Sightech Vision Systems, Inc.

Real World Objects

Animals See the World in Terms of Objects – not Pixels

Animals, especially the more compact ones, must make good use of the neural matter that they have been given. To learn and be able to recognize an object, animals can either use one or several bits (neural synapses) to establish familiarity with the concept of the object, or 100's of thousands of pixel data that would not work or recognize anything. Nature makes its choice – and the choice was easy.

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Real World data is never encountered twice in the life of the universe!

Consider an animals visual system when it sees the real world. Millions of pixels are acquired at the sensor level. Each pixel can be one of more than 1 million colors (CCD cameras see 16 Million colors). For this reason and others, the exact color value of just any given pixel is infrequently encountered the same twice. This is also true even if the image was translated somehow so XY movement (jitter) was reduced. This is also true if the brightness levels are corrected. If it is difficult for one pixel, how hard is it for an entire image for an animal to see anything twice? Does this discussion promote the idea that images encountered by an animal can never be *seen* (understood) twice?

Actually, the opposite is true – they can be *seen* over and over. Animals do this easily.

For an animal to *"see it again"* it must have *"seen it before"*

Although seemingly obvious, it is important to postulate that the visually learned knowledge that an animal exhibits is learned by visually *seeing it before*. This means Yellow Jacket wasps learn how to fly back to their nests by actually flying back to their nests. They learn how to fly to a food source repeatedly the same way.

While witnessing the real world, repetition of visual stimuli (and other stimuli as well) is crucial to an animal's ability to learn. If an animal could not see anything twice, it could never learn any associations because it would have no handles to associate with each other. It is absolutely crucial that and animal can "see it again".

We arrive at a conflict: If animals must *see it again*, and visual images are too complex to *see it again* in the life of the Universe, how can animals acquire knowledge from visual real world sources.

You and I, like other animals, have the same problem with acquiring and using knowledge

You and I, like other animals, have the same problem. When we *see* the real world, we see a noiseless cognitive understanding of this data. It is important to note that we do not see the actual pixels sensed on our eyeball's retina. The actual raw data collected by our eyes is quite noisy and lacking proper positioning and color balance. To make matters worse, the pixel locations are scattered – they are more densely spaced in the center of our retina. Also, as we grow older, they die – this leaves fewer and fewer of them for collecting visual data. Do we see "holes", noise, and poor color in our vision? NO! Our mind interprets (*sees)* the world as recognized cognitive *objects* – not raw pixel-level data.

When we witness noise on a poorly tuned TV, we can *see* the noise on the screen – our *view* of the real world never *looks* like this. Also, we *see* colors that do not exist as pixel data – such as silver, gold, granite, brown, gray, white, black, etc. Many of our cognitive *colors* are not colors at all – they are abstract concepts of color that we have learned to detect and understand. If you surround a perfectly gray (dark white?) patch near certain other colors, it will actually appear pink or light blue! It is easy to create *optical illusions* that produce surprising cognitive understandings. By doing this, we are witnessing clues as to how our cognitive process works.

Animals need to see the world as a collection of cognitive simplifications. We call these simplifications *objects*.

There are several important reasons for an *object* understanding of the real world:

Animals need a practical and effective interface with real world's visual stimuli. They sometimes need to do this vast processing in a brain the size of a tiny speck of black pepper. The Yellow Jacket wasp has a brain this small, and it effectively navigates complex and long visual pathways with ease.

Animals absolutely must be able to see things repeatedly – *objects* can be easily revisited.

Rapid visual navigation by animals is made possible by an *object* understanding of the real world. Since there is a high rate of image experiences encountered by a flying wasp, an object understanding allows the insect to perform fast and continuously.

And, perhaps for the most important reason, animals need to have *handles (concepts)* on *events (objects)* in the real world in order to establish useful associations between them. All higher-level learning completely depends of this *object* or the real world.

Objects are the cognitive analog to *things* that occur in the *real world.*

Neural tissue is designed to do this cognitive simplification at the *tissue level*. This amazing tissue cannot help it – it is designed to do cognitive simplification from the ground up.

Imagine that we had a cylindrical piece of neural tissue with a flat front and back with many of the neurons stretching in the direction of the length of the cylinder. Also imagine that we imaged image data of the real world electrically on the front of this piece of neural tissue. What we would notice, over time, is that the output of the neural tissue, the other end of the cylinder, would improve over time. It would, over time, automatically start outputting patterns of data that coincide with the occurrence of objects on the front end of the tissue. Neural tissue is designed to do this as part of its nature.

How does the real world accommodate animal's *neural tissue* in the learning of *objects* without a teacher? The *real world*, itself, is the *teacher!*

We postulate further that animals must learn objects without the help of a teacher. How is this possible? If there is no parent or other animal to hold classes on learning of all the important *objects*, how can an animal learn them? Again, on another front, it seems that the task is impossible to accomplish.

To the contrary, animals learn these *objects* quite easily. This is because of a very important fact: the *real world*, itself, is the teacher!

Why is the *real world* the teacher, since it does not care about things like this? In fact, the real world cannot help but be the teacher. The physics of the real world establish relational *forces* that be used to be the *teacher* of neural tissue. Like the fact that neural tissue must learn and simplify regardless, the *real world* must teach regardless.

The “*Forces of Weak Association”*

The physics of the *real world* provides clues about the relationships inherent in it – it cannot help but do this. The *real world* consists of *things* – not pixels. Pixels are merely the low-level sensory interface with an animal’s vision apparatus and *things* that exist *real world.* Neural tissue must be *taught* these things, and the *real world* provides the lessons.

Forces of Weak Associations:

Stimuli that repeatedly occur proximate to each other in space are likely to be related.

Stimuli that repeatedly occur proximate to each other in time are likely to be related.

Stimuli that are repeatedly similar to each other in appearance are likely to be related.

The closer in time, space, and/or similarity things are, the more they are related.

The more frequent these relationships happen, the more they are related.

These *forces* are inherent in the data provided as gift from the *real world.* It is neural tissues job to absorb these important clues, over a massive amount of data experiences, and automatically build up a highly simplified and conceptual understanding of the *things* in the *real world*.

We call these *forces* weak because neural tissue must extract these clues from a large amount of experiences over an extended period of time. *Things* in the *real world* are strong, but the pixel-based image interface in animals provides *weak* data about the relationships of these *things.* Gradually learning these relationships turns this *weak* data into a very strong conceptual understanding.

We define an *Object* as the following:

“An *object* occurs when stimuli are sensed repeatedly together” (where this *togetherness* is quantified by the *Forces of Weak Association).*

Patterns in data, in the dimensions of time, space, and similarity, are formed as *concepts* in neural tissue. These *concepts* are activated in the neural tissue with their *object* analogs occur in the *real world.*

Something is still missing: *Hierarchies* and *Features*

We are back to the original problem – we cannot see large amounts of data twice for the duration of the universe. But, we can see very small pieces of data twice – even in a relatively small interval of time. We call these *Features. Features* are fashioned to embody enough information to be useful, but not so much that these pieces of data cannot ever be experienced again. We call this low level carefully crafted interface with the real world *Blurred Vision.* We mean there is a special level of visual coupling with the *real world* at the atomic level.

The *Feature Size* is a delicate balance. If the *feature* is too small, then the *Forces of Weak Association* will not deliver useful relationships. If the *feature* is too large, it will never be *seen twice*. The design and size of the *feature* has to be just right.

On the cognitive level, the *feature* is the lowest level *object. Hierarchies* are employed here to use the *Forces of Weak Association* to build up relationships of *features* to develop higher-level *objects* that are formed from encountered relationships between these *features.*

Hierarchies can be established at learn time, and they can also be executed at run time. *Features* are the basis of *hierarchies*, and *hierarchies* take the *feature level* interface to a high-level cognitive understanding of the *real world.*