Computing Trustworthiness value of all components in physical CPS System

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Physical CPS System

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 $\neg$`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 `compFalseProp(c,p,S)` if $\neg$`holds(p,S)` holds at step S and there exists a relation between c and p (relation(c,p) holds)
- **Step 5**: Compute the value `tw_property(p)` of property p – the trustworthiness value of property p. `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 $\{p_1, ..., p_n\}$ is a set of properties such that `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 $\{p'_1, ..., p'_m\}$ is a set of properties such that `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