

Computing Trustworthiness value of all components in physical CPS System

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December 10, 2019

Definition

A physical CPS system S is a tuple (C, A, F, R) where:

- C is a set of physical components.
- A is a finite set of actions that can be execute over CPS system.
- F is a finite set of fluent literals.
- R is a set of relations that map each physical component $c \in C$ with a set of physical component properties that are defined in CPS Ontology. For any $r \in R$, $r : C \longrightarrow 2^P$. P is set of all properties that are defined in CPS ontology.

For each relation $r \in R$ is encoded by `relation(C1,P1)` which denotes that component $C1 \in C$ is related with property $P1 \in P$.

Representation the System

- **Step 1:** Representation of concerns, properties and their relations from CPS Ontology for Trustworthiness aspect by predicates `concern/1`, `property/1`, `subconcern/2`, `addressedBy/2`. Represent the observation of CPS initial state (TW aspect) by `obs(p,true/false)`
- **Step 2:** Representation the property p in the initial state of CPS that `holds(p,0)` holds if `obs(p,true)` and $\neg\text{holds}(p,0)$ holds if `obs(p,false)`
- **Step 3:** Representation of Physical CPS System of component, relations between components and properties by `component/1`, `relation/2`.
- **Step 4-1:** Reasoning that a component $c \in C$ has *good* property $p \in P$ at step S of evolution by predicate `compTrueProp(c,p,S)` if `holds(p,S)` holds at step S and there exists a relation between c and p (`relation(c,p)` holds).

Reasoning good/bad property holding

- **Step 4-2:** Reasoning that a component $c \in C$ has *bad* property $p \in P$ at step S of evolution by predicate $\text{compFalseProp}(c,p,S)$ if $\neg \text{holds}(p,S)$ holds at step S and there exists a relation between c and p ($\text{relation}(c,p)$ holds)
- **Step 5:** Compute the value $\text{tw_property}(p)$ of property p – the trustworthiness value of property p . $\text{tw_property}(p)$ = total number of links to the concerns that are addressed by and related to property p (that includes # of links to concerns that are directly addressed by p and the # of links to ancestors of these concerns and higher in concern-tree)

Compute Good/bad Truthworthiness Value of component c

- **Step 6:** For each component $c \in C$, assuming that $\{p_1, \dots, p_n\}$ is a set of properties such that $\text{compTrueProp}(c, p_i, S)$ holds at step S of evolution for any $i \in [1, n]$.

The *good* trustworthiness value of component c at step S will be computed by :

$$tw_comp(c, good) = \sum_{i=1}^n tw_property(p_i)$$

- **Step 7:** For each component $c \in C$, assuming that $\{p'_1, \dots, p'_m\}$ is a set of properties such that $\text{compFalseProp}(c, p'_i, S)$ holds at step S of evolution for any $i \in [1, m]$.

The *bad* trustworthiness value of component c at step S will be computed by :

$$tw_comp(c, bad) = \sum_{i=1}^m tw_property(p'_i)$$

Comparison TW value of components

Step 8 - Solution 1: For each pair components $c_1, c_2 \in C$ at step S of evolution, the trustworthiness value comparison between c_1 and c_2 is:

- If $tw_comp(c_1, good) > tw_comp(c_2, good)$ then:
 - If $tw_comp(c_1, bad) \leq tw_comp(c_2, bad)$ then: the trustworthiness value of c_1 is **higher** than of c_2
 - If $tw_comp(c_1, bad) > tw_comp(c_2, bad)$ then:
 - Compute $d_{good} = tw_comp(c_1, good) - tw_comp(c_2, good)$
 - Compute $d_{bad} = tw_comp(c_1, bad) - tw_comp(c_2, bad)$
 - if $d_{good} > d_{bad}$ then TW value of c_1 is **higher** than of c_2
 - if $d_{good} = d_{bad}$ then they are equal.
 - else TW value of c_1 is **less** than of c_2
- If $tw_comp(c_1, good) = tw_comp(c_2, good)$ then:
 - If $tw_comp(c_1, bad) > tw_comp(c_2, bad)$ then: the truthworthiness value of c_2 is **higher** than of c_1
 - If $tw_comp(c_1, bad) < tw_comp(c_2, bad)$ then: the trustworthiness value of c_1 is **higher** than of c_2
 - else they are equal.

Select the component with highest TW value

- Step 9: Based on the comparison all pair $(c_1, c_2 \in C)$, we can select the component(s) with the highest trustworthiness value in physical CPS system by predicate `highest_TW_comp(c_j)`
- End