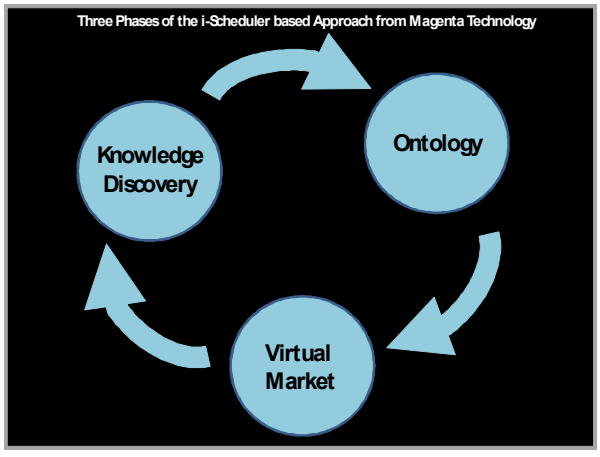
Applying Emergent Behaviour to Logistics

In this artlicle we explore the powerful potential of applications that exploit the concepts of Virtual Intelligent Life to generate Competitive advantage for Companies providing Logistics and Supply Chain services. We have selected the Intelligent Scheduler product from a Company called MAGENTA Technology for this purpose and will illustrate here its ability to generate significant improvements in the efficency and cost effectiveness of large scale Logistics networks. (Large here means upwards of thousands of a wide variety of orders being matched to resources in real time) In particular we feature its application to Companies involved in providing Logistic services over the UK Road Transportation Network. Our thanks go to MAGENTA Technology for agreeing to let us feature their Solutions in this article.

In the past people have approached the task of creating and managing Logistics Schedules by Conventional centralised, rules based designs. The resulting models are typically slow and non adaptive to real time events in the transportation network. These conventional models are at their weakest in dealing with large scale volatile scenarios.The use of a multi agent , evolutionary computing approach however can rapidly generate optimised and adaptive solutions even in this regime.

One of the attractive features of MAGENTA Technology's Solution to complex Scheduling problems is that it is based on a holistic cyclical approach as illustrated in the figure on the left which features three fundamental phase



1) Ontology

2) Virtual Market, and

3) Knowledge Discovery

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The typical Logistics network is very complex, e.g. cases involving the UK road Transportation network will involve multiple customer locations and cross docks (i.e. consoldation/ offloading points), multiple routes for order delivery, high volatility (i.e. unpredictable events such as new orders and weather impacts occuring throughout the day) as well as numerous constraints.

The Ontology Tool is employed in the first phase to capture this Conceptual Knowledge about the target Logistics Network and provides a formal representation of this knowlege in the form of a semantic network. This identifies the basic conceptual entities such as orders and resources and their inter-relationships. This has two benefits (a) it transfers knowlege from employees to the company, i.e. critical knowlege is not lost when employees leave, (b) a semantic network is by definition machine readable so it provides the playing field for the software Agents that drive the Virtual market that generates the actual resource allocation and the optimised Schedules.

The Virtual Market provides the environment that facilitates the interaction of the simple autonomous software Agents that are at the heart of the Solution. As we shall show it is from the interaction of these simple Agents that the optimised Global Schedule 'Emerges'. In the Market there are a number of different types of Agent, each representing a different player (object) in the Ontology. These include Customer Agents, Order Agents, Journey Agents, Truck Agents and in particular an Enterprise Agent. Each of these Agents selfishly and pro-actively pursues its own set of Goals (e.g. the Journey Agent seeks the best routes with minimal mileage.) In essence the Agents are trading in resource allocation and are provided with fixed amounts of virtual money (energy) with which to operate. The Solution allows each Agent to act in either supply or demand mode.

During the operation of the Virtual market the Agents interact as one or more swarms to achieve their individual goals, self organising into coalitions where it is in their own interest. Out of the non-linear dynamics of these interactions the Schedule emerges, typically oscillating dramatically at first between different network configurations before converging on a balanced Schedule. The Target balance here is defined by the Enterprise Agent and reflects the Enterprise Strategy e.g. defining the desired balance between profit and risk (e.g. confidence in delivering orders within customer time constraints)

The Solution enables the Emergent Schedule to be optimised in the event that it has initially converged on a Balance that is only partially satisfactory e.g. the profit may look great but the corresponding risk may be too high. In this case the Enterprise Agent can act as an Evolutionary Operator and generate a new evolved Schedule through a carefully controlled mutation of the Agent Goals (e.g. increasing the weight given to risk aversion slightly). This evolutionary process can be repeated using Darwinian (selection of the fittest) criteria to produce an optimised Schedule. From the perpective of Virtual Life the individual goals here can be thought of as genes making up the DNA of the Schedule.

The Intelligence that constructs the balanced Schedule emerges from the interaction of the simple Agents, it is not a top down human design! Simiarly the optimised Schedule can be

thought of as a product of the carefully controlled evolution of this intelligence under the influence of the Enterprise Agent, acting as an Evolutionary Operator.

UK Road Transportation Case Study - When fed with real world data from Logistics Service Providers using the UK Road Transportation network the Magenta Technology i-Scheduler produced impressive results. The case we feature here required the creation of transportation schedules for 4000 transportation orders and 200 trucks operating on the UK Transportation network. The network included primary and secondary deliveries between 600 locations, 3 cross docks, 4 secure trailer swap locations and other types of locations. The network was also characterised by a considerable number of very small orders. Special requirements included dynamic routing, cross docking, handling location availability windows and driver breaks.

It took the Magenta Technology i-Scheduler about 4 hours to build a schedule for 4000 orders and 200 trucks with dynamic routing through 3 cross docks. This schedule showed an effective consolidation of small orders onto trucks. It was capable of incrementally planning new orders in near real time (a few seconds was required for each new order). As far as we know this has not been achieved by any other transportation scheduling system.
Before testing the Magenta Technology solution the Client concerned had spent considerable resources searching for a scheduler capable of handling their requirements and had found none.

For a different UK Client the Magenta Technology i-Scheduler was able to provide transportation schedules in real time for 200 transportation instructions and 50 trucks. Again it was a complex network with 9 distribution centres, cross docking and 3 truck bases doing shared operations. Prior to using Magenta Technology the Client had to plan two days in advance of execution. The Magenta Technology i-Scheduler produced the Schedule within 8 minutes! So if you are in the Logistics business and you are looking for competitive differentation then we would recommend that you take a good look at Magenta Technology.

Knowledge Discovery is the third phase of the Magenta Technology approach to generating a complete Solution. The Knowledge Discovery tool exploits emergent intelligence by allowing Agents associated with individual records to swarm over the Logistics database interacting with other Agents to form clusters of similar records (patterns). The patterns that emerge are often unexpected and reveal knowledge about the Business. An example might be repeating sequences of orders from different customers. The data here includes data on past performances as well as data on tranportation routes, supplies, order history and so on. The knowledge harvested through this tool can then be used to improve and tune the Scheduling strategy, as part of a continuous cycle of improvement.

The Knowlege Discovery tool has significant potential in the wider Business Area of Data Mining. There are many industries that could benefit from the ability of the Magenta Technology Solution to discover and explore new Behaviourial patterns in large data bases in near real time. Obvious examples here include both Financial and Government Sector Applications.

Thought Leadership - One of the things we like about Magenta Technology is its pro-active approach to Research and Development. This is already helping to establish Magenta Technology as a thought leader in this field. Their Russian Research and Development Team have created a powerful generic Architecture that enables the Truck Scheduling product to be applied potentially to a wide variety of Business Applications.

Examples of this Research and Development investment that are already being applied to the Magenta Technology product set include the concepts of a Framework supporting Communities of Agents, microeconomic rules and vertical and horizontal interactions between Agents and Communities of Agents. Magenta Technology are also researching into the challenges associated with managing the system behaviour close to the edge of chaos where transitions between states governed by different Strange Attractors often occur. This is where you find the best levels of adaptability, navigating in the state space between the attractors that lie along the edge of chaos is a challenging task but has significant potential in many fields not just in Logistics.

We feature a video of the UK Road Transportation Show Case of Magenta Technology - i-Scheduler product on the Solutions section of our Pan European Web Site www.Evil.eu

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