Third Workshop on Hot Topics in Autonomic Computing (HotAC III)

Wheeling, IL
June 2, 2008

Summarized by Alva Couch, Tufts University

The theme of this year's Hot Autonomic Computing (HotAC) was "grand challenges of autonomic computing." By contrast with two prior iterations of HotAC involving papers and panels, this year's HotAC included short presentations, working groups, and plenty of discussion.

In the morning, selected attendees were given five minutes each to describe a grand challenge problem in autonomic computing, how to solve it, and what resources would be required. Presenters were selected based upon white papers submitted to the conference organizers in advance. In the presentations, several themes emerged, including monitoring, composition, applications, and human concerns.

Autonomic systems remain difficult to monitor and the monitored data remains incomplete. Autonomic system state remains difficult to characterize and more accurate models are needed (Salim Hariri, University of Arizona). There is a need for "adaptive monitoring" that tracks changing needs (Paul Ward, University of Waterloo), as well as "experiment-based" control based upon making changes and observing results (Shivnath Babu, Duke University). The resulting monitoring infrastructure must be scalable and adaptable to a changing Internet (Fabián Bustamante, Northwestern University).

It also remains unclear how to compose different control systems to control one entity, and how to deal with openness and unexpected events. It remains difficult to compose or combine autonomic systems (Alva Couch, Tufts University) and to deal with unpredictable behavior. An ideal autonomic system might employ scalable co-ordinated cross-layer management (Vanish Talwar, HP) in which control systems are composed vertically from lower-level elements.

Several application domains for autonomic computing were explored. Empathic autonomic systems (Peter Dinda, Northwestern University) optimize for perceived end-user satisfaction. Spatial computing (Jake Beal, MIT CSAIL) requires new languages and abstractions to control a computing medium in which computing presence approximates a continuous medium. Autonomics can help us construct "Green IT" computing environments (Milan Milankovic, Intel) that exhibit reduced energy consumption, lower carbon footprint, etc. Sensor networks can be managed through a holistic strategy that treats the whole network as a single entity (Simon Dobson, UC Dublin). P2P networks can benefit from "sloppy" autonomic control mechanisms that "leave well enough alone" and only react when basic objectives are not met (Guillaume Pierre, VU Amsterdam).

Autonomic systems must also enforce human objectives (Jeffrey Kephart, IBM). Human goals can conflict and require competitive—and not simply cooperative—strategies (Ivana Dusparic, TCD). Human trust of autonomic systems remains a key problem (John Wilkes, HP).

At the end of the morning's discussion, the group voted to study three issues in detail:

- Single self-adaptive system challenges: monitoring and modeling
- Multiple self-adaptive system challenges: composition and openness
- Goals, objectives, and trust: the human side of autonomics

A working group was convened to study each problem. Each working group met in the afternoon and presented a report; these are briefly summarized next.

SINGLE SELF-ADAPTIVE SYSTEMS

Single self-adaptive systems can now be built, but systematic methods should be developed for building these systems. Systematic methods require good models for prediction, control, error detection/fault diagnosis, and optimization. Models must describe behavior at different time and detail scales, for different tasks (e.g., energy, error detection) and for different degrees of accuracy. Models can be self-learned or provided by expert human engineers. Models should describe both the system and its environment. Objectives need to be clearly defined for accountability, performance, and reliability of self-adaptive systems.

MULTIPLE SELF-ADAPTIVE SYSTEMS

Multiple self-adaptive systems might include systems composed of equipment and software from several vendors, with limited knowledge of one another, and different administrative domains and management objectives. These objectives can potentially conflict with regard to performance, availability, energy efficiency, security, reliability, resource usage, and resilience. Potential problems include independent control systems trying to control the same actuator, indirect coupling through resource shortages, conflicting policies for interacting controllers, and invalidated models resulting from unforeseen interaction. Fully understanding the problem space is in itself a research issue.

GOALS, OBJECTIVES, AND TRUST

At the root of the trust issue for autonomic systems is that users do not know what they want, nor can they write it down. Requirements come from users with differing roles, information needs, and objectives. One potential mechanism for specifying needs is for users to say what they do not like and incrementally refine policy based upon interactions. Even so, requirements are expected to be incomplete and inconsistent. Possible techniques for coping with this situation include discovering and reporting conflicts ("asking for help") and exploring "what if" scenarios with the user. To ensure trust, systems can be constrained, can actively reassure users, and can explain their actions.

For more details on the discussions and outcomes of the workshop, please see http://www.aqualab.cs.northwestern.edu/HotACIII/program.html.