Mapping Architectural Decay Instances to Dependency Models

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Architectural Decay Instances

- Software architecture drift and erode
- Architectural decay instances
- Architecture debt
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Scattered Parasitic Functionality Decay Instance

Definition

- Multiple components are responsible for realizing the same high-level concern
- Some of those components are responsible for orthogonal concerns.

Formalization

\[ \exists z_1 \in T \mid P(z_1 \mid c_1) > \text{th}_1 \land \exists z_2 \in T \mid P(z_2 \in c_2) > \text{th}_1 \land z_1 = z_2 \land \exists z_3 \in T \mid P(z_3 \mid c_2) > \text{th}_2 \land z_1 = z_3, \] where \( \text{th}_1, \text{th}_2 \) are proportions such that \( 0 \leq \text{th}_1 \leq 1 \) and \( 0 \leq \text{th}_2 \leq 1 \).

\( \text{th}_1 \) and \( \text{th}_2 \) specify the acceptable degree of scattering per topic.
Challenge

- Heterogeneous elements
  - Component
  - Connecter
  - Concerns
  - Interfaces

- Difficult to automatically detect Decay Instances
Our Approach

- Uniform the heterogeneous elements and their relations to dependency model
  - Extended Augmented Constraint Network (EACN)
    - Constraint Network
    - Dominance Relation
    - Clustering Set
    - Concern Elements relation

- Design Structure Matrix (DSM)
  - Derived from EACN
  - Visualizing all the heterogeneous elements and their relations
EACN [Cai and Sullian 2012]

- Variables: Concerns, Components

- Constraints Network: StrateggeAnalyzer => ConnectorInteface

- Dominance relation: (StrateggeAnalyzer, ConnectorInteface)

- Clustering Set: Concern, Component

- Concern Element relations: <ResourceManager, Event and Message Management, 0.47>
## Emergency Response System (ERS) - Design Structure Matrix (DSM)

| Components                  | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
|-----------------------------|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| Component_RenderingAgent    |   |   |   |   |   |   |   |   |   | 0.19| x  | x  | 14 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_SimulationAgent   |   | 0.56| 0.24|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_ResourceManager   |   | 0.48| 0.47|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_SAKBUI            | 0.31| 0.33| 0.33|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_StrategyAnalyzer  | 0.14| 0.14| 0.14|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_DeploymentAdvisor | 0.49| 0.13| 0.23| 0.14|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_Monitor           | 0.43| 0.07| 0.30| 0.06| 0.10|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_map               | 0.30| 0.17| 0.60| 0.19|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_Repository        | 0.30| 0.20| 0.27| 0.33| 0.33| 0.30|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_Weather           | 0.54| 0.05| 0.23| 0.23| 0.23|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| Component_StrategyAnalyzerKB| 0.20| 0.25| 1.00| 0.30|    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |

**Concerns**

- Component_RenderingAgent
- Component_SimulationAgent
- Component_ResourceManager
- Component_SAKBUI
- Component_StrategyAnalyzer
- Component_DeploymentAdvisor
- Component_Monitor
- Component_map
- Component_Repository
- Component_Weather
- Component_StrategyAnalyzerKB
- Component_Clock

**Components**

- Commander

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Mapping and detecting Scattered Parasitic Functionality Decay Instance

- **Definition and Formalization**
  - Multiple components are responsible for realizing the same high-level concern; Some of those components are responsible for orthogonal concerns.

\[
\exists z_1 \in T \mid P(z_1 | c_1) > \text{th}_1 \land \exists z_2 \in T \mid P(z_2 | c_2) > \text{th}_1 \land z_1 = z_2 \land \exists z_3 \in T \mid P(z_3 | c_2) > \text{th}_2 \\
\land z_1 = z_3, \text{ where } \text{th}_1, \text{th}_2 \text{ are proportions such that } 0 \leq \text{th}_1 \leq 1 \text{ and } 0 \leq \text{th}_2 \leq 1.
\]

- **Mapping to the dependency model**
  - <ResourceManager, Event and Message Management, 0.47>
  - <StrategyAnalysisKB, Event and Message Management, 0.54>
  - <StrategyAnalysisKB, Commander and Agents concern., 0.33>
Summary

- All the heterogeneous elements and their relations can be modeled in the dependency model

- Mapping all the decay instances to the dependency model

- Detect the decay instances
Question?