Practical Tools For Modeling CPS and Reasoning About Them

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Tools For Modeling/Reasoning With CPS - Outline

- Ontologies in Practice as .owl Files

- Tool For Creating, Modifying Ontologies

- Tool For Reasoning About CPS

- Demo of Tools

Ontologies As .owl Files

- Uses the W3C Web Ontology Language (OWL), allowing for representation of complex knowledge.

- Precisely define classes of items, classes of relationships, individuals or instances of these classes.

- Many possible syntaxes, we use an XML-style syntax.

- CPS represented in two .owl files, a base file and application file.

Base Ontology

- Defines the application-agnostic structure of the CPS ontology.

- Concerns

- Aspects

- includesConcern

Concern

```
<!-- http://www.asklab.tk/ontologies/CPS-Framework#Concern -->

<owl:Class rdf:about="http://www.asklab.tk/ontologies/CPS-Framework#Concern">
    <rdfs:subClassOf rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#CPSFrameworkConcept"/>
    <rdfs:comment>all instances are CPS-independent</rdfs:comment>
    <rdfs:comment>pg 15</rdfs:comment>
</owl:Class>
```

includesConcern

```
<!-- http://www.asklab.tk/ontologies/CPS-Framework#includesConcern -->

<owl:ObjectProperty rdf:about="http://www.asklab.tk/ontologies/CPS-Framework#includesConcern">
    <rdfs:domain rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Concern"/>
    <rdfs:range rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Concern"/>
    <rdfs:comment>CPS-independent</rdfs:comment>
    <rdfs:comment>pg 15</rdfs:comment>
</owl:ObjectProperty>
```

NamedIndividual - Cybersecurity

```
<!-- http://www.asklab.tk/ontologies/CPS-Framework#Cybersecurity -->

<owl:NamedIndividual rdf:about="http://www.asklab.tk/ontologies/CPS-Framework#Cybersecurity">
    <rdf:type rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Concern"/>
    <includesConcern rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Availability"/>
    <includesConcern rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Confidentiality"/>
    <includesConcern rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Integrity"/>
</owl:NamedIndividual>
```

Application Ontology

- Defines the application-specific structure of the CPS ontology.

- Components

- Properties

- Formulas

- relateToProperty

- propertyAddConcern

- formulaAddConcern

Property

```
<!-- http://www.asklab.tk/ontologies/CPS-Framework#Property -->

<owl:Class rdf:about="http://www.asklab.tk/ontologies/CPS-Framework#Property"/>
```

propertyAddConcern

```
<!-- http://www.asklab.tk/ontologies/CPS-Framework#propertyAddConcern -->

<owl:ObjectProperty rdf:about="http://www.asklab.tk/ontologies/CPS-Framework#propertyAddConcern">
    <rdfs:domain rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Property"/>
    <rdfs:range rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Concern"/>
</owl:ObjectProperty>
```

NamedIndividual - Property

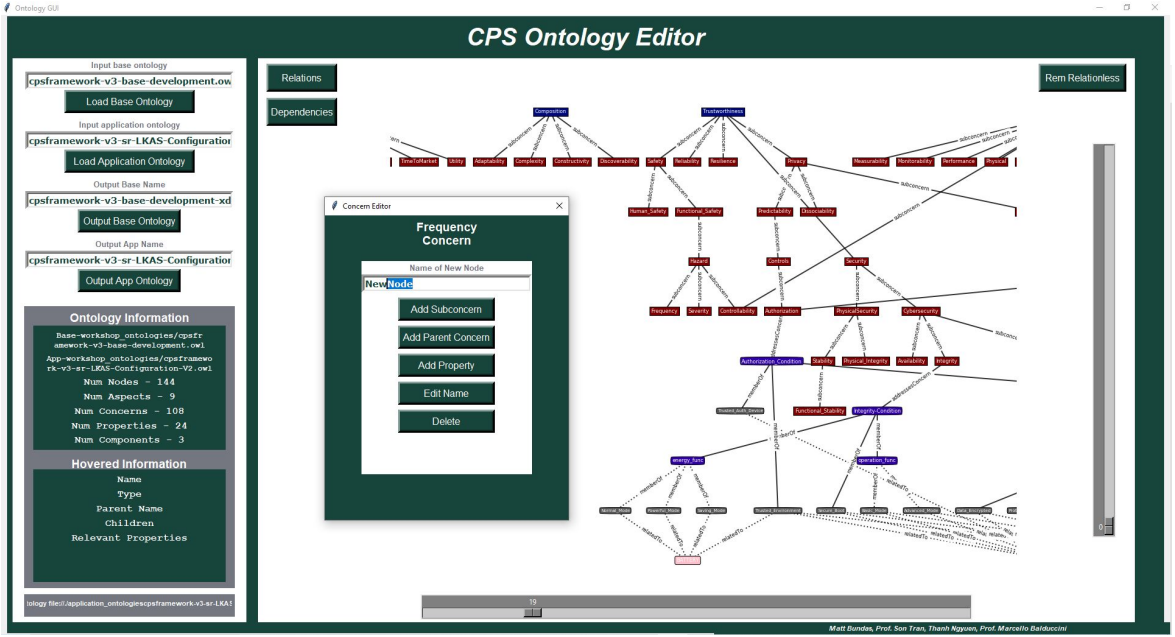
```
<!-- http://www.asklab.tk/ontologies/CPS-Framework#Advanced_Mode -->

<owl:NamedIndividual rdf:about="http://www.asklab.tk/ontologies/CPS-Framework#Advanced_Mode">
    <rdf:type rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Formula"/>
    <rdf:type rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Property"/>
    <memberOf rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#operation_func"/>
    <propertyAddConcern rdf:resource="http://www.asklab.tk/ontologies/CPS-Framework#Integrity"/>
</owl:NamedIndividual>
```

Ontology Editor Tool

- Allows for robust creation, modification, visualization of ontologies

- Loads .owl files and outputs .owl files

- Custom python-built application. Uses owlready2 package for ontology modification.

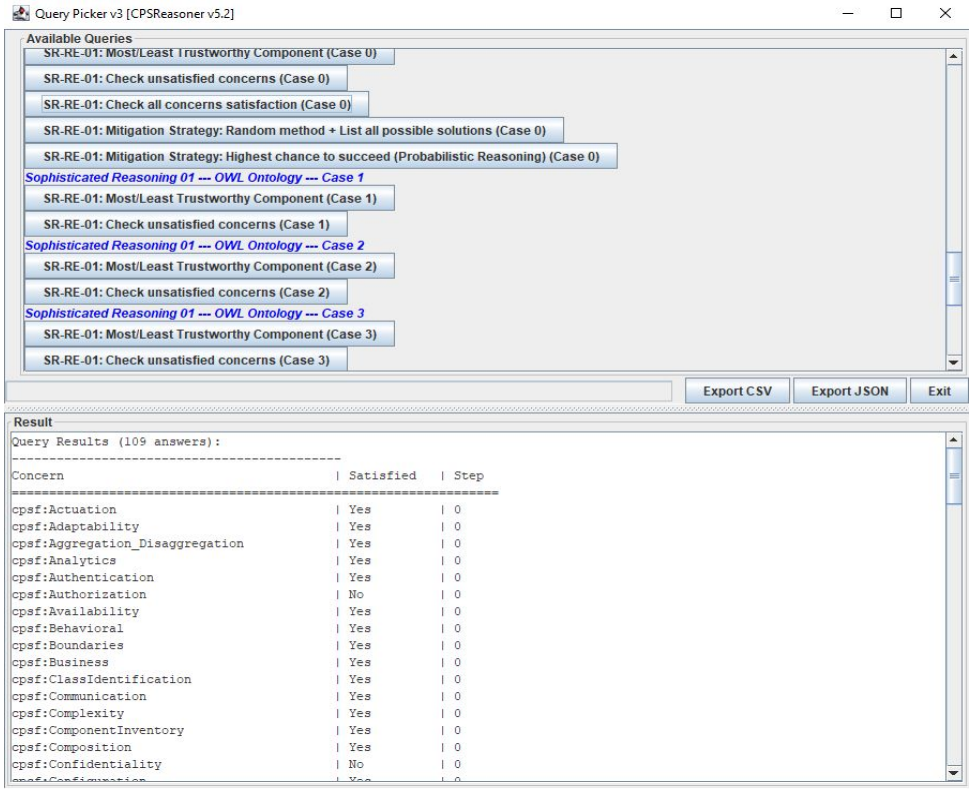


CPS ASP Reasoner Tool

- Java based application for reasoning about CPS

- Allows for execution, display of queries regarding a CPS

- Reads ontology from .owl files, ASP defined in text files



Demo