A Probabilistic Approach for Long-Term B2B Service Compositions

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Outline

1. Standard Service Composition
2. B2B Service Composition
3. Probabilistic Approach
4. Evaluation
Standard Service Composition

Given:

- Task A
- Task B
- Task C

Find:

- Service X
- Service Y
- Service Z

MINIMIZE \{0.8 \ t + 0.2 \ p\}
ENSURE \{t\leq50\text{ms} \ AND \ p\leq5\text{s}\}
Standard Service Usage

For each Task

• Select 1 Service
  – with 1 Service Level Agreement, e.g. [100ms, 5$]

• (Always) choose the same selected service at execution time
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B2B Service Compositions (1)

• Are
  1. **Complex** (e.g. long and nested workflows)
  2. Executed many times

• Require
  1. Effort to **build** workflows
  2. Effort to **integrate**
  3. Effort to **execute**

=> **Meant** for the **long-term** (many executions)
B2B Service Compositions (2)

• Require a high reliability

<table>
<thead>
<tr>
<th>Application type</th>
<th>9s</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-critical</td>
<td>2</td>
<td>99%</td>
</tr>
<tr>
<td>Task critical</td>
<td>3</td>
<td>99.9%</td>
</tr>
<tr>
<td>Business critical</td>
<td>4</td>
<td>99.99%</td>
</tr>
<tr>
<td>Mission critical</td>
<td>5</td>
<td>99.999%</td>
</tr>
<tr>
<td>Safety critical</td>
<td>6</td>
<td>99.9999%</td>
</tr>
</tbody>
</table>

=> **Hard** to achieve for complex workflows
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Probabilistic Patterns

How do the QoS of a service change over time?

When is a service used by a specific user?

=> Compute expected long-term QoS
Service Groups

• Select **multiple** services
  – which will be tried to execute **sequentially**
  – until one **succeeds** or all have failed.

• Example

=> Achieve **high reliability**
Time-dependent Execution Policy

• For each task
  – Set of discrete points in time \{t_1, t_2, \ldots, t_n\}
  – For each point in time
    • Service group \{s_1, s_2, \ldots, s_n\}

• E.g. two service groups for Task A

- Mo-Fr
  - Service A_1
  - Service A_5
  - Service A_3
  - Service A_4

- Sa/Su
  - [in case of failure]

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Approach

(Providers’) QoS Pattern

(Users’) QoS Pattern

Adaptive GA

Time-dependent Execution Policies

Task A

Task B

Task C
Adaptive GA

• Encoding

• Customized Operators
  1. Mutate
     *(avoid *duplicate* values inside group)*
  2. Uniform Crossover
     *(account for *different parents’ group sizes)*
  3. New **Adapt Operator**
Adapt Operator

Applied after mutate and crossover operators

1. **Rank** service groups according to Δ of desired and actual reliability of their task
2. **Adapt** a fixed ratio of groups
3. **Increase** or **decrease** group size by one service depending on Δ
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**Evaluation: Algorithms**

$\text{GA}_i$

denotes a naive adoption of using service groups with a **static group size** that is denoted by the *index*.

$\text{GAUP}_i$

(analog, considering QoS and **Usage Patterns**)

$\text{TG}_6$

denotes our **adaptive Teikou algorithm** which determines the groups sizes *dynamically* up to a maximum size of six services per group.

$\text{TGUP}_{6}$

(analog, considering QoS and **Usage Patterns**)

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Utility

(a) Utility without Usage Patterns

(b) Utility with Usage Patterns
Reliability & Runtime

(a) Reliability

```
   1
   0.8
   0.6
   0.4
   0.2
   0

   0.1  0.2  0.3  0.4  0.5  0.6  0.7  0.8  0.9  0.99

   GA₁ — GB₄ — TG₆
   GA₂ — GA₆
```

(b) Runtime

```
   400
   300
   200
   100

   0.1  0.2  0.3  0.4  0.5  0.6  0.7  0.8  0.9  0.99

   GA₂ — GA₄ — GA₆ — TG₆
   GAUP₂ — GAUP₄ — GAUP₆ — TGUP₆
```
Summary

• We addressed the following two concerns of B2B service compositions
  – Long-term QoS
  – High reliability

• Our approach is
  – Adaptive to the reliability constraint
  – Incurs a reasonable overhead
Thank you for your attention!
Looking forward to your questions and comments