A novel algorithm for assessing services interfaces integrability

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Outline

Integration

Definition

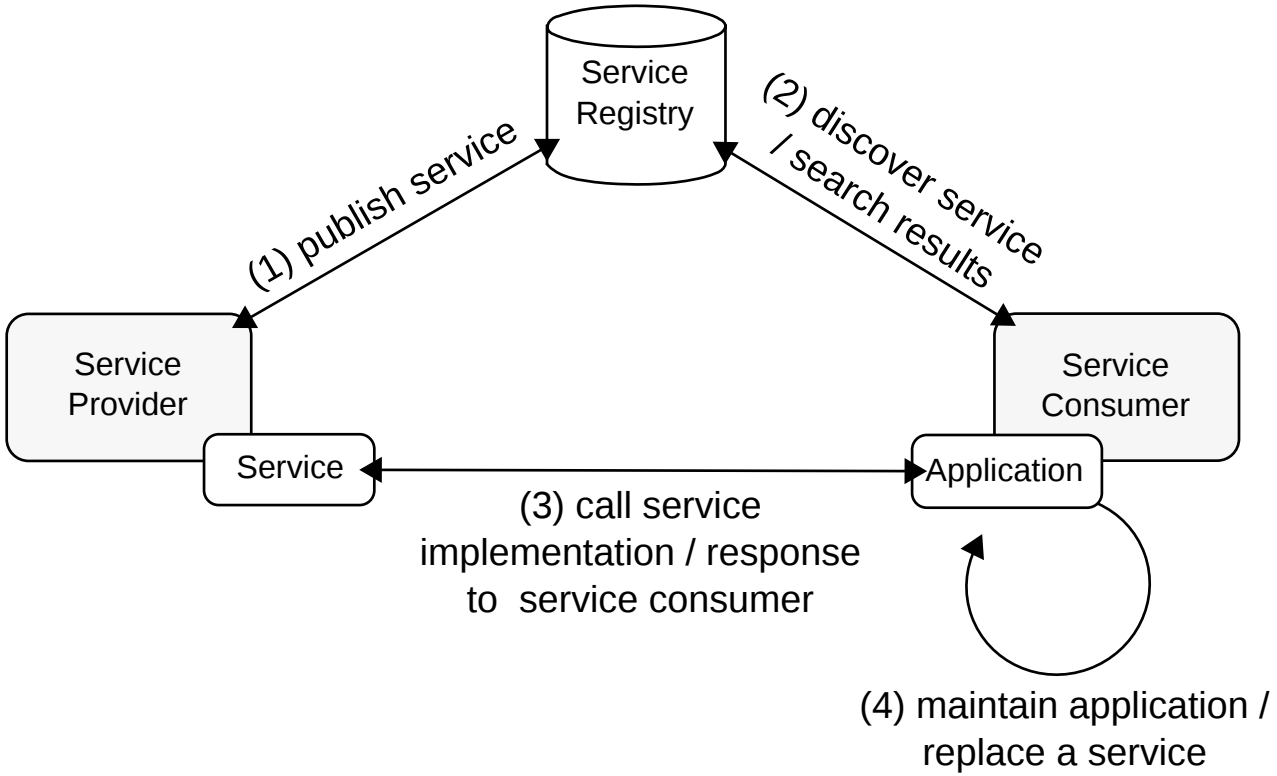
IEEE defines integration as “the process of combining software components, hardware components, or both into an overall system” [1]

Services Integration

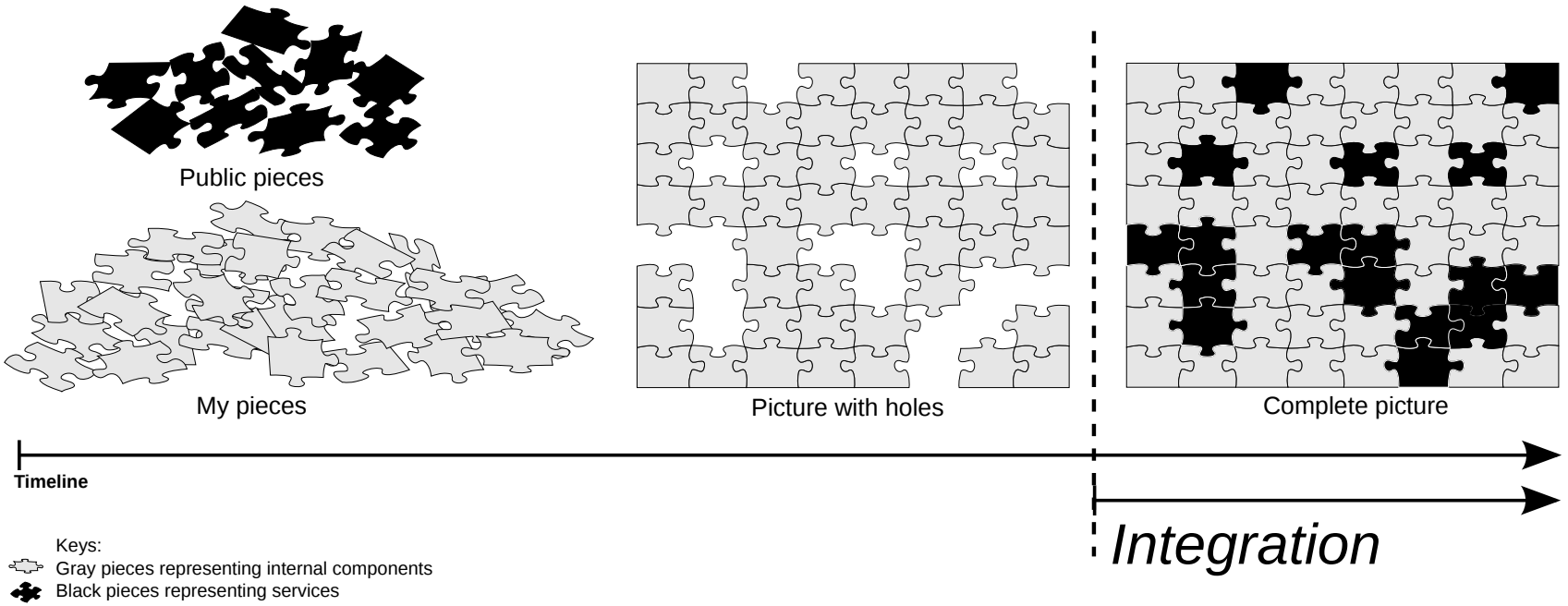
- The concept of software integration is essential for both already established computing paradigms and emerging ones:
  - Component-based software.
  - Service-Oriented Computing, and its satellite paradigms.
- Current main and preferred trends in software development are the integration of prefabricated software components, called ***services***.

Service-Oriented Computing

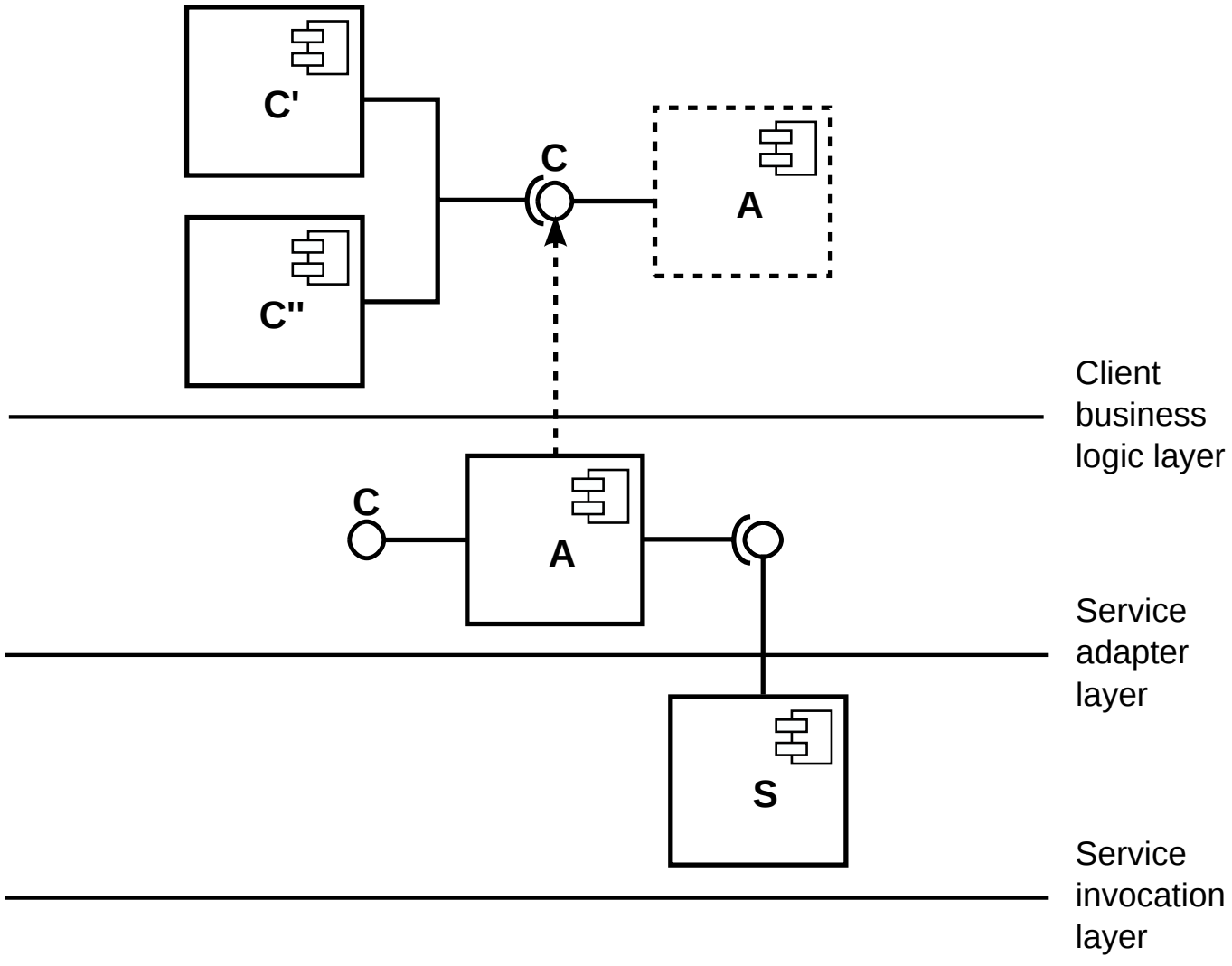
- SOC is a relative new and exciting paradigm for distributed computing



Conceptual Anatomy of a Service-Oriented Application



Maintainable Model of Service-Oriented Applications [3]



Services Integration Challenges

- Usually an interface (a set of operations with inputs-outputs) is the only available description of a service.
- There may be many services offering the same functionality.
- Differences between interfaces C and S impact on the adaptation layer.

Question

How we can determine which is the more integrable candidate?

Intuitive Criteria for Assessing Integrability

- The kind and amount of types conversions performed within the adaptation layer.
- The difference on the number of operations provided by each interface.
- The number of matched operations and the number of non-matched ones.
- The relevance of non-matched operations in terms of how many internal components call them.
- The degree of functional similitude between the operations of C and S.

Algorithm for Assessing Service Interface Integrability (AASII)

Inputs

- C: the interface, with n_C operations, expected by the application components.
- S: represents a candidate service interface with n_S operations.
- $\vec{r}$: relevance of each operation offered by interface C.

Output

- $[0, 1]$: a number representing how well the interface S integrates to those components that are already integrated to interface C.

Main Steps of AASII

1. calculate the normalized operations similitude matrix,
   1. e.g. by using any function from [4] provided it satisfies that
      $\forall i, i \epsilon [1, n_c] \wedge \forall j, j \epsilon [1, n_s] : f(op_i, op_j) \geq 0$

   $M = n_c \times n_s$

   $M_{i,j} = f(op_{C,i}, op_{C,j})$

   $\mu M_{i,j} = \frac{M_{i,j}}{\sum_{c=1}^{n_c} \sum_{s=1}^{n_s} M_{c,s}}$

2. calculate the best possible assignation between C operations and S operations,
   1. e.g. by using the Hungarian algorithm [5]

   $\vec{a} =< a_1, ..., a_{n_c} >$

   $\forall i, a_i \epsilon [0, n_s]$

   A : *assignations*

3. calculate the Integrability Metric

   $IM(\vec{r}, \mu M, \vec{a}, n_c, n_s) : [0, 1]$

Integrability Metric (IM)

$$IM(\vec{r}, \mu M, \vec{a}, n_c, n_s) = \frac{1}{\alpha} \times (\sum_{i=1}^{n_c} sim(op_i)) \times \frac{\sum_{i=1}^{n_c} rel(op_i)}{\sum_{i=1}^{n_c} \vec{r_i}} \times \frac{1}{\beta} \times [1 - (\frac{n_s - A}{n_s})]$$

$$sim(op_i) = \begin{cases} 0 & \vec{a_i} = 0 \\ \mu M_{i,\vec{a_i}} & \vec{a_i} \neq 0 \end{cases}$$

$$rel(op_i) = \begin{cases} 0 & \vec{a_i} = 0 \\ \vec{r_i} & \vec{a_i} \neq 0 \end{cases}$$

Theoretical Validation

- Researchers defined mathematical properties to which a software engineering metric should adhere:
  - Weyuker's work titled *"Evaluating software complexity measures" [6].*
  - Basili et at. work titled *"Property-based software engineering measurement" [2].*

- The proposed IM adheres to the following properties:
  - *Null Value* [2].
  - *Monotonicity* [2].
  - *Not Additive* [2].
  - *Nonnegativity* [6].
  - *Not Commutable* [6].

Algorithm Complexity

$$O(max(n_c \times n_s, f, n_c^3))$$

$O(n_c \times n_s)$: matrix calculation
$O(f)$: similitude function complexity
$O(n_c^3)$: Hungarian algorithm complexity

First Example (Scenario I: $n_c = n_s$)

- $n_C = n_S = 2$.
- $\vec{r} =< 1,1 >$, $\alpha = 1, \beta = 1$.
- $\mu M =$

	$op_{s,1}$	$op_{s,2}$
$op_{c,1}$	0.21	0.07
$op_{c,2}$	0.57	0.14

  $\vec{a} =< 2,1 >$.
- $IM(C,S) = (0.07 + 0.57) \times (2/2) \times 1 - [(2-2)/2] = 0.64 \times 1 \times 1 = 0.64$.

Second Example (Scenario II: $n_c < n_s$)

- $n_C = 3, n_S = 2.$
- $\vec{r} =< 1, 1, 1 >, \alpha = 1, \beta = 1.$
- $\mu M =$

μM	$op_{s,1}$	$op_{s,2}$	$op_{s,3}$
$op_{c,1}$	0.11	0.03	0.15
$op_{c,2}$	0.3	0.07	0.29

$\vec{a} =< 3, 1 >.$

- $(0.15 + 0.3) \times (2/2) \times 1 - [(3-2)/3] = 0.45 \times 1 \times (0.66) = 0.29.$
- $IM(C, S') < IM(C, S)$, because of the “dangling” operation.

Contributions

- A novel algorithm for assessing the effort needed to integrate a service into an application.
- The Integrability Metric (IM), a new software engineering metric.
- This represents a step towards alleviating the selection and integration of external services into service-oriented applications.

Future Work I

- To integrate the IM into the approach to discover services known as Query-By-Example (QBE).
- Conduct empirical evaluations of the proposed algorithm.

There are more details in the paper

- The theoretical validation.
- Four integrability scenarios.
- Related work discussion.

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Questions...

Thank you!