

The Semantic Web, linked data, knowledge graphs

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Big Data for Labour Market Intelligence
For ETF Online capacity development programme
Module 2 – session 7

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Credential
Engine™



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www.credentialengine.org

Themes

- Diversity is to be welcomed.
- Interoperability is a necessity.
- Technical choices have consequences.



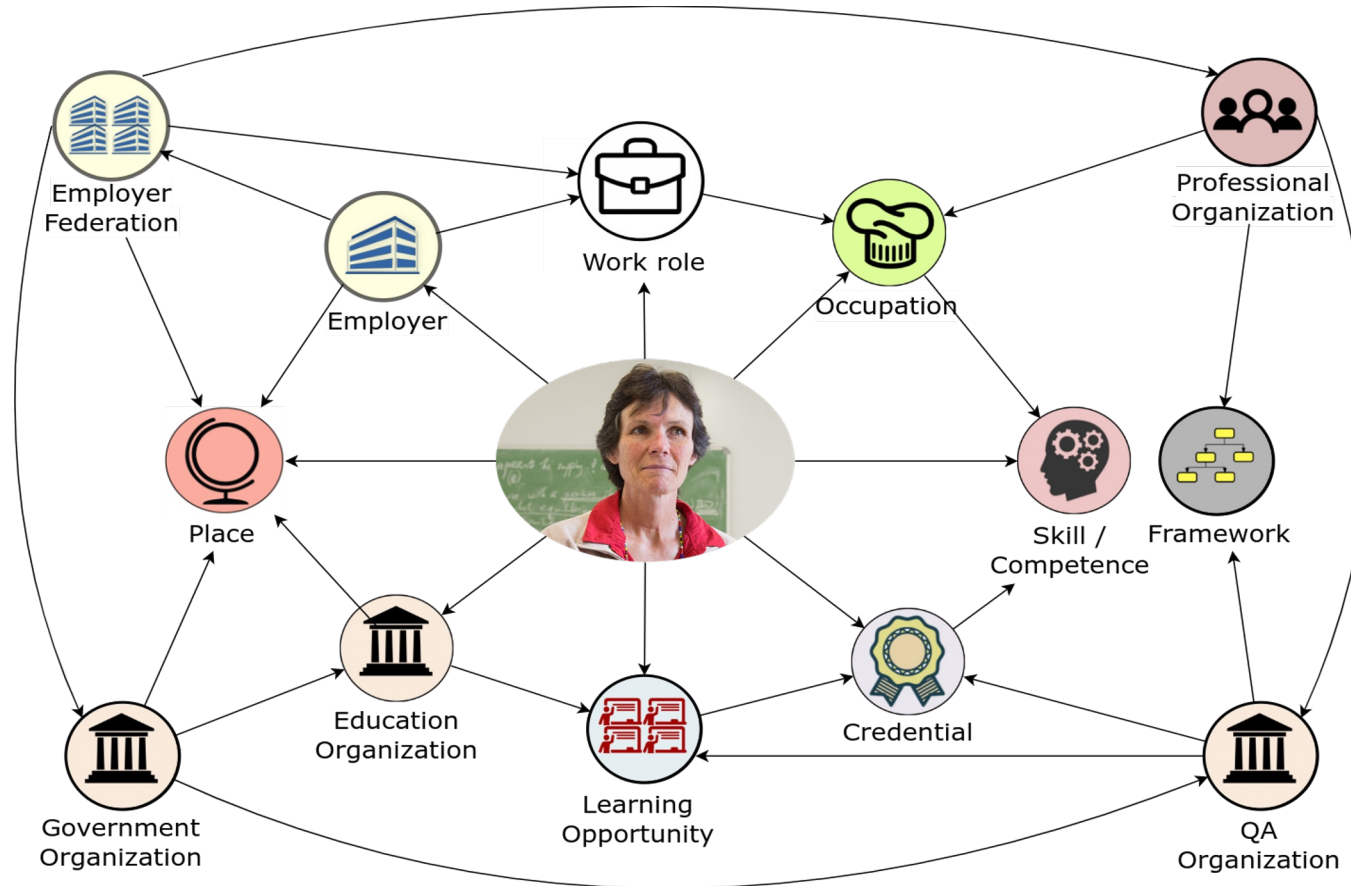
These are big themes, which require broad brush strokes, but the details matter.



Context: Diversity & the Requirement for Interoperability



A View of a Labour Market



Diversity

Actor	Interests	Interact with
Employers	Filling work roles with the right people, recruitment, advancements, payroll ...	Employees, applicants, other employers, professional orgs, government ...
Education Organizations	Programme design, course management, assessment, accreditation ...	Students, applicants, employers, government, QA orgs...
Professional Organizations	Frameworks for roles, career paths ...	Individuals, employers, education & QA orgs ...
QA Organizations	Accrediting program design and assessment against competencies	Education and Professional organizations
Government	Economy, legislation, regulation ...	All



Key Points

- The labour market involves a diversity of different actors, each with their own concerns, practices and uses for data.
- Interoperability is facilitated when a common standard is used.
- Common standards are possible when there are common concerns, practices and uses for data.

There is not (and should not be) a common standard across the whole of the labour market.

There is, however, still a need to share data.





The technical basis of the semantic web, linked data and knowledge graphs

RDF: Resource Description Framework



- W3C Recommendations from 1999 onwards.
- Early 2000's focus on the "**semantic web**":
ontologies, knowledge representation and logical
inferencing.
- 2006 onwards focus on "**linked data**" and
interoperability.
- 2012 onwards focus on "**knowledge graphs**" and
data mining.

RDF: Resource Description Framework



Subject - predicate - Object

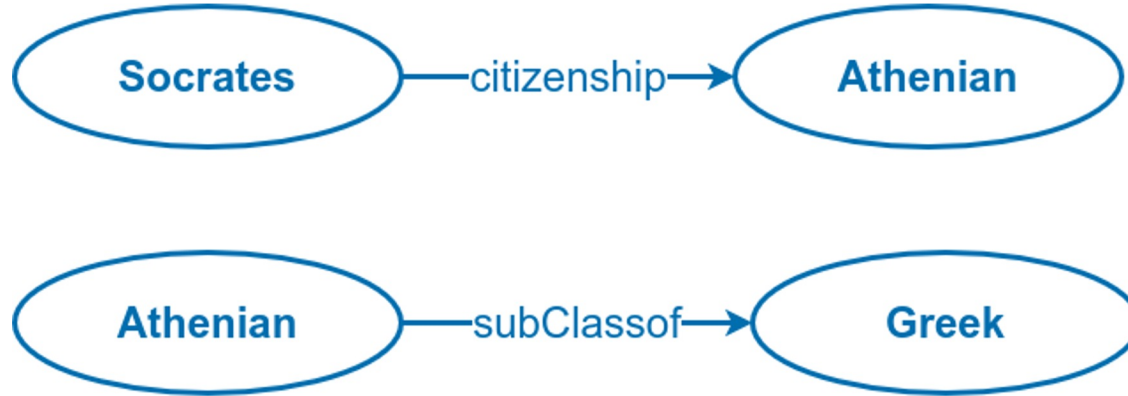
Everything can be identified with URIs:

<<https://www.wikidata.org/entity/Q913>> <<http://www.wikidata.org/prop/direct/P27>> <<https://www.wikidata.org/entity/Q844930>>.

"People think RDF is a pain because it is complicated. The truth is even worse. RDF is painfully simplistic, but it allows you to work with real-world data and problems that are horribly complicated."

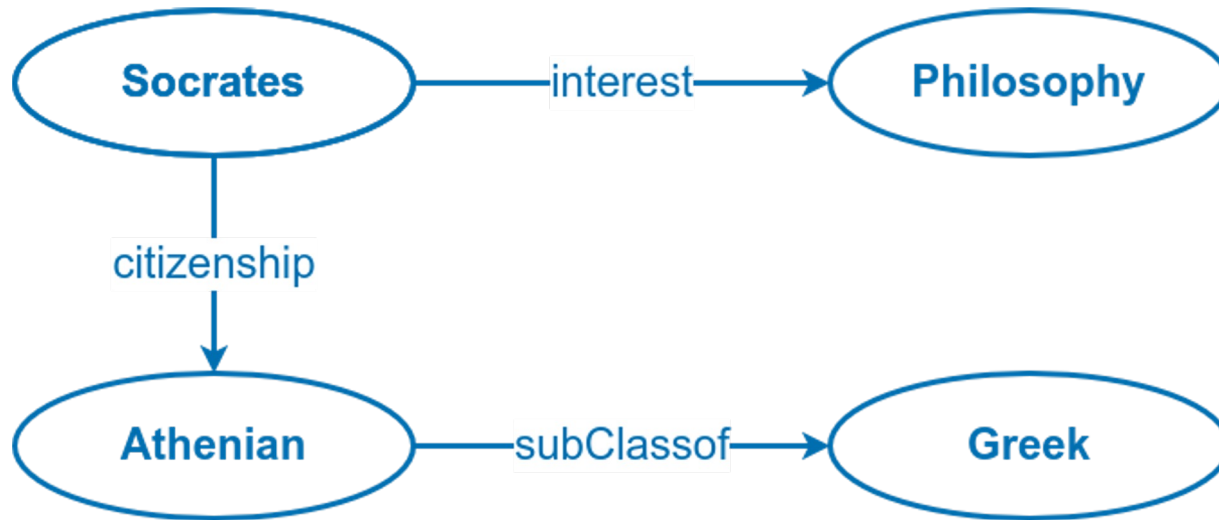
Dan Brickley, Schema.org and Google; Libby Miller, BBC ([source](#))

RDF and Semantics



Therefore: Socrates is Greek

Knowledge Graphs



- Add more data
- The object of one statement can be the subject of another.
- Link the statements into a "graph".
- Start answering questions like "how many Greeks are interested in Philosophy"

URIs and Linked Data

- Uniquely identify everything with a URI

Image is the Google "knowledge panel" from a search for Socrates.



URIs and Linked Data

- Uniquely identify everything with a URI
 - Allows disambiguation
 - Q: when is Socrates not Greek?
 - A: when Socrates is
- Sócrates <<https://www.wikidata.org/entity/Q102331>>, not
Σωκράτης: <<https://www.wikidata.org/entity/Q913>>

Image is the Google "knowledge panel" from a search for Socrates.



Sócrates
Brazilian footballer

Sócrates Brasileiro Sampaio de Souza Vieira de Oliveira, simply known as Sócrates, was a Brazilian footballer who played as a midfielder. His medical degree and his political awareness, combined with style and quality of his play, earned him the nickname "Doctor Socrates".
[Wikipedia](#)

Born: 19 February 1954, [Belém, State of Pará, Brazil](#)

Died: 4 December 2011, [Albert Einstein Israelite Hospital, São Paulo, State of São Paulo, Brazil](#)

Height: 1.92 m

Spouse: [Katia Bagnarelli](#) (m. ?–2011)

Children: [Gustavo Vieira de Oliveira](#), [MORE](#)

Siblings: [Raí](#)

Parents: [Guiomar de Oliveira](#), [Raimundo de Oliveira](#)

URIs and Linked Data

- Uniquely identify everything with a URI
- Allows disambiguation
 - Q: when is Socrates not Greek?
 - A: when Socrates is Sócrates
- Can follow the link for more data
- Human language independent

Image is the Wikidata entry for Socrates name in various languages.

Socrates (Q913)

ancient Greek philosopher

Sokrates

▼ In more languages

[Configure](#)

Language	Label	Description
English	Socrates	ancient Greek philosopher
British English	Socrates	classical Greek Athenian philosopher
Spanish	Sócrates	filósofo griego clásico ateniense
Greek	Σωκράτης	φιλόσοφος της Αρχαίας Ελλάδος (-470/-399)
Afrikaans	Sokrates	Griekse filosoof
Amharic	ሶክራቴስ	No description defined
Aragonese	Socrates	No description defined
Old English	Socrates	No description defined
Arabic	سقراط	أغريقى قديم
Egyptian Arabic	سوقراط	No description defined
Assamese	সক্ৰাট	No description defined
Asturian	Sócrates	No description defined
Azerbaijani	Sokrat	No description defined
South Azerbaijani	سقراط	No description defined
Bashkir	Сократ	No description defined
Bavarian	Sokrates	No description defined
Central Bikol	Socrates	No description defined

Recap: Standards and interoperability

If organizations are using similar data for similar things, and they want to cooperate, they can use the same data standard to share data (interoperate)

- HR department can send job vacancy data to Recruiting partner
- Publisher can supply data about learning resources to a school

Within each domain IT systems implement the relevant standards.

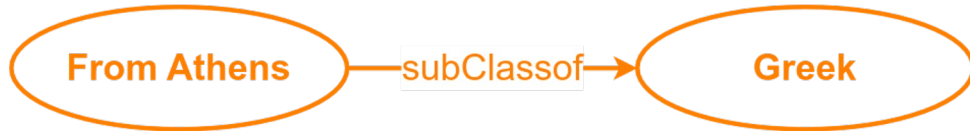
BUT: different standards are appropriate for different domains

- HR standard to describe salaries and skills required for job
- LMS standard to describe courses and learning outcomes

RDF and harmonization



Different standards in RDF use the same **meta-model**



(i.e. statements as triples involving subject - predicate - object, identified with URLs.)

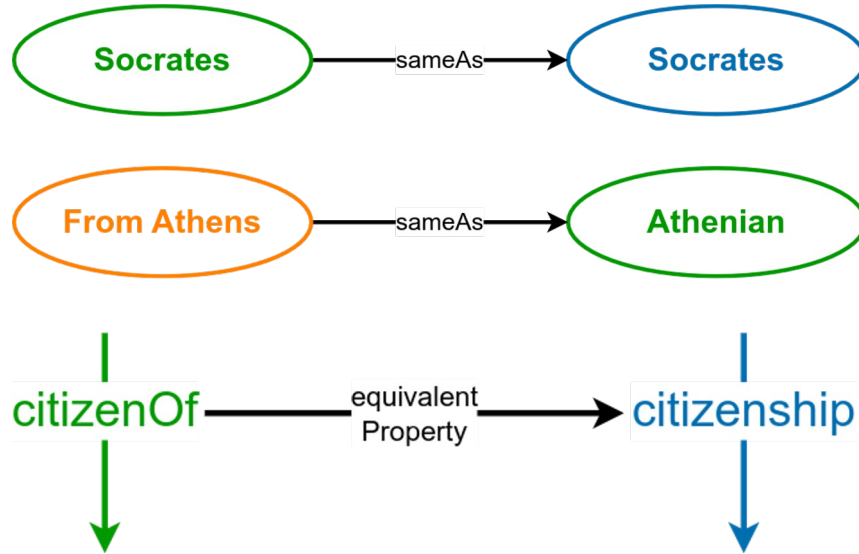


Here green, orange and blue statements represent data from three different RDF standards.

RDF allows mixing and matching

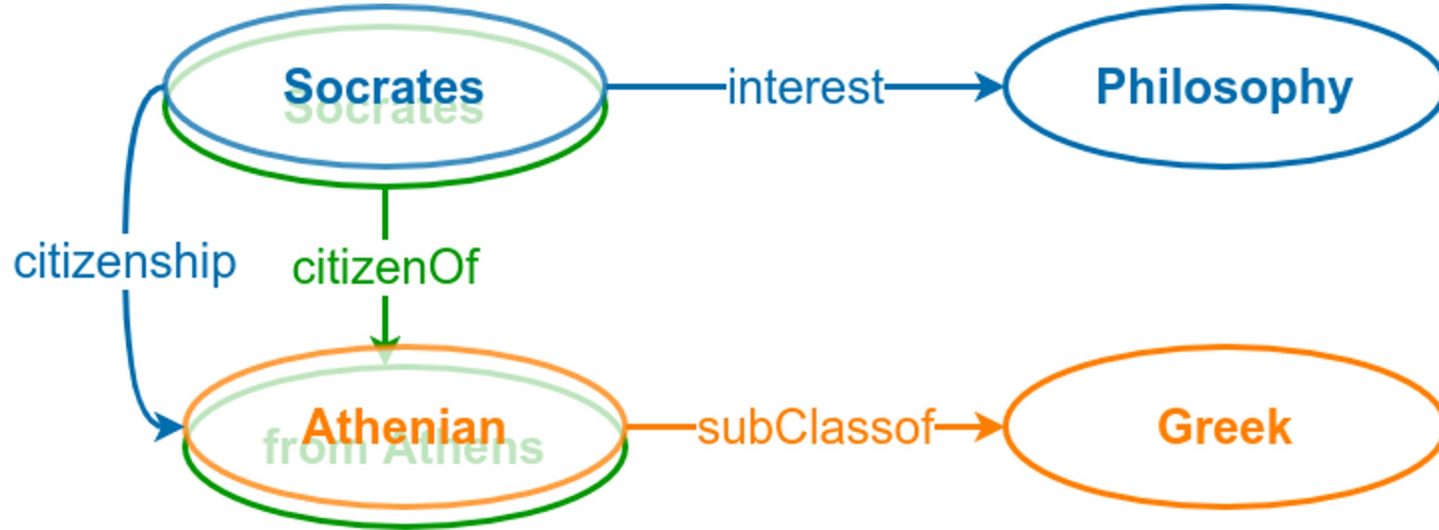


Terms from different standards can be used together.



RDF has standards to assert equivalence between terms.

RDF allows mixing and matching



- Same knowledge graph as before, but created by mixing and matching terms from different RDF standards



Key Points

RDF:

- Stable, mature, open standards framework.
- Foundation of the semantic web / linked data / knowledge graphs
- Allows you to infer information that is not explicitly in the data
- Decentralized: link between datasets
- Large, public datasets are possible
- Harmonization on a common meta-model: interoperability between different domain standards



Credential Engine: Credential Transparency, CTDL and the Credential Registry



Credential Engine & What It Does

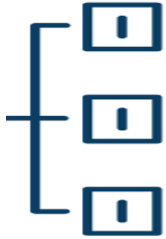
Our Mission: Credential Engine is a non-profit whose mission is to map the credential landscape with clear and consistent information, fueling the creation of resources that empower people to find the pathways that are best for them.

Our Vision: We envision a future where millions of people worldwide have access to information about credentials that opens their eyes to the full range of opportunities for learning, advancement, and meaningful careers.

How we accomplish our Mission and Vision:

- Building common infrastructure and language
- Collaboration
- Empowerment

Credential Engine's open technologies



Credential Transparency Description Language (CTDL)

Linked open data schema that describes over 800 characteristics of credentials, skills, jobs, and providers.



CTDL Publishing Tools

Providers use the API or any of the publishing system tools to convert information to CTDL, publish to the Registry, and create globally unique identifiers (CTIDs).



Credential Registry

The Registry collects and connects credential, skill, and job data described with CTDL as a linked open data graph to power tools and applications, including the Credential Finder.

CREDENTIAL FINDER

Credential Finder

A tool to view and explore the information stored in the Registry.

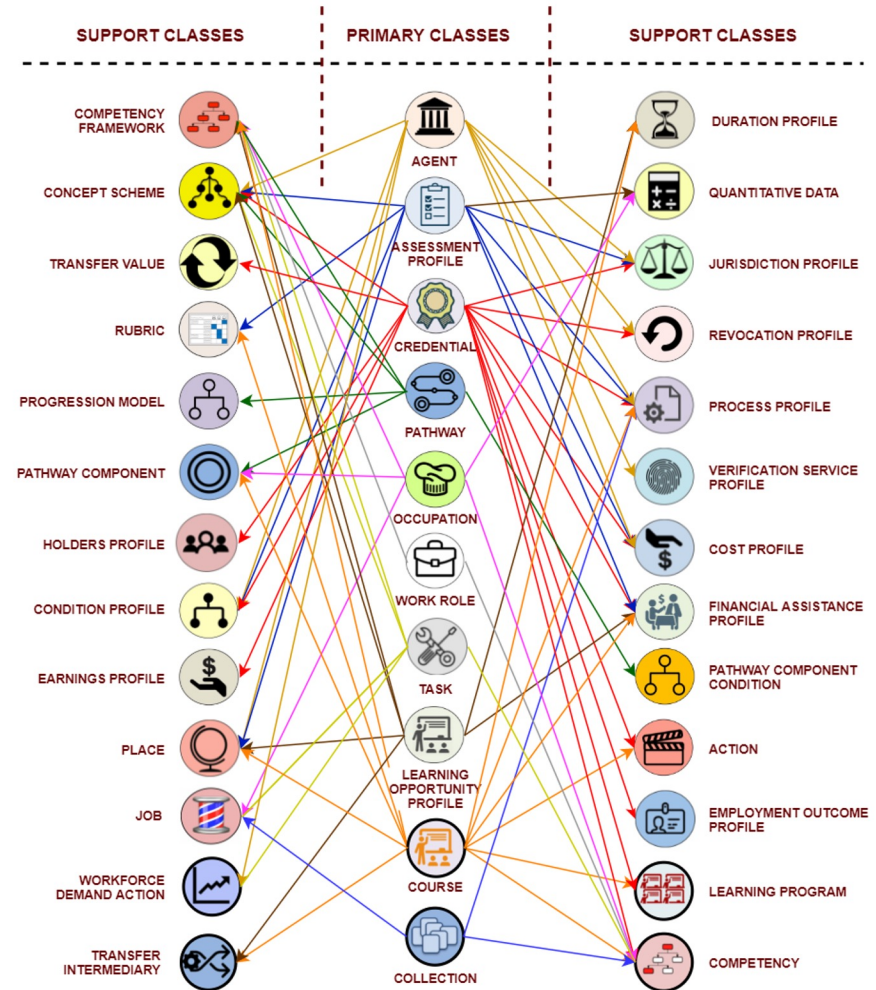
Credential Transparency Description Language (CTDL)

An openly licensed common language modeled on World Wide Web Consortium (W3C) specifications for the semantic web to enable transparency and comparability of credential and competency information.

Three Schemas:

1. [CTDL](#) - Credentials and adjacent classes
2. [CTDL-ASN](#) - Competencies
3. [QDATA](#) - Quantitative Data

[CTDL Handbook](#) via <https://credreg.net>



Credential Transparency Description Language (CTDL) Terms

Over 800 Linked Open Data terms providing rich descriptions of credentials and competencies

ceterms:Certification	
URI:	https://purl.org/ctdl/terms/Certification
Shorthand URI:	ceterms:Certification
Label:	<i>en-US</i> : Certification
Definition:	<i>en-US</i> : Time-limited, revocable, renewable credential awarded by an authoritative body for demonstrating the knowledge, skills, and abilities to perform specific tasks or an occupation.
Comment:	<i>en-US</i> : Certifications can typically be revoked if not renewed, for a violation of a code of ethics (if applicable) or proven incompetence after due process. Description of revocation criteria for a specific Certification should be defined using Revocation Profile.
Type of Term:	rdfs:Class
Status:	vs:stable
Subclass Of:	ceterms:Credential ceterms:Credential
	ceterms:accreditedBy ceterms:isRequiredFor

Certification:

Time-limited, revocable, renewable credential awarded by an authoritative body for demonstrating the knowledge, skills, and abilities to perform specific tasks or an occupation.

Example data from the Credential Finder



Associate's Degree

A.A.S. in Dental Assisting

Ivy Tech Community College of Indiana

Last updated: Dec 22, 2020

Compare



About this Credential

Basic information about the Credential

The Dental Assisting program at Ivy Tech is taught by instructors who have all worked as dental assistants in the field. Students will get to study in a state-of-the-art facility learning a variety of skills involving radiography, dental materials, infection control, chairside, and general dentistry as well as dental specialties. For more information about dental assisting, visit the American Dental Assistant's Association website. The Dental Assisting program is a selective admission program. When you apply to the college, you would be accepted into the Healthcare Specialist program with a concentration in Dental Assisting while you complete the prerequisite requirements. The Dental Assisting program accepts a limited number of students each year and there is a separate application process.

[View this Credential](#)

Credential Type



Related Organization(s)

Organizations that own, offer, or perform other services related to the Credential

Owned and Offered By

[Ivy Tech Community College of Indiana](#)



Connections

Relationships between the Credential and other data in the Registry

Related Competencies

Teaches 50 Competencies

Example data from the Credential Finder

The screenshot displays the 'A.A.S. in Dental Assisting' credential page on the Credential Registry. The page is titled 'A.A.S. in Dental Assisting' and includes a 'Registry Info' section. The 'Raw Metadata' is shown as a JSON-LD object. The interface also features a sidebar with navigation links and a footer with social media and legal links.

Process
Processes related to the Credential

A.A.S. in Dental Assisting

Registry Info

Raw Metadata:

```
{
  "@context": "https://credreg.net/ctdl/schema/context/json",
  "@id": "https://credentialengineregistry.org/resources/ce-dd1df89c-5ed7-43ee-be8e-44e799ca6f13",
  "@type": "ceterms:AssociateDegree",
  "ceterms:ctid": "ce-dd1df89c-5ed7-43ee-be8e-44e799ca6f13",
  "ceterms:name": {
    "en-US": "A.A.S. in Dental Assisting"
  },
  "ceterms:ownedBy": [
    "https://credentialengineregistry.org/resources/ce-1abb6c52-0f8c-4b17-9f89-7e9807673106"
  ],
  "ceterms:requires": [
    {
      "@type": "ceterms:ConditionProfile",
      "ceterms:name": {
        "en-US": "Credit Hours"
      },
      "ceterms:assertedBy": [
        "https://credentialengineregistry.org/resources/ce-1abb6c52-0f8c-4b17-9f89-7e9807673106"
      ]
    }
  ]
}
```

Powered by the
Credential Registry

Home
Search
Reports and Data
Benchmark Reports

Facebook
YouTube

Terms of Use
Publishers Agreement

Credential Planning

Credential
JSON-LD

All the information about this credential is directly from the Credential Registry as JSON-LD



Key Takeaways

- Credential Engine is a not-for-profit organization aiming to collaborate in improving the outlook for education and employability
- CTDL is an RDF-based language for describing Credentials (qualifications) and things related to them
- Data using CTDL can be stored in registries such as the Credential Registry



CTDL and Verifiable Credentials (briefly)

W3C Verifiable Credentials

- Standard for tamper evident assertions of an individual's achievements.
 - RDF Data Model <https://www.w3.org/TR/vc-data-model/>
 - Protocols for privacy-respecting issuing of this data.
- The educational examples in the standard are very scant on detail.
- A W3C Community Group has been looking at education use cases.
- Basis of 1EdTech(*) OpenBadges V3

(* was IMS)

W3C VC Example

```
{
  "@context": [
    "https://www.w3.org/2018/credentials/v1",
    "https://www.w3.org/2018/credentials/examples/v1"
  ],
  "id": "http://example.edu/credentials/3732",
  "type": ["VerifiableCredential", "UniversityDegreeCredential"],
  "issuer": "https://example.edu/issuers/565049",
  "issuanceDate": "2010-01-01T00:00:00Z",
  "credentialSubject": {
    "id": "did:example:ebfeb1f712ebc6f1c276e12ec21",
    "degree": {
      "type": "BachelorDegree",
      "name": "Bachelor of Science and Arts"
    }
  }
}
```

It is not enough to just say that
you have a degree.

CTDL in a W3C VC

```
{ "@context": [...],  
  ...  
  "credentialSubject": {  
    "id": "did:example:ebfeb1f712ebc6f1c276e12ec21",  
    "achievement": [  
      { "id": "res:ce-49247727-7cbd-4f0e-8179-e51036d1f14a", // the degree achieved  
        "type": "ceterms:BachelorDegree",  
        "ceterms:name": { "en-US": "Bachelor's Degree" },  
        "ceterms:requires": [ "res:ce-84958217-1323-46fe-87c8-652120800190",  
                              "res:ce-8aa6b5b5-095c-4152-89b2-06438129002c" ]  
      }, {  
        "id": "res:ce-84958217-1323-46fe-87c8-652120800190", // List of competencies acquired  
        "type": "ceasn:Competency",  
        "ceasn:codedNotation": "EXKSCI1",  
        "ceasn:competencyLabel": "Knowledge of Science",  
        "ceasn:competencyText": "Demonstrate a good knowledge of science..."  
      }, {  
        "id": "res:ce-8aa6b5b5-095c-4152-89b2-06438129002c",  
        "type": "ceasn:Competency",  
        "ceasn:codedNotation": "EXKART1",  
        "ceasn:competencyLabel": "Knowledge of Arts",  
        "ceasn:competencyText": "Demonstrate a good knowledge of arts..."  
      }  
    ]  
  }  
}
```

In JSON-LD playground
<https://tinyurl.com/2twaddyv>



Key Takeaways

- CTDL can be used with other RDF languages to provide rich data about the educational and occupational achievements of individuals,
a personal knowledge graph
- which can be compatible with data from other sources, such as educational offers, job adverts etc.

For more details see our discussion document:

[CTDL terms and Registry data in Verifiable Credentials \(VC / Open Badges 3.0 / CLR 1.1\)](#)



Thank You



Phil Barker

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Website: credentialengine.org

Technical Information: credreg.net

Credential Finder: credentialfinder.org



Social Media

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