Ambient, Autonomic and Organic Systems—collectively called Complex Adaptive Systems—are software systems that sense changes in their environment and adapt their behaviour accordingly.

First, they collect data from sensors, then analyse that data for relevance, and act on this information by modifying and optimising their behaviour.

As they evolve, they can learn new adaptations and strategies for self-management, giving way to emergent behaviour.

Incoming sensor data is highly voluminous, noisy and incomplete. This creates challenges for system designers and administrators in managing, understanding and reasoning about such a large, constantly-changing data set.

By coupling visual analysis of the sensor data that the system is reasoning about with information about the system’s reasoning process, we afford the designer insight into why the system is behaving as it is.

My research involves the development of visual analytics tools to support the development and comprehension of complex adaptive systems.

Contextual data derived from sensors drive context-sensitive systems. This data must be distributed so that adaptive systems can use it. This tool visually charts the diffusion of data around a highly volatile network of nodes, allowing the protocol designers to observe the emergent behaviour of the devices in the network, and watch problems developing in real time.

Reasoning about all of the accumulated contextual information involves distilling information based on readings from heterogeneous sensors, all of which may be transmitting data at different frequencies and resolutions. The presumed accuracy of the sensor should be taken into account, as well as historical patterns to make up for gaps in the sensor's readings.

Adaptive behaviours have a corresponding time criticality and execution window. With the amount of sensor data being transmitted around the system, deciding which sensors to accommodate and which patterns to look for is difficult. This visualisation allows the designer to interact with the weights assigned to each input, so they can limit the influence of noisy sensors and highlight sensors likely to be useful.

The designers of complex adaptive systems must explore the sensor data that the system is receiving to discover patterns and trends, and then attach behaviours to these situations.

Even a small number of sensors will result in an enormous amount of incoming data, which is difficult for the system designer to reason about, much less use as a basis in developing a robust, complete set of adaptation rules.

To achieve this we are developing a visualisation framework which models incoming sensor data as a set of continuous function curves. By layering these curves together in one view, the patterns of values, rates of change and margins of error can be viewed simultaneously, giving the developer an overview while allowing them to extract detail when needed.

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