Welcome to SENG 371 Software Evolution Spring 2013

A Core Course of the BSEng Program

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Announcements

- Course website
  - Up and running
  - http://www.engr.uvic.ca/~seng371
- Labs start this week
  - Instructors
    - Lorena Castaneda
    - Pratik Jain
    - Przemek Lach
  - This week
    - Visualization tools
- Assignment 1
  - Due Jan 28
  - Cite your sources
  - Part I — Useful definitions
  - Part II — Growing systems in emergent organizations
  - Part III — Ultra large scale systems (ULS)

Reading assignments

- IBM Corporation: An Architectural Blueprint for Autonomic Computing, Fourth Edition (2006) http://people.cs.kuleuven.be/~danny.weyns/csds/IBM06.pdf
- Truex, Baskerville, Klein: Growing Systems in Emergent Organizations. Communications of the ACM, 42(8):117-123 (1999). http://portal.acm.org/citation.cfm?id=310930.310984&coll=GUIDE&dl=GUIDE.ACM&CFID=2240896&CFTOKEN=98671917
- Northrop, et al.: Ultra-Large-Scale Systems. The Software Challenge of the Future. Technical Report, Software Engineering Institute, Carnegie Mellon University, 134 pages ISBN 0-9786956-0-7 (2006) http://www.sei.cmu.edu/uls

Calendar and deadlines

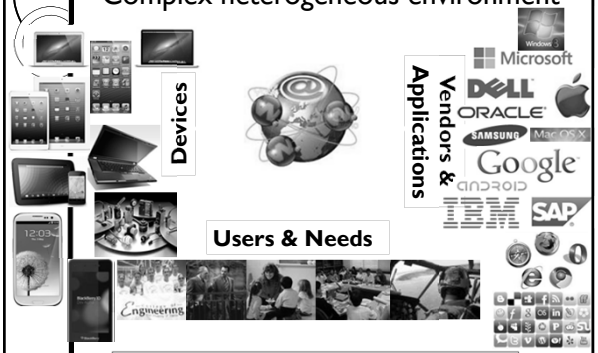
- Assignment 1
  - Due Mon, Jan 28
- Assignment 2
  - Due Thu, Feb 28
- Assignment 3
  - Due Thu, March 28
- Breaks
  - Reading Feb 18-22
  - Easter April 1
- Midterm
  - Thu, Feb 14
  - In class, closed books, closed notes
- Final
  - April 2013 to be scheduled by university
  - 3 hours, closed books, closed notes

Course requirements

- Three assignments 45%
- Midterm 15%
- Final 40%
- Class participation +/-10%

- All materials discussed in class are required for the midterm and final examinations
- Passing the assignments and the final exam is required to pass the course

Complex heterogeneous environment



Alan Ganek, Vice President, IBM Autonomic Computing Initiative

The Complexity Problem

- The increasing complexity of computing systems is overwhelming the capabilities of software developers and system administrators to design, evaluate, integrate, and manage these systems
- Major software and system vendors are concluding that the only viable long-term solution is to create computing systems that manage themselves

… an elusive goal?

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The Conquest of Complexity

- There has never been anything quite like information technology before, but there have certainly been other complex technologies that needed simplifying
- To be truly successful, a complex technology needs to "disappear"

Source: A. Kluth. Information Technology. *The Economist*, Oct 28, 2004

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Predictable evolutionary path of technology

- Early stages
  - Technology needs lots of human involvment
  - New inventions are typically "geeky", requiring significant expertise to install and maintain
  - In general, the "default" seems to be human work, due to its flexibility and adaptivity
  - At an early stage human involvement is always superior to alternatives
  - Culling of features is futile
- Push the complexity to the back end to make the front end very simple
  - Consumers don't know when the Power Company upgrades its technology

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Predictable evolutionary path of technology

- Mature stage
  - Need for human expertise is greatly reduced due to technology becoming simple and standardized
  - To increase adoption and sales (electricity, cars)
  - To decrease cost (industrial revolution, agriculture)
  - To allow super-human performance (space aviation)
- Simplicity of usage often means increased overall system complexity
  - For every mouse click we take out of the user experience, 20 things have to happen in the software behind the scenes

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Given this historical perspective, maybe there is hope for the information technology sector?

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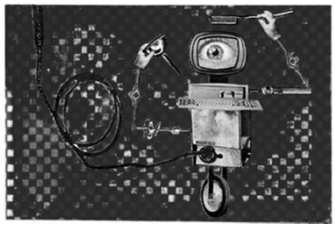
IBM's Complexity Solution

- Automation through self-adaptive and self-managing systems or autonomic computing



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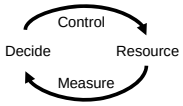
What is Autonomic Computing?

- Webster's definition
  - Acting or occurring involuntarily; automatic: an autonomic reflex
  - Relating to, affecting, or controlled by the autonomic nervous system or its effects or activity
  - Autonomic nervous system: that part of the nervous system that governs involuntary body functions like respiration and heart rate

- IBM's definition
  - An approach to self-managed computing systems with a minimum of human interference
  - The term derives from the body's autonomic nervous system, which controls key functions without conscious awareness or involvement



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What is the most famous autonomic system?

You all know it intimately ☺

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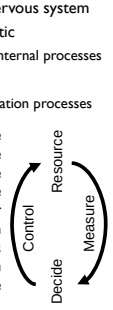
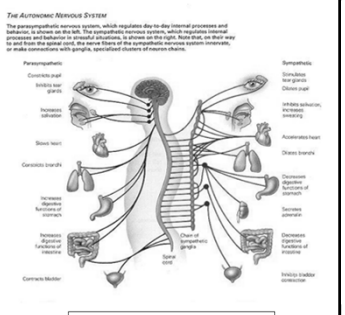
The Most Famous Autonomic System

- Autonomic nervous system
- Parasympathetic
  - Day-to-day internal processes
- Sympathetic
  - Stressful situation processes

Temperature
Heart rate
Breathing rate
Blood pressure
Blood sugar
Pupil dilation
Tears
Digestion
Immune response





Monitor and Regulate

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Ideas for Adaptive Systems in Nature Viability Zone

- The internal mechanisms of humans continuously work together to maintain essential variables within physiological context and limits—the *n-dimensional viability zone*
- The goal of human self-managing behavior is directly linked to survivability
  - If the external or internal environment pushes the system outside its physiological equilibrium zone, the system will work towards returning to the equilibrium zone

n-dimensional viability zone equilibrium

Aubin, Bayen, Saint-Pierre: *Viability Theory: New Directions*, Springer (2011)

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Characteristics of autonomic or self-managing systems

- Self awareness, reflexivity, identity
  - Possesses a system identity
  - Must know itself
  - Needs detailed knowledge of its components, current status interconnections with other systems and available resources to manage itself
- Able to configure and reconfigure itself under varying and unpredictable conditions
  - For example, adaptive algorithms running on each subsystem could learn the best configurations to deliver functionality in different ways to achieve mandated performance
- Continually seek to optimize its operations
  - Adaptive algorithms for monitoring and execution

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Characteristics of autonomic or self-managing systems

- Systems that self-manage
  - self-configure, self-tune, self-repair, self-protect, …
- For a software system to be autonomic, it needs to support a range of behaviours; then
  - Self-configuring means choosing a suitable behaviour, based on user preferences, context, …
  - Self-tuning means choosing behaviours that optimize certain qualities (performance, year-end profits, …)
  - Self-repairing means shifting execution to another behaviour, given that the current one is failing
  - Self-protecting means choosing a behaviour that minimizes risks (attacks, viruses, …)

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What autonomic or self-managing systems deliver

Increased Responsiveness
Adapt to dynamically changing environments

Operational Efficiency
Tune resources and balance workloads to maximize use of IT resources

Business Resiliency
Discover, diagnose, and act to prevent disruptions

Secure Information and Resources
Anticipate, detect, identify, and protect against attacks

*Self – **

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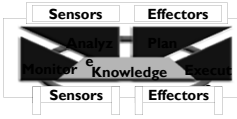
IBM's approach

- Create and deploy self-managing infrastructure technologies to
  - reduce complexity
  - lower cost of ownership
  - increase reliability
- Establish an architectural framework for autonomic computing
- Provide technologies to reduce the cost of managing systems
  - Automating automation



Automation²

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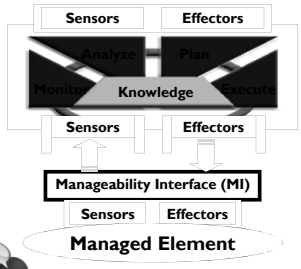
Architectural Building Blocks and Level of Indirection

- Autonomic System (AS)
- Autonomic Element (AE)
- Autonomic Manager (AM)
- Managed Element (ME)
- Manageability Endpoint (ME)
- Manageability Interface (MI)
- Knowledge sources
- Enterprise service bus



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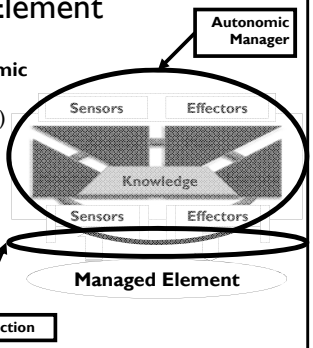
Autonomic Element

- Consists of an **Autonomic Manager (AM)** and an Autonomic Element (AE)
- Manager and managed element form a **level of indirection**
  - Spatially and temporally separate entities
  - Enterprise Service Bus



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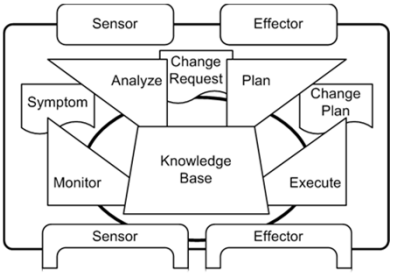
Autonomic Manager MAPE or MAPE-K Loop



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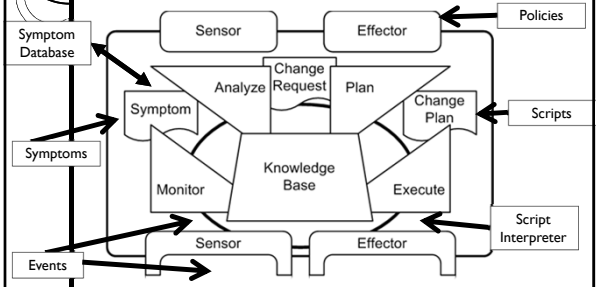
MAPE-K Loop
Standards & Interfaces

MD Metaphor



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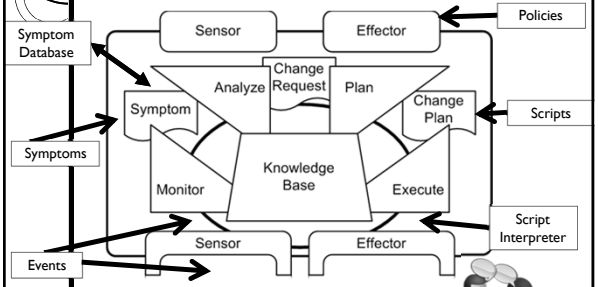
MAPE-K Loop
Standards & Interfaces



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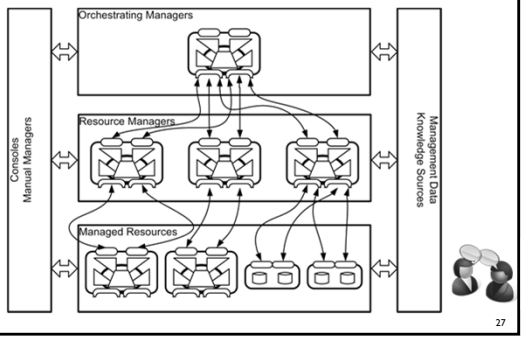
ACRA: Autonomic Computing Reference Architecture



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Questions?

- Organization of the course?
- Evaluation scheme?

- Study course web site carefully
- Visit course web site regularly
- Other questions?!?

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Keep in mind

- Ask questions at any time ☺ !! ☺
- Let's make this a truly interactive course!!!
- Take full advantage of this opportunity to work on your communication skills ☺ !!

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