Towards a Semantic Model for Wise Systems
Graph Matching Algorithm

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Before you code, you have to think, in order to think, you must have a paradigm.

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Ph.D Student Teacher
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Python, PHP/Symfony3.4 consultant
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English: Fluent
1 Basic idea of wise objects
   - Wise objects
   - Wise objects from the conceptual view?

2 IOSTS for humans to machines communication
   - Why using an IOSTS?

3 Problematic
   - How to add semantics to the STG graph using the IOSTSe?

4 Towards the solution
   - How to link the two representations?
   - Approach

5 Current/Future work
   - Many variables approach
   - Towards a contextual approach
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Wise objects

To begin with

The first idea was to create an object that could learn by itself about itself to moderate attention from the end-users [8] [7] (Calm technology).

Currently, the wise object:

- Gets knowledge about its capabilities.
- Gets knowledge about its use.
- Analyses its knowledge to generate new one.
- Reacts according to its knowledge.
To begin with

The first idea was to create an object that could learn by itself about itself to moderate attention from the end-users [8] [7] (Calm technology).

Currently, the wise object:

- Gets knowledge about its capabilities.
- Gets knowledge about its use.
- Analyses its knowledge to generate new one.
- Reacts according to its knowledge.
**Figure 1:** WO respects the notion of MAPE-K to ensure adaptability
Conceptual view [1]

Figure 2: Different states of wise object

Lacks

- How to make a wise object able to communicate with humans?
- What are the limits of such an object?
Basic idea of wise objects

Wise objects from the conceptual view

Conceptual view [1]

Figure 2: Different states of wise object

Lacks

- How to make a wise object able to communicate with humans?
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Why using an IOSTS?

In oracle or controller synthesis, IOSTS graphs are often used to model the behaviour of systems, and as this type of graph is conceptually understandable by humans, it has semantics.

**Definition 1 (IOSTS).**

An IOSTS automaton is a syntax that allows finite descriptions of infinite transition systems [4] [3].
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**Figure 3**: IOSTS representation of a roller shutter
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Problematic diagram

Knowledge
Represented as an STG
How to add the semantic to the STG graph

Semantic Problem

Where can we find the meaning of those information (STG)?

Semantic

Giving the wise object a sort of human logic
= semantic

The object can communicate with human

Figure 4: From wise object knowledge to human semantics\(^1\).

\(^1\) Semantic is the meaning given to something so that it can be understood by humans as mentioned in [2]. This definition also applies to objects/devices, as semantic is used to communicate with humans.
How to add semantics to the STG graph using the IOSTSe?

Figure 4: From wise object knowledge to human semantics\(^1\).

\(^1\)Semantic is the meaning given to something so that it can be understood by humans as mentioned in [2]. This definition also applies to objects/devices, as semantic is used to communicate with humans.
Problematic diagram

Figure 4: From wise object knowledge to human semantics\(^1\).

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**Problematic diagram**

![Problematic diagram]

**Figure 4: From wise object knowledge to human semantics**

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Problematic diagram

Knowledge

Represented as an STG

Semantic
Problem

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Where?

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How to link the two representations?

Proposal

Extend the generated knowledge (STG) with the conceptual knowledge (IOSTS) using a matching algorithm based on graph morphism.

Figure 5: Two representations of knowledge
Algorithm: Based on the concept of graph morphism

Uniqueness of localities
\[ \forall q, q' \in Q, \text{dom}(q, x_e) \cap \text{dom}(q', x_e) = \emptyset. \]

Variable matching
\[ \exists ! x_e \in X, \exists ! att_e \in A \mid x_e = att_e, \ x_e \equiv att_e \Leftrightarrow \text{Dom}(att_e) \subseteq \text{Dom}(x_e). \]

States matching
\[ \forall v_i \in V, \exists ! q_j \in Q, \ \text{value}_{i,e} \in \text{dom}(q_j, x_e) \Leftrightarrow v_i \rightarrow q_j. \]

Figure 6: Two representations of knowledge
Towards the solution

**Algorithm:** Based on the concept of graph morphism

### Uniqueness of localities

\[ \forall q, q' \in Q, \text{dom}(q, x_e) \cap \text{dom}(q', x_e) = \emptyset. \]

### Variable matching

\[ \exists! x_e \in X, \exists! \text{att}_e \in A | x_e \equiv \text{att}_e, x_e \equiv \text{att}_e \iff \text{Dom(}\text{att}_e) \subseteq \text{Dom}(x_e). \]

### States matching

\[ \forall v_i \in V, \exists! q_j \in Q \quad \text{value}_{i, e} \in \text{dom}(q_j, x_e) \iff v_i \iff q_j. \]

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**Figure 6:** Two representations of knowledge
Algorithm: Based on the concept of graph morphism

Uniqueness of localities

$$\forall q, q' \in Q, \text{dom}(q, x_e) \cap \text{dom}(q', x_e) = \emptyset.$$  

Variable matching

$$\exists! x_e \in X, \exists! \text{att}_e \in A | x_e \equiv \text{att}_e, x_e \equiv \text{att}_e \iff \text{Dom(}\text{att}_e) \subseteq \text{Dom}(x_e).$$

States matching

$$\forall v_i \in V, \exists! q_j \in Q, \text{value}_{i,e} \in \text{dom}(q_j, x_e) \iff v_i \iff q_j.$$  

Figure 6: Algorithm result of the variable/attribute matching
Algorithm: Based on the concept of graph morphism

Uniqueness of localities

∀q, q′ ∈ Q, dom(q, x_e) ∩ dom(q', x_e) = ∅.

Variable matching

∃!x_e ∈ X, ∃!att_e ∈ A | x_e ≡ att_e, x_e ≡ att_e ⇔ Dom(att_e) ⊆ Dom(x_e).

States matching

∀v_i ∈ V, ∃!q_j ∈ Q
value_i,e ∈ dom(q_j, x_e) ⇔ v_i ⟷ q_j.

Figure 6: Algorithm result of the graph matching
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   - Towards a contextual approach
Current work: Many variables approach

Figure 7: How can the matching algorithm be improved to take into account many variables?
Current work: Many variables approach

Figure 8: $\text{level} \equiv \text{height}; \text{orientation} \equiv \text{angle}$

Figure 9: $\text{orientation} \equiv \text{height}$
Towards a Semantic Model for Wise Systems

Graph Matching Algorithm

Thank you
Towards a contextual approach

Future work: Ontology & Knowledge graph

I propose to link the graph matching result with one of the four generality level\(^2\) of ontology\(^3\) levels in order to contextualize the result.

**Definition 2 (Ontology).**

An ontology is an explicit specification of a conceptualization. The term is borrowed from philosophy, where an Ontology is a systematic account of Existence. For artificial intelligence systems, what exists is that which can be represented.


- How to link the result of the graph matching algorithm with the ontology to contextualize it?

- Which of the four generality levels of ontology should be used [6]?

\(^2\)Four generality levels of ontologies: Domain ontologies, Generic ontologies, Application ontologies and Representational ontologies

\(^3\)Definition 2
Bibliography I


