

## WHITE PAPER

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# Continuously Learning Systems and the Hybrid System from iOmniscient

There is often a debate on which type of Artificial Intelligence - neural network (learning systems) or heuristic ones (rule-based systems) - are best able to cope with complex environments. In fact both have advantages and disadvantages. To take advantage of the strengths and eliminate the weaknesses of each type of Artificial Intelligence iOmniscient developed a hybrid that uses the strengths of both types of algorithms.

The use of continuous learning systems is not new. Many older systems have used the technique and in fact iOmniscient's hybrid system itself has used this for over 20 years. But continuous learning systems have many limitations which is why iOmniscient uses Continuous Learning Neural Networks as a small component of its overall system to complement the real intelligence which arises from the heuristic algorithms.

As a pioneer in Video Analytics, iOmniscient understands that using a pure learning system can have many disadvantages in that it cannot cope with constant changing circumstances – e.g. normally its ok if people on a railway platform put their bags down for 5 minutes because the trains come 5 minutes apart. But one day the trains are delayed and will only come every 10 minutes so on that day it would be considered normal for people to put their bags down for a maximum of 10 minutes while they are waiting. In a rule based system this is easy to change. In a neural network based learning system it would take a very long time for the system to learn the new rules and one would require a large sample size for the system to learn well. And then if the following day the trains are back on their 5 minute schedule it would cause havoc in a system that relied totally on neural networks.

In complex environments such as railways and airports, many things change constantly. Systems that are reliant on learning their environment on their own are only useful for very simple situations eg cars going one way on a road. If one vehicle goes the wrong way it can be caught. These purely learning systems are not useful in a complex environment as the system needs to respond fast to changed situations. One cannot afford to spend another 2 weeks learning the new “normal”.

Further ALL pure neural network based systems use Video Motion Detection to understand the motion in the scene. This limits them to operating in relatively empty scenes. None of them can cope with the crowded environment with significant obscuration.

Rule based systems too have one disadvantage. If the system is based on fixed rules it cannot automatically adapt to a changing requirement without reconfiguring the system to do so. For example, today the user wants to catch people wearing red shirts but tomorrow the user wants to catch people wearing yellow shirts.

The iOmniscient system uses a neural network based learning capability to understand the environment. When day transforms to night, when a cloud hides the sun, the system continuously learns about the changing situation. However, the objectives of the system are set by the user of the system. He (or she) decides what the system must achieve and at different times these objectives may change. A heuristic rule based system is used to set the rules for determining what behaviour to detect. The rules can be modified quickly and efficiently.

Systems that use only neural network based systems to determine what is normal and what is abnormal, have two major problems. It takes such systems a long time to learn what is normal (weeks, months, sometimes never). Further they cannot do it consistently. Promoters of such systems often suggest that their strength is that they do not require configuration. However the inability to configure them as required and their lack of adaptability to changing objectives usually makes such systems unusable.

*Example of a real situation that is too complex for Pure Neural Network based systems to cope with:*

At an airport they start to renovate one side of the terminal. Trades people with long ladders walk through the building. This is considered to be abnormal and hence it raises multiple alarms. Over a long period the system learns that it is acceptable for people with ladders to walk in that environment. By this time the renovations have been completed. Now a person with a ladder walks into the environment with the objective of using it for a nefarious purpose. The system will not recognize it because it assumes that it is normal for people to carry ladders in the airport.

Continuous Learning Neural Network Systems	Rule Based Heuristic Systems	Hybrid Systems (iOmniscient)
Very old technology	Newer more sophisticated technology	Uses both technologies as appropriate
Cannot cope with sudden change in the environment	Rules can be changed at short notice	Rules can be changed at short notice
Can only cope with empty scenes	The more sophisticated NMD systems can cope with complex and crowded scenes	iOmniscient has patents on coping with Complex and Crowded scenes – these are based on heuristic algorithms
Can only cope with simple behaviours	Can cope with complex behaviours	Can cope with complex behaviours
Can cope with slow changes in the environment	Cannot cope with slow changes in the environment	Can cope with slow changes in the environment.
Takes a long time to set up (weeks, months)	Can be set up very quickly (minutes)	Can be set up very quickly (minutes)
Can learn about and cope with some types of regularly occurring false alarms but cannot cope with sudden unexpected false alarms	Can cope with a wide range of false alarms	iOmniscient's unique NAMS system can cope with both regularly occurring and sudden false alarms.