the logic specifications and construction specifications come? This will be discussed later, but for now I will say that trial and error will play a big part in this. This may seem to be asking a lot of a trial and error process, given that the patterns are supposed to provide a system with intelligence. It is important to realize, however, that patterns are not expected to be very intelligent by themselves. A pattern is not required to solve any complex problem. All a pattern is required to do is expose a statistically interesting relationship within its set of pattern instances." [16]

I will not be trying to describe exactly how patterns are generated in this article. That would depend on how the pattern construction works. Having each pattern instance directing the wiring of its pattern instances into the hierarchy, as described in the first article, is only one way of doing it. In *An Attempt to Generalize AI - Part 10: Alternatives for Pattern Instance Construction*, different ways in which pattern construction specifications could work were discussed.[17] For example, one of these ways involved pattern instances being generated randomly, and then patterns awarding pattern instances varying degrees of membership, based on the wiring of the pattern instance and the local wiring of the hierarchy.

---

[16] 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. p.29.
[17] Almond, P., 2010. *An Attempt to Generalize AI - Part 10: Alternatives for Pattern Instance Construction*. [Online] paul-almond.com. http://www.paul-almond.com/AI0.pdf or http://www.paul-almond.com/AI10.doc.

We do not need to know exactly how patterns would work, or how they would be generated, to have some idea of how we would select patterns for use once they have been generated: We just need to know how to assess the relevance of a pattern. Fitting a way of doing this in with the ERP, discussed in previous articles, is not very complicated.

The ERP works on the basis of relevance being assigned externally to particular pattern instances corresponding to future inputs: pattern instances which will be used in the action selection process for future input of the evaluation function score (EFS). A pattern can be assessed according to how it affects the uncertainty of the same pattern instances. If a pattern is not is not in use – meaning no pattern instances associated with that pattern are active – and the pattern is then activated, the change in the uncertainties of some pattern instances corresponding to future input of the EFS can be examined, and this would indicate the benefit that the pattern was providing. All else being equal, a pattern which caused the uncertainty in the pattern instances of interest to decrease a lot – meaning that their probability values moved away from 0.5 – would be considered very useful. This might not be the only thing that would be considered, however: The amount of computing power consumed by the pattern might be taken into account and weighed against the reduction in uncertainty, to give an overall indication of usefulness of the pattern.

When a new pattern is generated in some trial and error process, its desirability, in terms of reducing uncertainty in the bottom-level pattern instances involved in the action selection process, would be assessed. A limited pool of the most desirable patterns would be maintained, and these would be available for use in the ERP, with their pattern instances continually being added to the system, and removed from it, in the ERP. If the new pattern's desirability were high enough, it would be added to the pool, displacing a pattern already in it, and it would remain there until it was itself displaced by more desirable patterns.

An approach like this could be used if pattern instances were being generated randomly, but it could also be used if Darwinian evolution were used to generate patterns: Instead of generating patterns completely randomly, new patterns could be generated by variation, meaning mutation or crossover, of those already in the pool, and the desirability of these patterns would be assessed in the same way.

This kind of approach should be considered part of the ERP.

3.2 More Sophisticated Versions

A more sophisticated version of the above approach might involve patterns having variable levels of activity. The patterns considered most effective, in terms of reducing uncertainty in pattern instances corresponding to future EFS input, would be kept in a pool, but they would not have equal status. The more effective a pattern, in terms of

reducing uncertainty, the more pattern instances it could construct. The approach may also involve varying the activity of pattern instances over time. The best-performing patterns may be kept in the pool, but the effectiveness of each may vary over time, and as this occurs the extent to which it is used will vary. The ERP might also vary the level of activity of different patterns in different regions of the hierarchy. If pattern instances of a particular pattern, in a particular region of the hierarchy, seem to significantly decrease uncertainty in the pattern instances corresponding to future EFS input, that pattern may be allowed to insert more pattern instances in that region. It should be noted that the removal of pattern instances in the EFS achieves this ultimately anyway: If the pattern instances of a pattern are effective in some region of the hierarchy, they will tend to stay there, and if not they will tend to be removed.

4 A General View of the Exploratory Relevance Process

I will now give some consideration to what is *really* going on in the BERP or some other ERP.

4.1 The ERP is exploratory

When new pattern instances are added to the hierarchy, they are connected to pattern instances that have already survived previous pruning, so they are being added to parts of the hierarchy that are already particularly relevant. It does not *guarantee* that they will be relevant too, but the chances are increased a lot. The process is an exploratory one.

This might be thought of as being similar to growth of plant roots, as they seek out water and nutrients for a plant. Once a root has grown into some region and found suitable amounts of these, it makes sense to extend more roots out to explore from there. The process is therefore not totally random: It builds on what has been found. However, this analogy does not give a complete picture, as will now be described.

4.2 The ERP is *Directed* by the Hierarchy

The above analogy of the growth of plant roots misses out an important feature of the BERP or some other ERP. With plant roots, whether the tip of a given root will obtain water is mainly based just on where it is: The rest of the structure does not matter much. The actual hierarchy is not like this. In the actual hierarchy, the amount of relevance that a pattern instance gets does not depend just on "where" it is. Relevance is assigned to a pattern instance by the relevance back-propagation process, and this measures the effects that a pattern instance has on reduction of uncertainty of the bottom-level pattern instances that are of interest in the action selection process. A pattern's relevance only makes sense, however, within the context of the rest of the actual hierarchy. For a pattern instance to have high relevance, the following are needed.

1. The rest of the hierarchy, which propagates probabilistic information into the pattern instance in logical application or statistics application, propagates a significant amount of information into the pattern instance.
2. The rest of the hierarchy, into which the pattern instance propagates probabilistic information in logical application or statistics application, causes the uncertainty of the bottom-level pattern instances, corresponding to future EFS input, that are of interest in the action selection process to decrease significantly, as a result of this information being propagated into it.

The first condition applies because, if hardly anything is known about a pattern instance, what we know about it cannot significantly affect anything else. It is a prerequisite for a pattern instance to affect other pattern instances significantly that its own uncertainty should be reduced significantly.

The second condition applies because the information propagated into the hierarchy by a pattern instance does not *directly* affect the predictions that are to be made. Instead, a pattern instance affects other pattern instances, which affect others and so on. Ultimately, this chain of propagation affects the bottom-level pattern instances corresponding to future EFS predictions. Whether or not the information put into the hierarchy by a pattern instance is relevant depends on what the rest of the hierarchy does with this information – what happens in the rest of the chain.

The relevance of a pattern instance comes from *context*. The relevance of a pattern instance depends on the pattern instance and what is going on around it – what information is being propagated into it and what is happening to the information propagated out of it. This means that in the exploratory growth of the hierarchy in the EFS, the rest of the hierarchy imposes requirements that must be met for any single pattern instance to have high relevance, or for the pattern instances in any given region to have high relevance. A pattern instance can only have high relevance if it "fits in" with the rest of the hierarchy – if it receives significant information from it and puts information into it which causes the hierarchy as a whole to make useful predictions. Suppose that a new pattern instance is connected into the hierarchy as part of the ERP. If the pattern instance "fits in" with the rest of the hierarchy it will have high relevance, and will be likely to survive the later pruning of the hierarchy, but if it does not "fit in" with the rest of the hierarchy it will have low relevance and will be likely to be removed very quickly. The hierarchy is determining the properties that new pattern instances need to survive in it for any significant period of time, and it is directing its own growth along particular paths – quickly filtering out growth in directions that are not along these paths. The hierarchy can be viewed as *directing* its own growth.

This article has discussed dealing with patterns in the BERP or some other ERP, so that the ERP includes processes to select a number of preferred patterns from all the patterns that have been tried, and possibly to give different degrees of preference to different patterns in some way. This view of the hierarchy as directing its own growth is relevant here as well. Suppose a new pattern is generated and experimentally applied in the hierarchy. If it fits in well with the rest of the hierarchy, and achieves a significant reduction in the uncertainty of the hierarchy's predictions of future EFS values, then the pattern will remain in the hierarchy: otherwise it will be removed soon.

It is not all about pattern instances and patterns having requirements imposed on them by the rest of the hierarchy. A new pattern could be added to the hierarchy that generates a large number of high-level pattern instances that dictate the requirements for relevance of the pattern instances between them, so the new pattern itself can be

imposing what we might think of as hills and valleys in the landscape of the hierarchy beneath it, directing the addition of the pattern instances that are propagating information upwards.

4.3 High relevance is not everything

In the BERP, or some other ERP, the continual pruning could remove all but the most relevant pattern instances, but this would be inadvisable: There might be parts of the hierarchy of lower relevance that could become relevant later, and growing the hierarchy step by step into these regions when they start to become relevant could become an impractically slow process of crossing low-relevance gulfs. In *An Attempt to Generalize AI – Part 7: A Basic, Exploratory Relevance Process*, I discussed this issue, and suggested dealing with it by merely *favoring* pattern instances with high relevance to some (limited) degree, so that each pattern instance's "life expectancy" in the hierarchy depends on its relevance. I stated the following.

"We might adopt an approach of only allowing the most relevant pattern instances in the hierarchy, so that if the hierarchy contains n pattern instances then the only way any pattern instance can remain in the hierarchy is by being one of the n most relevant pattern instances known to the system at any time and the system not encountering any pattern instance with higher relevance. A possible issue with such an approach is one of accessibility. There could be regions of the hierarchy with very high relevancy, but which can only be reached via intermediate pattern instances with slightly lower relevancy. If such pattern instances are not allowed, such regions could never be reached.

For this reason, a better approach may be one that does not always select the absolute 'best' pattern instances, but instead favors those with higher relevance, so that the number of pattern instances allowed in the hierarchy at any time with a given degree of relevance is related to that degree of relevance, increasing as the degree of relevance increases: We would have a lot of pattern instances with high relevance and fewer pattern instances with low relevance. It should be noted that an approach of selecting only the most relevant pattern instances is really only a special case of this, in which the distribution of pattern instances over a range of relevance is made as narrow as possible." [18]

The result is a hierarchy that varies in density, rather than one which leaves entire regions entirely deserted. The hierarchy will extend lower-relevance "tendrils" out and these can be considered like tripwires, as described in the previous article.

[18] 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. pp.6-7.

"One way of thinking about the low-relevance pattern instances is in terms of 'tripwires'. The hierarchy will spread out a network of paths featuring low density, low relevance pattern instances, and these will play little part in any of its predictions. Occasionally, something may happen that causes the relevance of some of these pattern instances to increase. This causes the density of the hierarchy to increase locally, with more exploration occurring and more paths being generated locally. This low density, low-relevance part of the hierarchy has acted as a tripwire, ready to detect something interesting impinging on that part of the world view." [19]

[19] 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. p.10.

5 Conclusion

The exploratory relevance process (ERP), as previously described,[20] deals with selection of pattern instances in the hierarchy, on the basis of relevance, but the issue of which patterns to use has been ignored. This issue has been considered in this article. Patterns will be selected based on the extent to which they reduce uncertainty in the particular, bottom-level pattern instances corresponding to future input of the evaluation function score (EFS) in the action selection process.

Two important features of the ERP have been discussed.

- The ERP is exploratory. New pattern instances are connected to those already there, meaning that they will tend to be in regions of the hierarchy already known to have high relevance.
- The hierarchy directs its own growth. The relevance of a pattern instance depends on its context within the rest of the hierarchy. The structure of the hierarchy at any time, therefore, establishes future high-relevance paths that will be favored for addition of new pattern instances.

A point I will make her is that this series of articles is an attempt to develop an AI approach and a view of cognition, and I will not rigidly remain with any aspect of it if changing it seems appropriate. Right now, I am describing incorporating patterns into the ERP, but it could be that some change in approach regarding the relationship between patterns and pattern instances takes place later.

[20] 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. 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 Bibliography

Almond, P., 2010. *An Attempt to Generalize AI - Part 1: The Modeling System*. [Online] paul-almond.com. Available at: http://www.paul-almond.com/AI01.pdf or http://www.paul-almond.com/AI01.doc [Accessed 15 June 2010].

Ibid. p.29.

Almond, P., 2010. *An Attempt to Generalize AI - Part 2: Planning and Actions*. [Online] paul-almond.com. Available at: http://www.paul-almond.com/AI02.pdf or http://www.paul-almond.com/AI02.doc [Accessed 15 June 2010].

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 15 June 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 15 June 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 15 June 2010].

Almond, P., 2010. *An Attempt to Generalize AI - Part 6: Measuring Relevance*. [Online] paul-almond.com. Available at: http://www.paul-almond.com/AI06.pdf or http://www.paul-almond.com/AI06.doc [Accessed 15 June 2010].

Almond, P., 2010. *An Attempt to Generalize AI - Part 7: A Basic, Exploratory Relevance Process*. [Online] paul-almond.com. Available at: http://www.paul-almond.com/AI07.pdf or http://www.paul-almond.com/AI07.doc [Accessed 15 June 2010].

Ibid. pp.6-7.

Ibid. p.10.

Almond, P., 2010. *An Attempt to Generalize AI - Part 8: Forgetting as Part of the Exploratory Relevance Process*. [Online] paul-almond.com. Available at: http://www.paul-almond.com/AI08.pdf or http://www.paul-almond.com/AI08.doc [Accessed 15 June 2010].

Almond, P., 2010. *An Attempt to Generalize AI - Part 9: Improving the Exploratory Relevance Process*. [Online] paul-almond.com. Available at: http://www.paul-almond.com/AI09.pdf or http://www.paul-almond.com/AI09.doc [Accessed 15 June 2010].

Almond, P., 2010. *An Attempt to Generalize AI - Part 10: Alternatives for Pattern Instance Construction*. [Online] paul-almond.com. Available at: http://www.paul-almond.com/AI10.pdf or http://www.paul-almond.com/AI10.doc [Accessed 15 June 2010].

Almond, P., 2010. *An Attempt to Generalize AI - Part 11: Explaining Dreaming*. [Online] paul-almond.com. Available at: http://www.paul-almond.com/AI11.pdf or http://www.paul-almond.com/AI11.doc [Accessed 15 June 2010].