Coordinating Self-Healing & Self-Optimizing Disciplines in Autonomic Elements: An Experiment

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Problem Statement

- Self-managing software through self-CHOPs disciplines
- Each discipline addresses a different concern of the autonomic element
  - Mostly monitoring and analyzing different information & symptoms
  - Mostly using different decision-making methods
- Research problem: How to coordinate disciplines with different natures toward a set of goals such as business objectives
- Research focus: Coordinating self-healing and self-optimizing at the element level
Self-Healing Discipline

- **Parameters:**
  - $E_h$: Event set
  - $SD_h$: State diagram of the system
  - $DM_h$: Dependency model
  - $A_h$: Actions (primitive/non-primitive)
  - $C(A_i)$: Cost of action $A_i$
  - $H$: history of actions in states
  - $PS$: Policy set

- **Problem:** returning to the previous healthy state (if possible) or going to another healthy state

- **Solution:** Planning especially AI-Planning seems to be appropriate, Probability network
Self-Healing - Actions

<table>
<thead>
<tr>
<th>Action</th>
<th>Entity</th>
<th>Adaptation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Restarting</td>
<td>Components, Servers, Services</td>
<td>Weak Adaptation</td>
</tr>
<tr>
<td>Restructuring</td>
<td>System, Subsystem, Application</td>
<td>Strong Adaptation</td>
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<tr>
<td>Redeploying</td>
<td>Components, Servers</td>
<td>Weak Adaptation</td>
</tr>
<tr>
<td>Provisioning</td>
<td>Servers, Machines</td>
<td>Strong Adaptation</td>
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</table>

**Weak Adaptation**: Modifying/tuning/adjusting parameters, variables or the actions that does not change drastically the system entities.

**Strong Adaptation**: Modifying/changing more significant system properties such as architecture, or adding/deleting entities.
Self-Optimizing Discipline

- **Parameters:**
  - $E_o$: Event set
  - $SD_o$: State diagram of the system
  - $DM_o$: Dependency model
  - $A_o$: Actions (primitive/non-primitive)
  - $C(A_i)$: Cost of action $A_i$
  - $U(.)$: Utility function
  - $PS$: Policy set

- **Problem:** Adjusting attributes such as performance, response time and throughput regarding system policy/goals (i.e. QoS)

- **Solution:** Optimization (utility functions), Controlling (feedback & adaptive control methods)
## Self-Optimizing Actions

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Tuning</td>
<td>Generally resources and parameters</td>
<td>Weak Adaptation</td>
</tr>
<tr>
<td>Restructuring</td>
<td>System, Subsystem, Application</td>
<td>Strong Adaptation</td>
</tr>
<tr>
<td>Load Balancing</td>
<td>Components, Servers, Services</td>
<td>Strong Adaptation</td>
</tr>
<tr>
<td>Provisioning</td>
<td>Servers, Machines</td>
<td>Strong Adaptation</td>
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Self-Optimizing is a continuous process with proactive and reactive actions
Coordination Joint Points
## Combinations of Adaptation Types

<table>
<thead>
<tr>
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<th>Self-Optimizing</th>
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<tbody>
<tr>
<td>Weak Adaptation</td>
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The Experimental Model
Implementing Self-Healing & Self-Optimizing

- **Self-healing**
  - Using AI-planning (in ABLE)
  - Continuous re-planning

- **Self-optimizing**
  - Using utility-based fuzzy rules
A Sample Result

Summary

- Lessens learned
  - Coordinating autonomic disciplines can help autonomic managers to achieve goals such as business objectives.
  - Execution-based coordinating seems to be appropriate for weak-strong adaptation action trade-offs for self-healing and optimizing

- Future works
  - Execution-based coordinating would change the rest of action plan for another discipline. How to update the action plan?
  - Solutions in strong-strong and weak-weak cases
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