ONTOLOGY DRIVEN WEB-APP DEVELOPMENT USING JSON-LD

A Presentation to the NASA Datanauts

By Daniel A. O'Neil

```
{
  "@context": {
     "name": "http://schema.org/name",
     "homepage": {"@id": "http://schema.org/url", "@type": "@id"},
     "image": {"@id": "http://schema.org/image", "@type": "@id"}
   }
   "name": "Daniel A. O'Neil",
   "homepage": "https://www.linkedin.com/in/simtologist",
   "image": "https://media.licdn.com/media/p/3/000/0c4/113/3932a00.jpg"
 }
```

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Terminology and Resources

- **Ontology** - Defines terminology and semantic relationships among concepts
- **Web Ontology Language (OWL)** – a World Wide Web Consortium (W3C) specification for expressing ontologies. https://www.w3.org/TR/owl-features/
- **JavaScript Object Notation Linked Data (JSON-LD)** – a W3C specification for a serialization and messaging format https://www.w3.org/TR/json-ld/
- **Protégé** – is an ontology editor developed by the Stanford Center for Biomedical Informatics Research http://protege.stanford.edu/
- **Space Situational Awareness Ontology (SSAO)**
  - Developed by Robert Rovetto
  - Expressed in OWL
  - Explained in "Preliminaries of a Space Situational Awareness Ontology" https://arxiv.org/ftp/arxiv/papers/1606/1606.01924.pdf

Rovetto, Robert J.

Ontologist
University of Maryland, Department of Philosophy (2007 alum)
University at Buffalo, SUNY, Department of Philosophy (2011 alum)

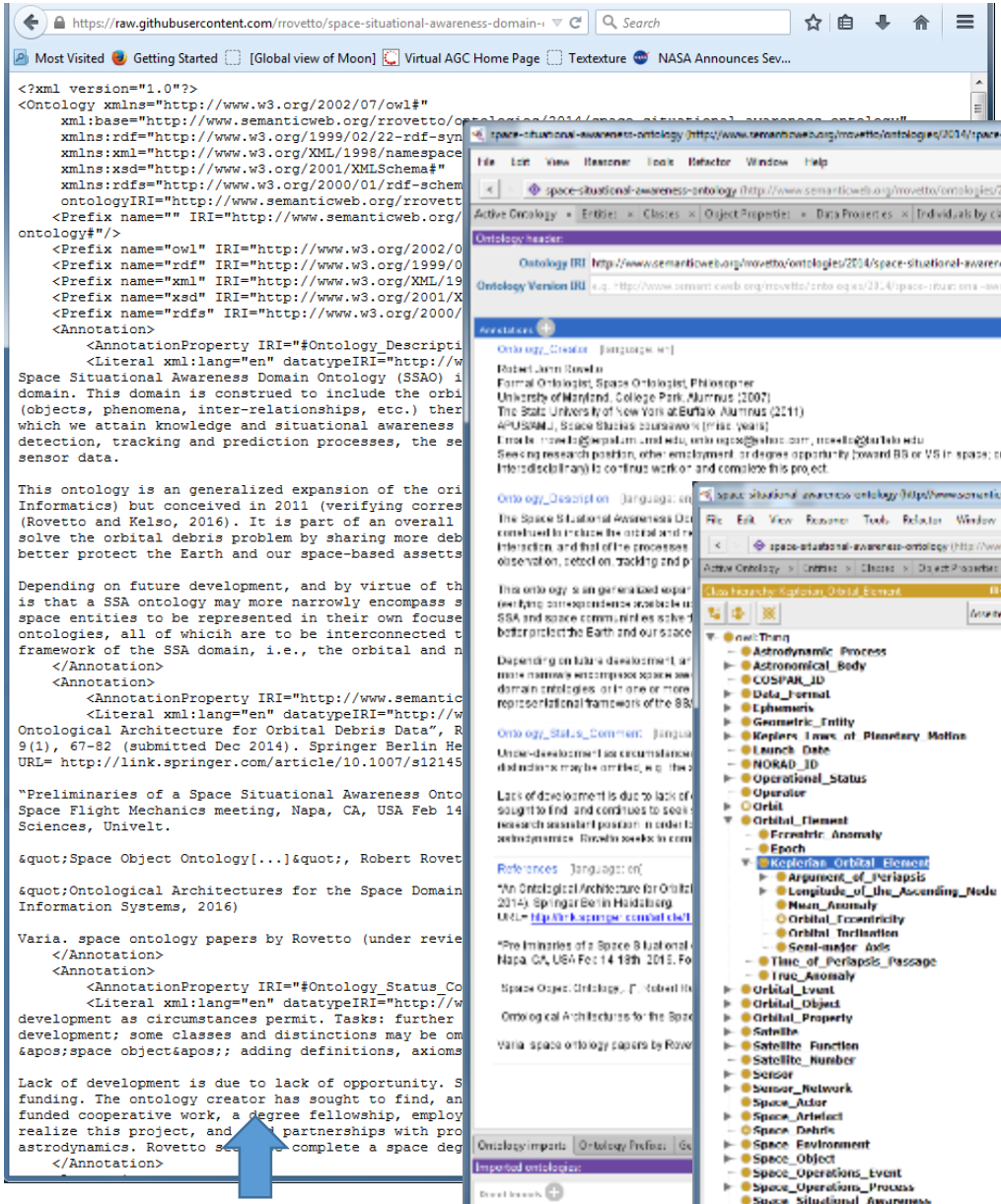
CODER
CENTER FOR ORBITAL DEBRIS EDUCATION AND RESEARCH

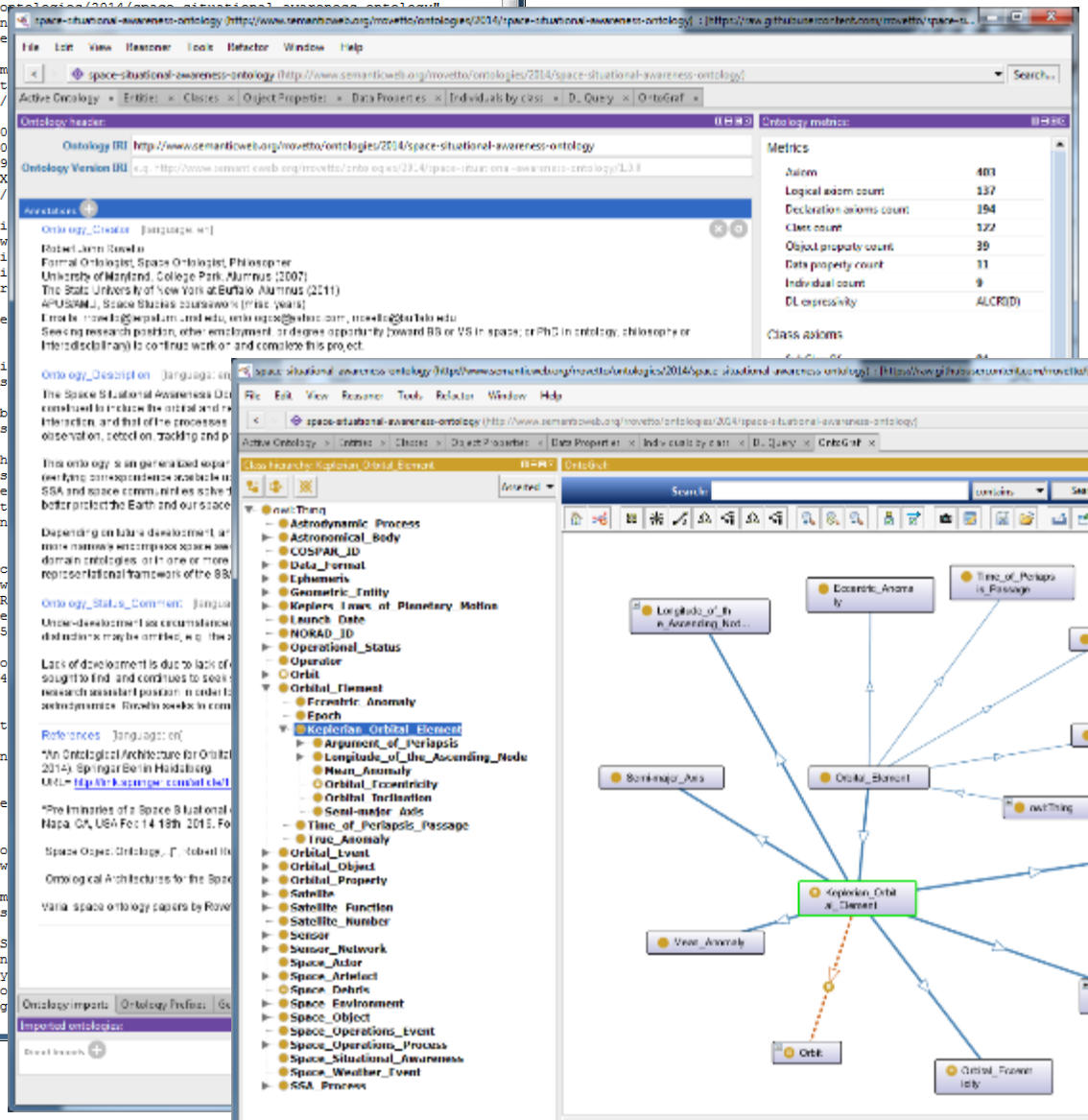
Research topic: ***Space Ontology***, Formal Ontology

http://www.coder.umd.edu/node/285

Space Situational Awareness Ontology

(SSAO) by Robert John Rovetto



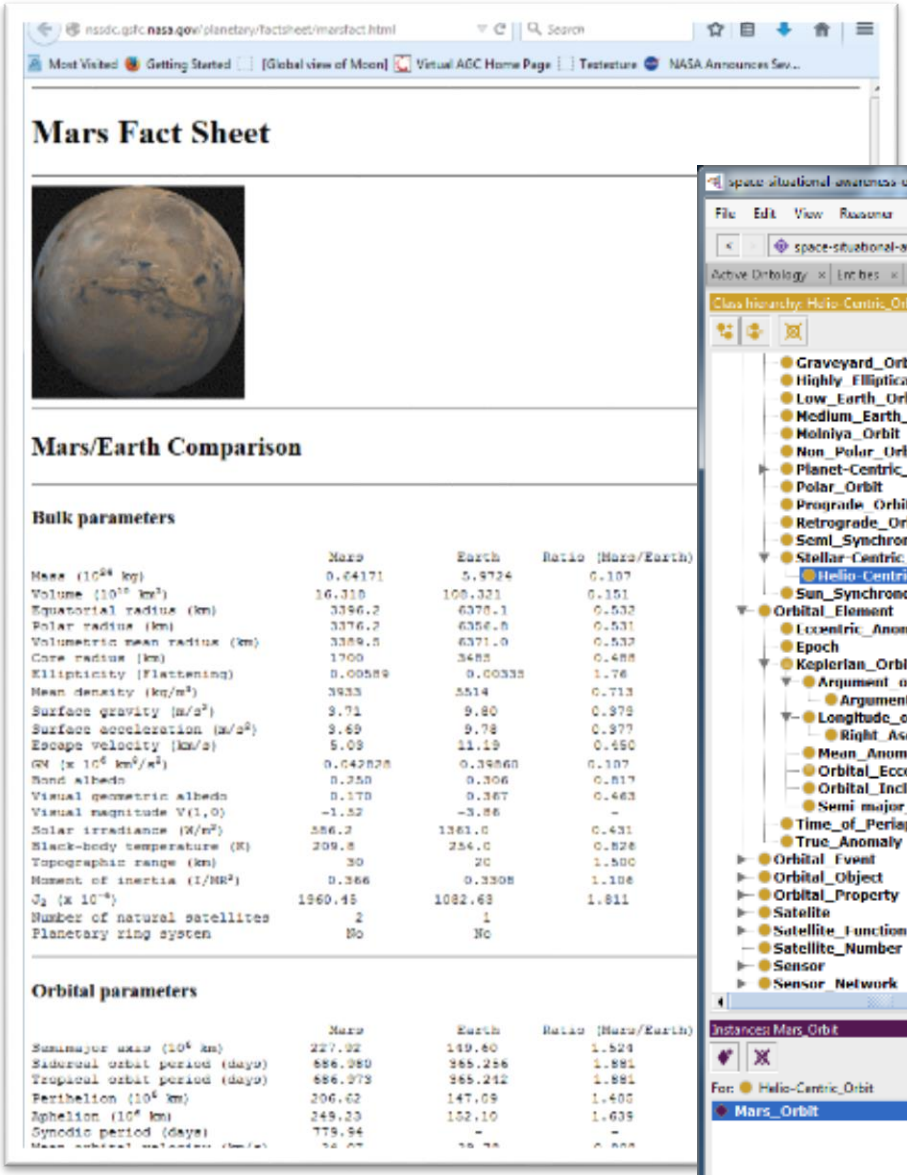


Protégé Screenshots of the SSAO

Ontology file located in Robert John Rovetto's Github repository

https://raw.githubusercontent.com/rrovetto/space-situational-awareness-domain-ontology/master/SSAO_rovetto.owl

Create Planetary Orbits in Protégé and Populate the parameters using data from NASA Fact Sheets



Mars Fact Sheet

Mars/Earth Comparison

Bulk parameters

	Mars	Earth	Ratio (Mars/Earth)
Mass (10^{24} kg)	0.64171	5.9724	0.107
Volume (10^{10} km^3)	16.318	108.321	0.151
Equatorial radius (km)	3396.2	6378.1	0.532
Polar radius (km)	3376.2	6356.8	0.531
Volumetric mean radius (km)	3389.5	6371.0	0.532
Core radius (km)	1700	3485	0.488
Ellipticity (Flattening)	0.00589	0.00335	1.76
Mean density (kg/m^3)	3933	5514	0.713
Surface gravity (m/s^2)	3.71	9.80	0.379
Surface acceleration (m/s^2)	3.69	9.78	0.377
Escape velocity (km/s)	5.03	11.19	0.450
GM (x 10^6 km^3/s^2)	0.042828	0.39860	0.107
Bond albedo	0.250	0.306	0.817
Visual geometric albedo	0.170	0.367	0.463
Visual magnitude V(1,0)	-1.52	-3.86	-
Solar irradiance (W/m^2)	586.2	1361.0	0.431
Black-body temperature (K)	209.8	254.0	0.826
Topographic range (km)	30	20	1.500
Moment of inertia (I/MR^2)	0.366	0.3308	1.106
J_2 (x 10^{-6})	1960.45	1082.63	1.811
Number of natural satellites	2	1	
Planetary ring system	No	No	

Orbital parameters

	Mars	Earth	Ratio (Mars/Earth)
Semimajor axis (10^6 km)	227.92	149.60	1.524
Sidereal orbit period (days)	686.980	365.256	1.881
Tropical orbit period (days)	686.973	365.242	1.881
Perihelion (10^6 km)	206.62	147.09	1.405
Aphelion (10^6 km)	249.23	152.10	1.639
Synodic period (days)	779.94	-	-

http://nssdc.gsfc.nasa.gov/planetary/factsheet/marsfact.html

JavaScript Object Notation Linked Data (JSON-LD) Overview and Resources

3.3 Syntax Tokens

@context – define short-hand names
@id – uniquely identify things
@type – specify a data type
@value – specify a graph property value
@graph – express relationships of things

A JSON-based Serialization for Linked Data

https://www.w3.org/TR/json-ld/

Manu Sporny

- Is one of the authors of the JSON-LD W3C Recommendation
- Has YouTube channel for JSON-LD tutorials

https://www.youtube.com/channel/UCnaA8lQHipp7D6nedkpdE0A

https://github.com/digitalbazaar/jsonld.js *Code library*

Example: Compacting an Expanded Document

```
var doc = {
  "http://schema.org/name": "Manu Sporny",
  "http://schema.org/url": {"@id": "http://manu.sporny.org/"},
  "http://schema.org/image": {"@id":
"http://manu.sporny.org/images/manu.png"}
};
var context = {
  "name": "http://schema.org/name",
  "homepage": {"@id": "http://schema.org/url", "@type": "@id"},
  "image": {"@id": "http://schema.org/image", "@type": "@id"}
};

// compact a document according to a particular context
// see: http://json-ld.org/spec/latest/json-ld/#compacted-
document-form
jsonld.compact(doc, context, function(err, compacted) {
  console.log(JSON.stringify(compacted, null, 2));
  /* Output:
  {
    "@context": {...},
    "name": "Manu Sporny",
    "homepage": "http://manu.sporny.org/",
    "image": "http://manu.sporny.org/images/manu.png"
  }
  */
});
```

6.17 Expanded Document Form

Expanding a JSON-LD document applies the Internationalized Resource Identifiers (IRI) to the things, types, and values, so the @context is not necessary.

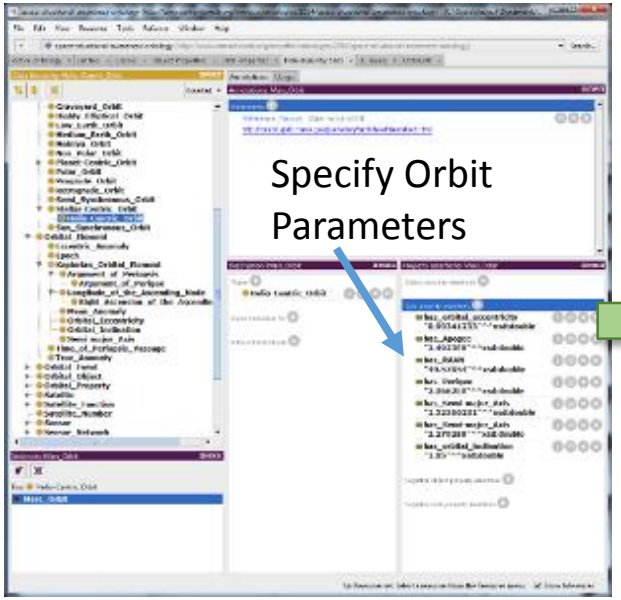
6.18 Compacted Document Form

Compacting a JSON-LD document applies the developer supplied context to shorten the IRIs to terms. This format is simpler because it is expressed in application specific terms and it is easier to read.

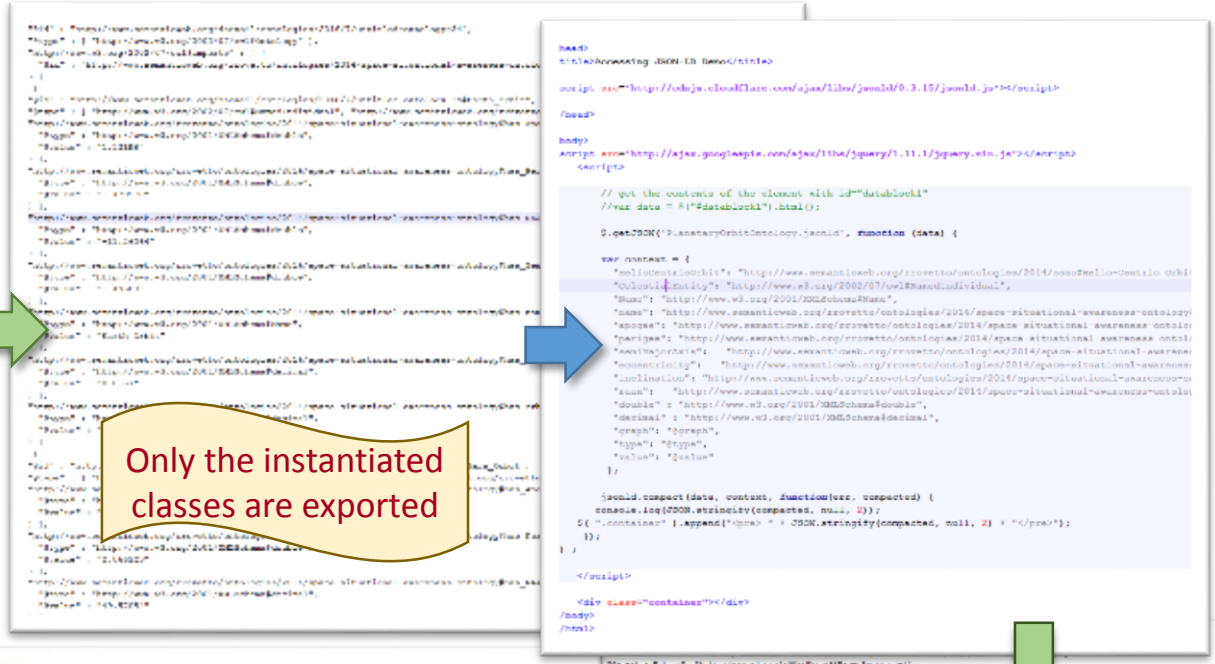
6.19 Flattened Document Form

Flattening a JSON-LD document collects all properties of a node into a single JSON object and labels all blank nodes with blank node identifiers, e.g., “@id”: “_:b0”. A Flattened document “may drastically simplify” processing code.

1. Space Situational Awareness Ontology (SSAO) Imported into Protégé

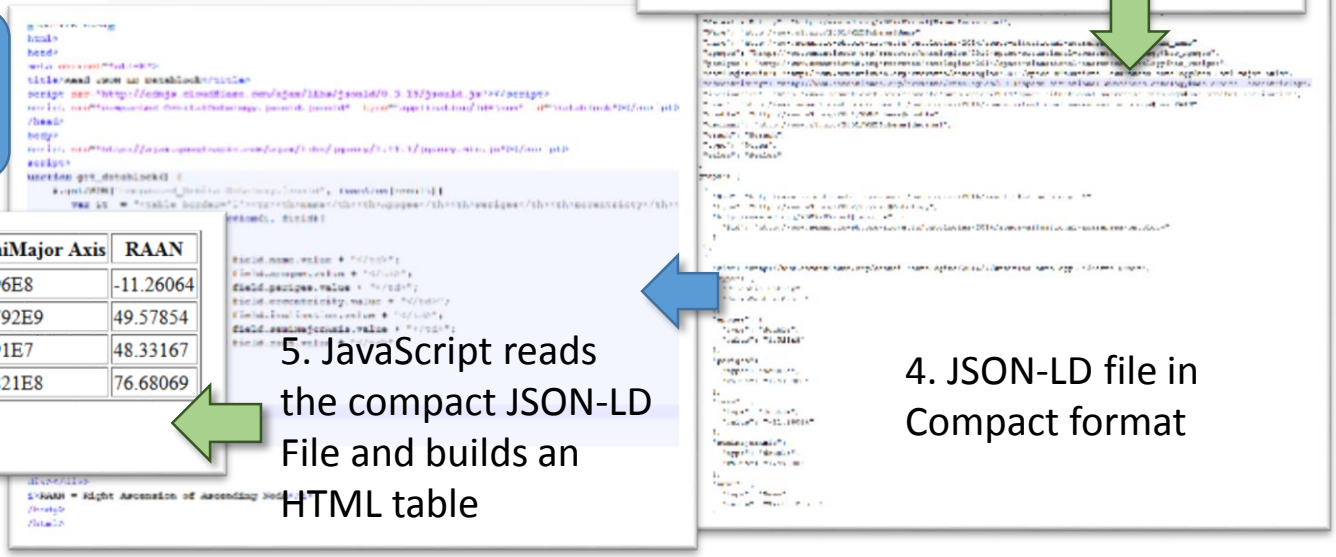


2. Output from Protégé JSON-LD Expanded format



3. JavaScript using jsonld.js code library for converting expanded to compact format

Ontology Driven Web-App Development Process



Name	Apogee	Perigee	Eccentricty	Inclination	SemiMajor Axis	RAAN
Earth_Orbit	1.521E8	1.4709E8	0.0167	0.000	1.496E8	-11.26064
Mars_orbit	2.4923E9	2.0662E9	0.0935	1.85	2.2792E9	49.57854
Mercury_Orbit	6.982E7	4.6E7	0.2056	7.0	5.791E7	48.33167
Venus_Orbit	6.98E7	4.6E7	0.007	3.4	1.0821E8	76.68069

RAAN = Right Ascension of Ascending Node

Rendered Web-Page

5. JavaScript reads the compact JSON-LD File and builds an HTML table

4. JSON-LD file in Compact format

Conclusions

- Build upon existing ontologies developed by researchers in the domain
  - Protégé can import multiple ontologies
  - Additional custom classes can be added
  - Exported ontology only has the instantiated classes; so, there are no unused classes to cluster the data file
- The JSON-LD format builds upon JavaScript Object Notation (JSON) and provides terminology references
  - Protégé 5 exports an ontology in JSON-LD expanded format
  - The jsonld.js code library provides an example for converting the expanded format to the compact format
- The jQuery $.getJSON() command can read the compact version of JSON-LD
  - The Context section translates the expanded format of JSON-LD @variables to the JSON “variable” format
  - A JSON-LD compact file can serve as a complexly structured data-base for web-apps