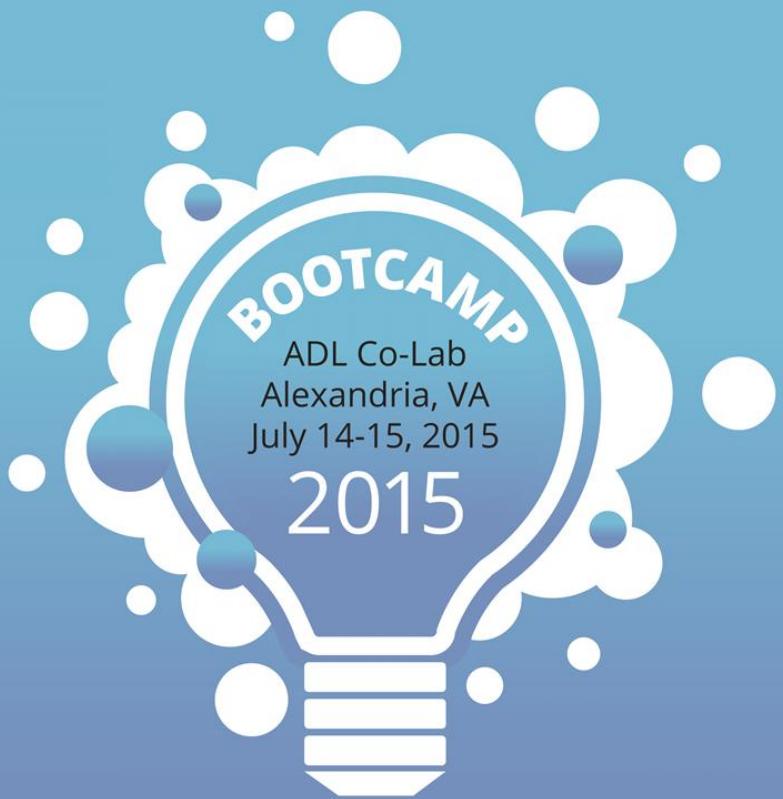


EXPERIENCE xAPI

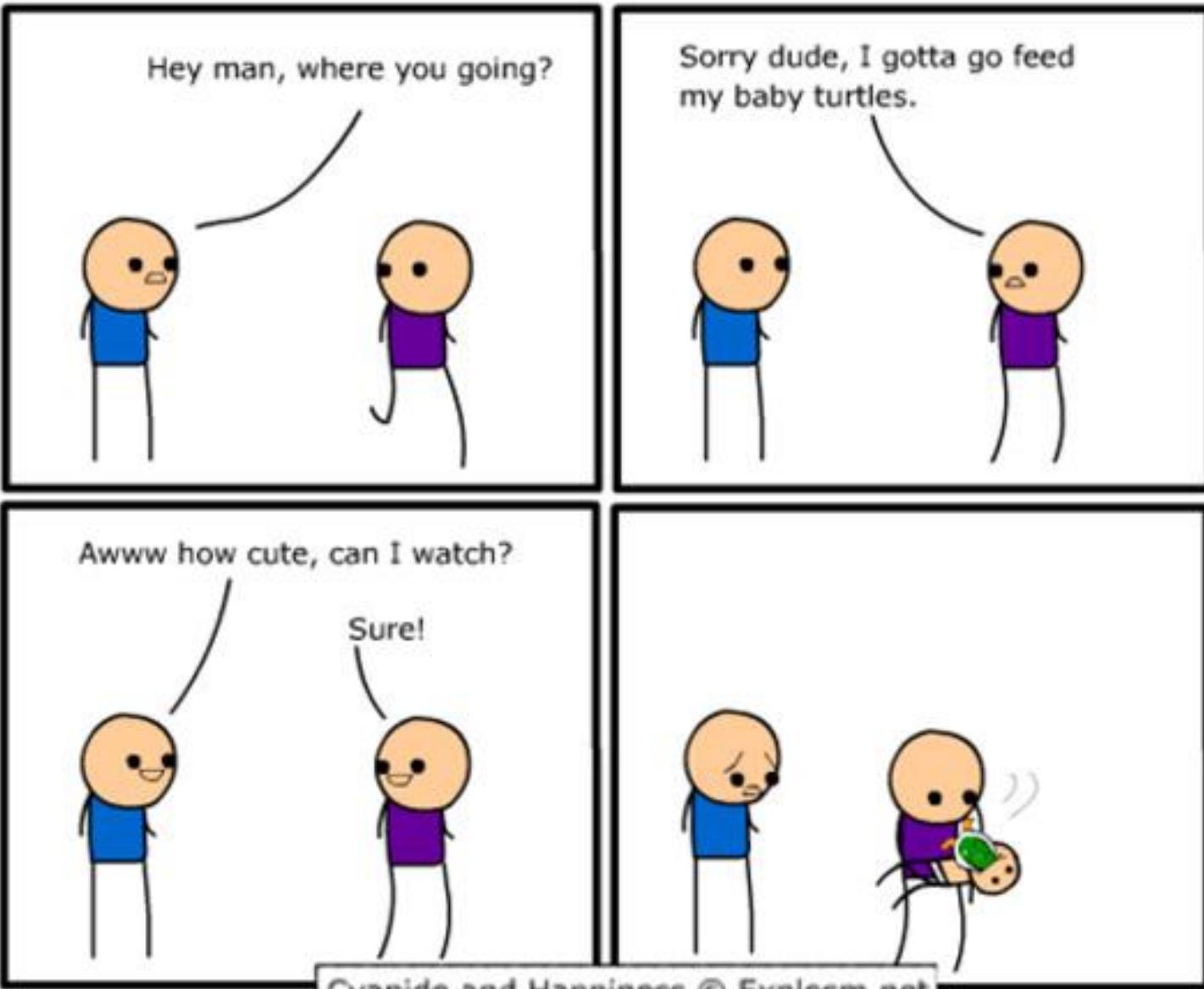


Learn, Design, Implement



Jason Haag
ADL Technical Team
Mobile Lead, Research Analyst
The Tolliver Group, Inc. ADL SETA Support

Obligatory Opening Semantics Joke



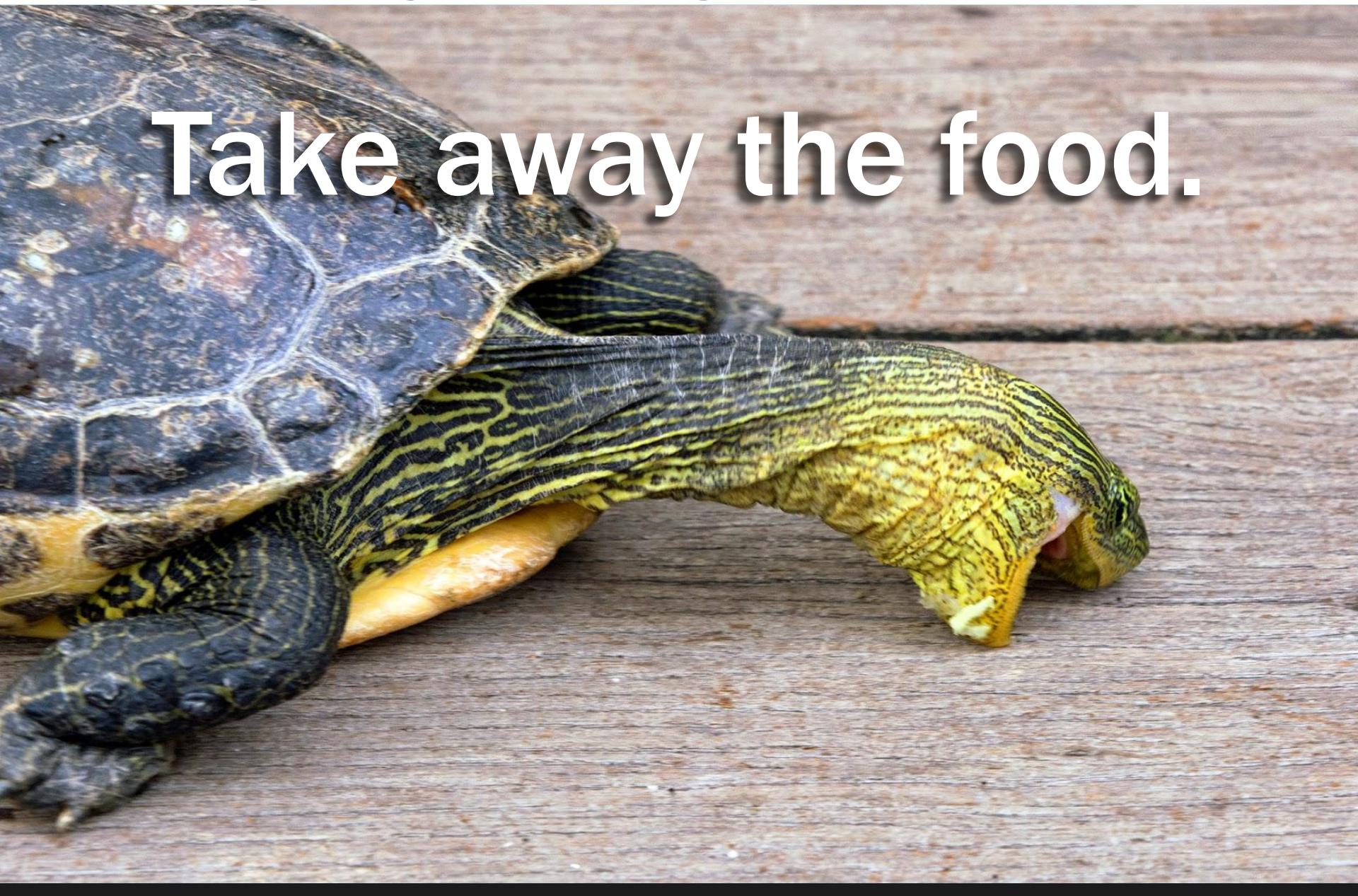
Obligatory Opening Semantics Joke

How do you make a
turtle fast?



Obligatory Opening Semantics Joke

Take away the food.



WHAT PROBLEMS ARE WE TRYING TO SOLVE?



Current Practices

- Initial focus of xAPI has been on “structural” interoperability
 - defined the syntax and ensured data can be exchanged/processed
 - RESTful API principles / style / simplicity
 - syntax of data exchange (JSON)
 - This was needed to support multiple devices/platforms and scalability

Current Practices

- Spec guidance only mentions human readable identifier metadata (literal name(display), description)
- *Based on natural language, but...*
 - No focus on prescribing semantic meaning and disambiguation for controlled vocabularies

Problem Definition

- 1. The xAPI spec recommends CoPs to create controlled vocabularies...BUT**
 - *No guidance on creating, publishing, or managing controlled vocabulary data (e.g., verbs, activityTypes, attachments, extensions)*
- 2. Natural language presents 2 challenges:**
 - *2 or more terms can be used to represent a single concept*
 - *2 or more words that have the same spelling can represent different concept*

Actor

Verb

Object

Johnny

passed

life

Actor

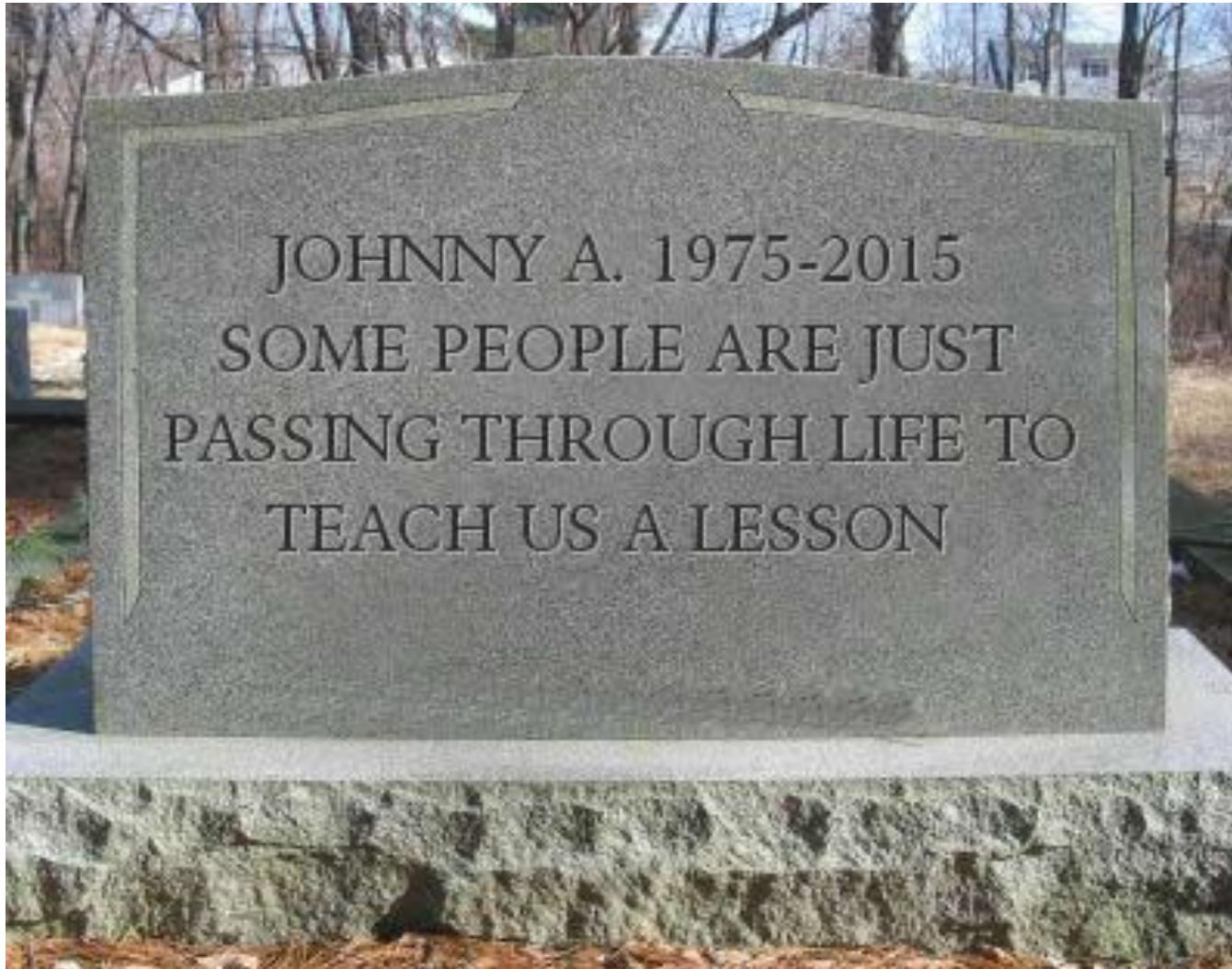
Verb

Object

Johnny

passed

life



Actor

Verb

Object

Johnny

passed

life

mbox: johnny@appleseed.com

http://adlnet.gov/expapi/verbs/Passed

http://www.gameoflifeonline.com/play-game-of-life-online

```
{  
  "actor": {  
    "mbox": "mailto:johnny@appleseed.com",  
    "name": "Johnny",  
    "objectType": "Agent"  
  },  
  "verb": {  
    "id": "http://adlnet.gov/expapi/verbs/Passed",  
    "display": {  
      "en-US": "Passed"  
    }  
  },  
  "object": {  
    "id": "http://www.gameoflifeonline.com/play-game-of-life-online",  
    "definition": {  
      "name": {  
        "en-US": "Life"  
      },  
      "description": {  
        "en-US": "The game of life"  
      }  
    }  
  }  
}
```

Current Guidance - Verbs

*“The IRI contained in an id **SHOULD** contain a human-readable portion which **SHOULD** provide meaning enough for a person reviewing the raw statement to disambiguate the Verb from other similar(in syntax) Verbs.”*

Current Guidance - Activity Definitions

*"If an Activity IRI is an IRL, an LRS **SHOULD** attempt to GET that IRL, and include in HTTP headers: "Accept: application/json, /"."*

*"An Activity with an IRL identifier **MAY** host metadata using the Activity Definition JSON format which is used in Statements, with a Content-Type of "application/json"*

Actor

Johnny

mbox: johnny@appleseed.com

Verb

passed

http://adlnet.gov/expapi/verbs/passed

passed

Verb Meaning:

Definition: pass (go successfully through a test or a selection process)

Usage: Used to affirm the success a learner experienced within the learning content in relation to a threshold. If the user performed at a minimum to the level of this threshold, the content is 'passed'. The opposite of 'failed'..

Object

life

http://www.gameoflifeonline.com/play-game-of-life-online

activityType

http://activitystrea.ms/schema/1.0/game

Activity Streams

Not Found

The page you're looking for can't be found. We've been moving things around a bit, so you might want to go to the [home](#) and navigating from there.

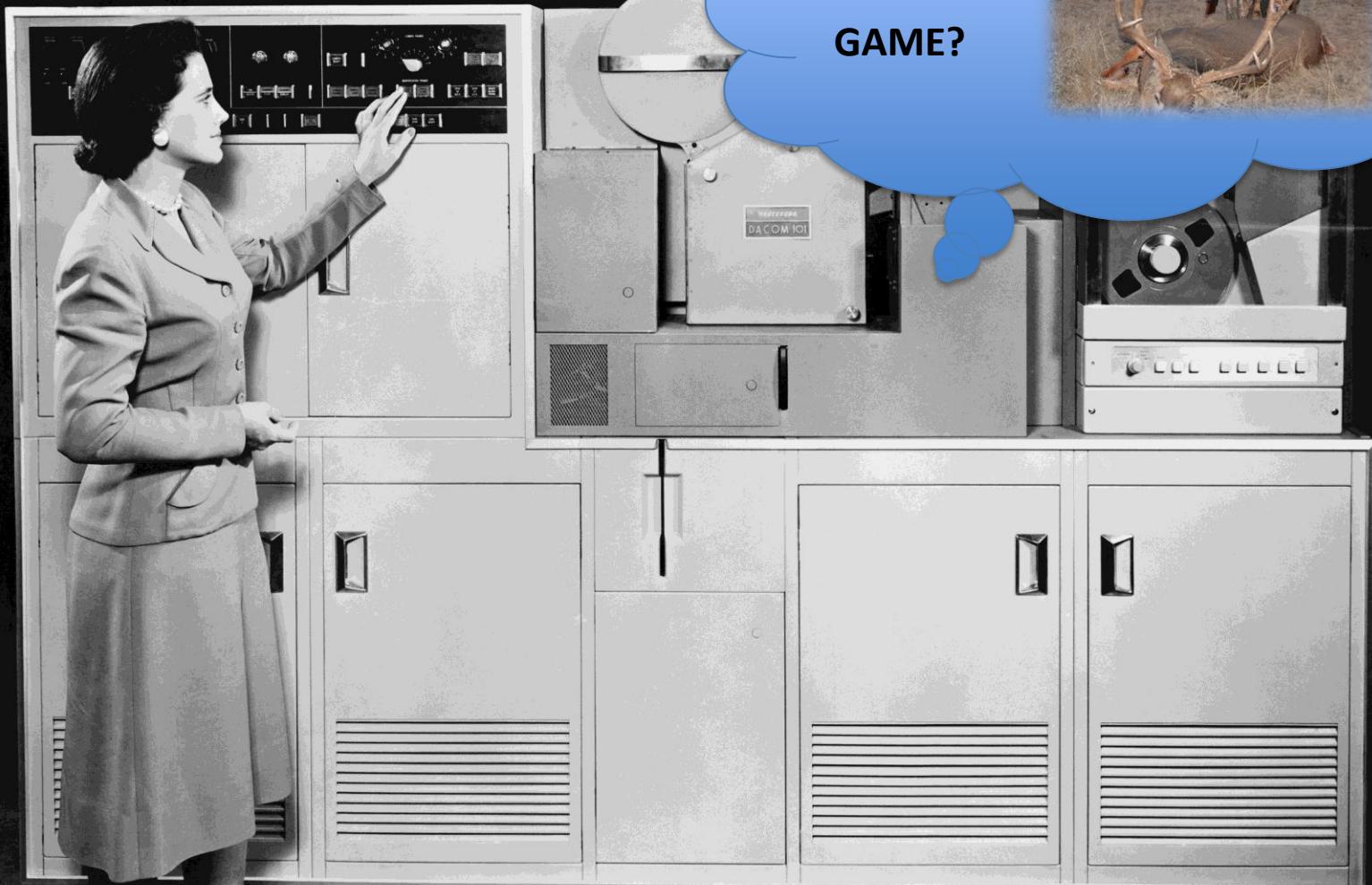
Outcome: Human readable Text/HTML

Outcome: Human readable Error Page

<http://activitystrea.ms/schema/1.0/game>

**DOES NOT COMPUTE...
WHAT DOES IT MEAN?**





"PASSED"

GAME?



“PASSED”

GAME?



Actor

Johnny

mbox: johnny@appleseed.com

Verb

passed

http://adlnet.gov/expapi/verbs/passed

Object

life

http://www.gameoflifeonline.com/play-game-of-life-online

activityType

http://wordnet-rdf.princeton.edu/wn31/202530710-v.json

```
wordnet-ontology:gloss: "go successfully through a test or a selection process",
wordnet-ontology:hypernym: "http://wordnet-rdf.princeton.edu/wn31/202529837-v",
wordnet-ontology:hyponym: "http://wordnet-rdf.princeton.edu/wn31/202528247-v",
wordnet-ontology:lexical_domain: "wordnet-ontology:verb.social",
wordnet-ontology:part_of_speech: "wordnet-ontology:verb",
wordnet-ontology:sample: "She passed the new Jersey Bar Exam and can practice law now",
wordnet-ontology:synset_member: [
    - {
        @id: "http://wordnet-rdf.princeton.edu/wn31/make+it-v"
    },
    - {
        @id: "http://wordnet-rdf.princeton.edu/wn31/pass-v"
    }
],
wordnet-ontology:translation: [
    - {
        @language: "ind",
        @value: "berhasil"
    },
    - {
        @language: "jpn",
        @value: "受かる"
    },
    - {
        @language: "fin",
        @value: "läpäistä"
    },
    - {
        @language: "ind",
        @value: "berjaya"
    },
    - {
        @language: "dan",
        @value: "bestå"
    },
    - {
        @language: "ind",
        @value: "meluluskan"
    }
]
```

http://purl.org/xapi/adl/activityTypes/game

```
label: "game",
wordnet-ontology:gloss: "an amusement or pastime",
wordnet-ontology:hypernym: "http://wordnet-rdf.princeton.edu/wn31/100461405-n",
wordnet-ontology:hyponym: [
    "http://wordnet-rdf.princeton.edu/wn31/100460594-n",
    "http://wordnet-rdf.princeton.edu/wn31/100461767-n",
    "http://wordnet-rdf.princeton.edu/wn31/100459914-n",
    "http://wordnet-rdf.princeton.edu/wn31/100461040-n",
    "http://wordnet-rdf.princeton.edu/wn31/100460308-n",
    "http://wordnet-rdf.princeton.edu/wn31/100461139-n",
    "http://wordnet-rdf.princeton.edu/wn31/100461602-n",
    "http://wordnet-rdf.princeton.edu/wn31/100459665-n",
    "http://wordnet-rdf.princeton.edu/wn31/100460906-n",
    "http://wordnet-rdf.princeton.edu/wn31/100459824-n
],
wordnet-ontology:lexical_domain: "wordnet-ontology:noun.act",
wordnet-ontology:part_of_speech: "wordnet-ontology:noun",
wordnet-ontology:sample: [
    "he thought of his painting as a game that filled his empty time",
    "his life was all fun and games",
    "they played word games"
],
wordnet-ontology:synset_member: [
    @id: "http://wordnet-rdf.princeton.edu/wn31/game-n"
],
wordnet-ontology:translation: [
    - {
        @language: "zsm",
        @value: "permainan"
    }
]
```

Outcome: Human + Machine readable data!

Machine Readable: <http://wordnet-rdf.princeton.edu/wn31/202530710-v.json>

```
@id: "http://wordnet-rdf.princeton.edu/wn31/202530710-v",
@type: "wordnet-ontology:Synset",
- http://www.w3.org/2002/07/owl#sameAs: [
    - {
        @id: "http://www.w3.org/2006/03/wn/wn20/instances/synset-pass-verb-14"
    },
    - {
        @id: "http://lemon-model.net/lexica/uby/wn/WN_Synset_94670"
    }
],
- label: [
    "pass",
    "make it"
],
wordnet-ontology:gloss: "go successfully through a test or a selection process",
wordnet-ontology:hypernym: "http://wordnet-rdf.princeton.edu/wn31/202529837-v",
wordnet-ontology:hyponym: "http://wordnet-rdf.princeton.edu/wn31/202528247-v",
wordnet-ontology:lexical_domain: "wordnet-ontology:verb.social",
wordnet-ontology:part_of_speech: "wordnet-ontology:verb",
wordnet-ontology:sample: "She passed the new Jersey Bar Exam and can practice law.",
- wordnet-ontology:synset_member: [
    - {
        @id: "http://wordnet-rdf.princeton.edu/wn31/pass-v"
    },
    - {
        @id: "http://wordnet-rdf.princeton.edu/wn31/make+it-v"
    }
],
- wordnet-ontology:translation: [
    - {
        @language: "fin",
        @value: "läpäistä"
    },
    - {
        @language: "jpn",
        @value: "合格+する"
    },
    - {
        @language: "ind",
        @value: "mengangsurkan"
    }
]
```



make it, pass

What is
WordNet?

People

News

Use WordNet
online

▪ WordNet RDF

Download

Citing
WordNet

License and
commercial
use

Related
projects

WordNet
documentation

Publications

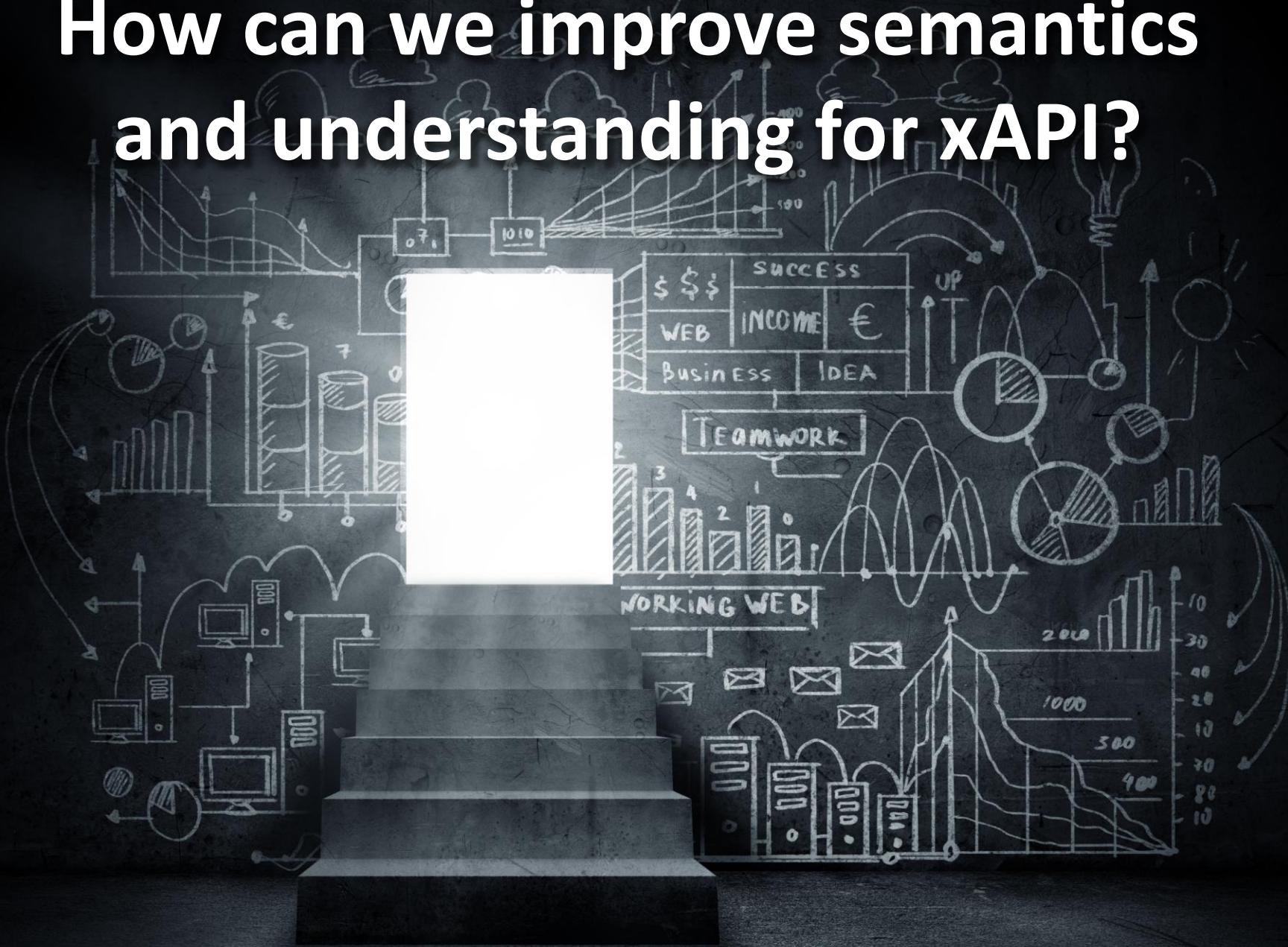
Frequently
Asked
Questions

Gloss	go successfully through a test or a selection process
Hypernym	202529837-v
Gloss	attain success or reach a desired goal
Hyponym	202528247-v
Gloss	succeed at easily
Lexical Domain	verb.social
Part Of Speech	verb
Same As	w3c:synset-pass-verb-14
Same As	lemonUby:WN_Synset_94670
Sample	She passed the new Jersey Bar Exam and can practice law now
Synset Member	pass-v
Synset Member	make+it-v
Translation	🇩🇰 bestå
Translation	🇫🇮 onnistua
Translation	🇫🇮 läpäistä
Translation	🇫🇷 passer
Translation	🇫🇷 donner
Translation	🇫🇷 réussir

A few ‘words’ about WordNet

- WordNet is not required for xAPI Controlled Vocabularies, but...
 - Provides an example of linking terms to an authoritative lexical source / semantic database
 - Useful for natural language processing (verbs, nouns) and disambiguation
 - Originally provided as English, but also has translations in several other languages

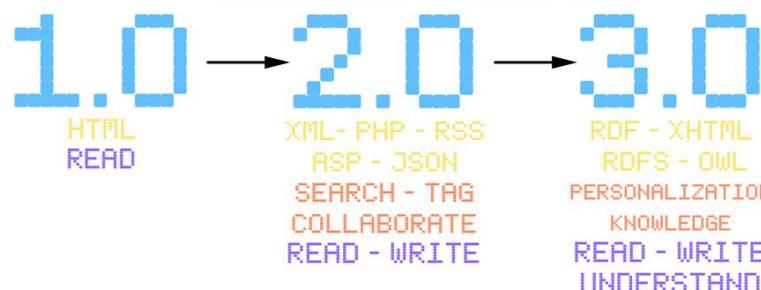
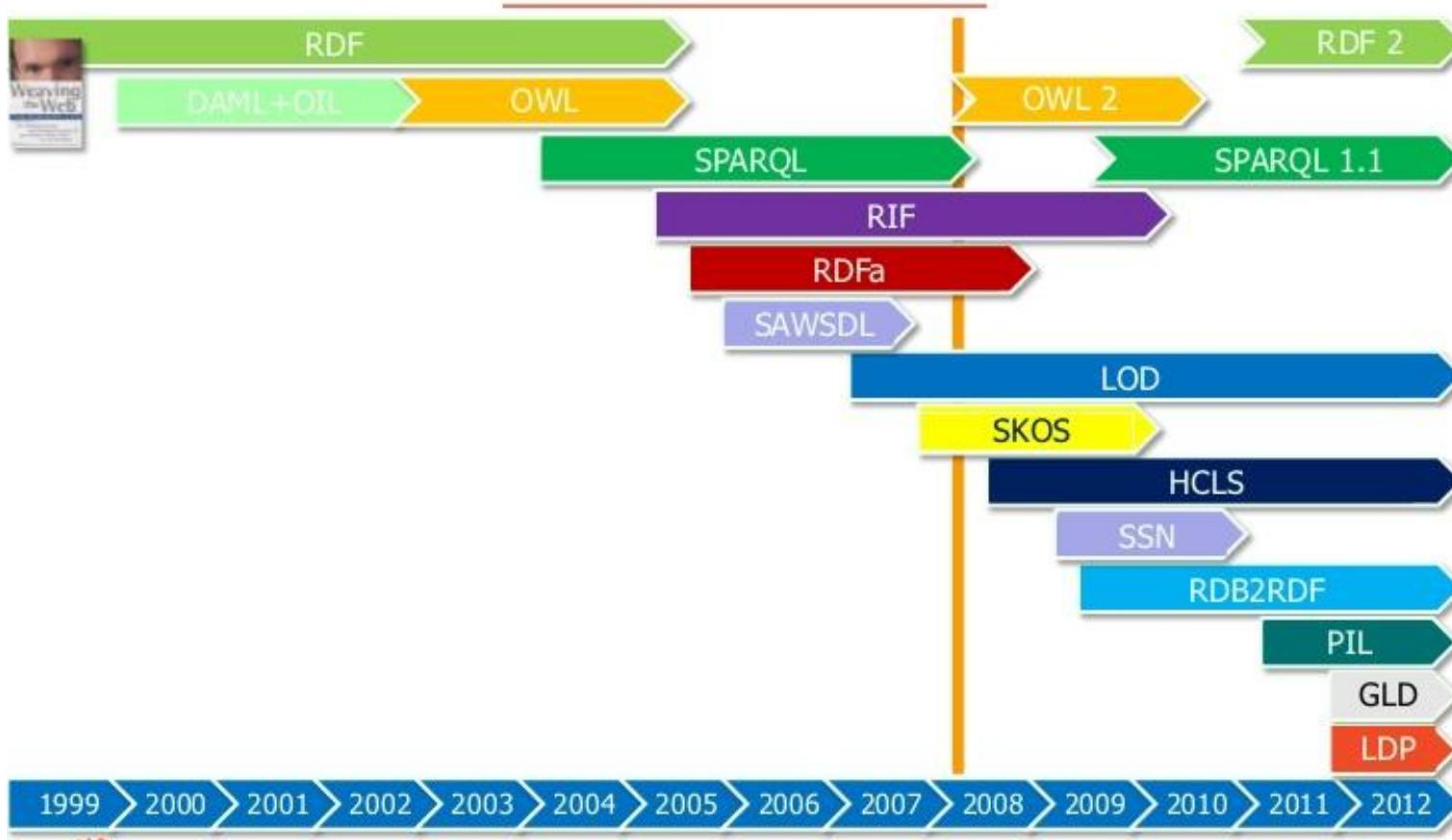
How can we improve semantics and understanding for xAPI?



Answer: Leverage Semantic Big Data Technology

The background of the slide consists of a dense grid of binary digits (0s and 1s) in white on a black background. A prominent red starburst graphic is centered on the slide, pointing towards the right. Inside the starburst, the word "Semantic" is written in a bold, black, sans-serif font. The rest of the slide is blank black space.

The Semantic Web timeline



Semantic Web Technologies

- Can improve meaning/understanding of xAPI data for LRS, Systems, Analytics
- Reduce potential for duplication of terms (e.g., verbs, activityTypes, attachments, extensions)
- Improve discoverability and reusability of vocabularies for designers/developers, repositories, registries

Why is Semantic Tech Important?

- Allows a copy of the data to be returned and understood by different agents (both humans & machines/apps)
 - Exposes the data (linked open data)
 - Provides the latest version of the data
 - Promotes & facilitates reuse of terms
 - Authoring tools could provide a dynamic look-up of existing Verbs, Activities, Attachments, Extensions
 - Any applications (e.g., not just LRS or LMS) could obtain additional metadata
 - Potential Reasoner engine/ applications

Data Modeling & Formats

- Linked Data can be serialized into several different formats:
 - RDF/XML, Turtle, N-Triples, N3, RDFa, JSON-LD

From JSON to JSON-LD

- JSON = Human-readable + machine-interchangeable (processed)
- JSON Linked Data (JSON-LD) = Human-readable + machine-readable (processed and understandable)





SCORM

EXPERIENCE
SCAPI™

What is Linked Data?

- LD is semantic metadata based on the RDF data model
- Different from “SCORM metadata aka LOM”
 - Not static XML: dynamically linked and naturally discoverable and open via the web and applications
- LD is about using the web to connect related data and resources that weren’t previously linked

4 Linked Data Principles

1. Use IRIs as names for things
2. Use HTTP IRIs, so that people can look up those names
3. When someone looks up a IRI, provide more information/metadata using the standards (RDF, SPARQL)
4. Include links to other IRIs, so they (humans and machines) can discover more things



RDF Data Model

XAPI = statements are about learning experiences

RDF= statements are about xAPI resources

subject

predicate

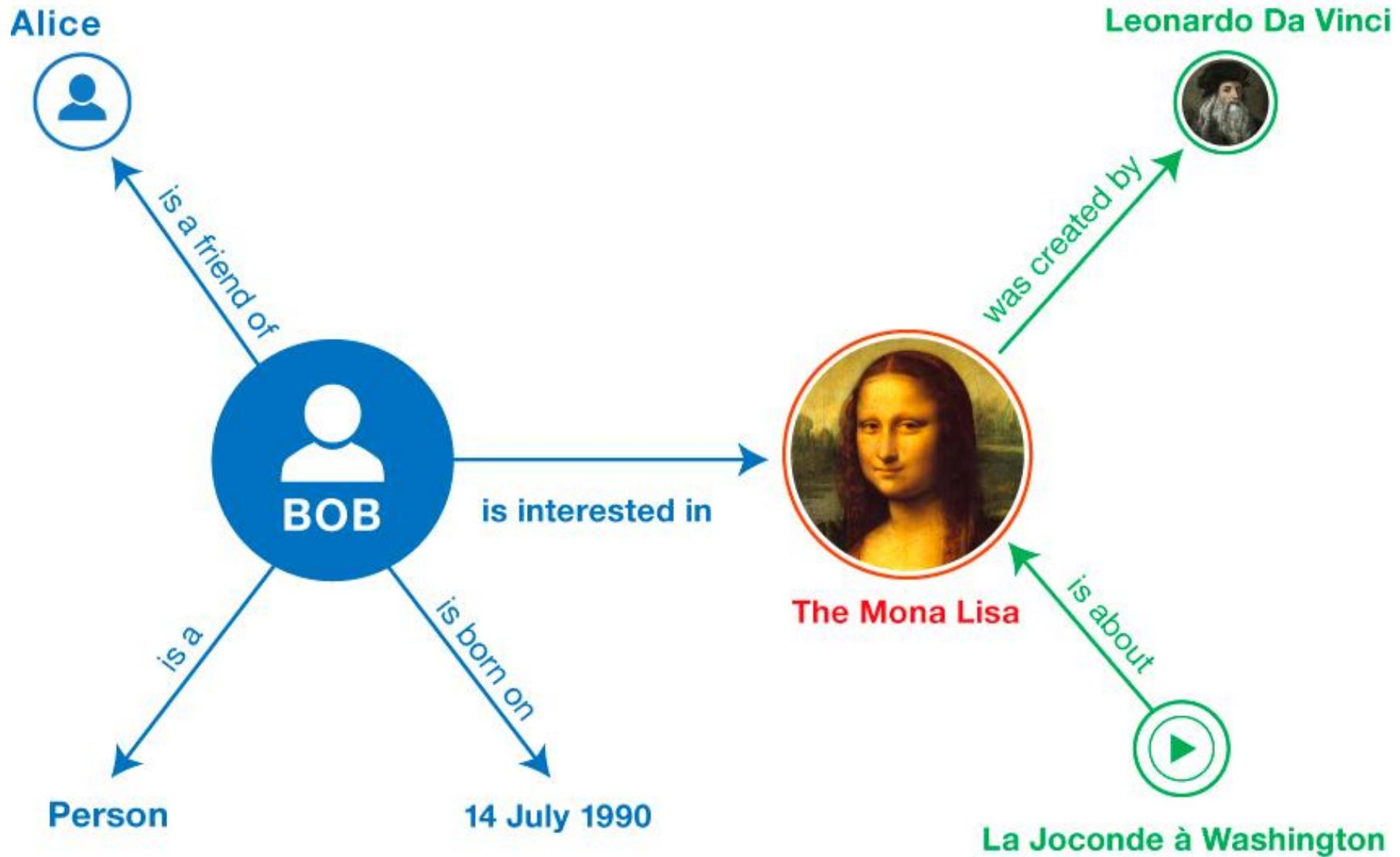
object

[resource]

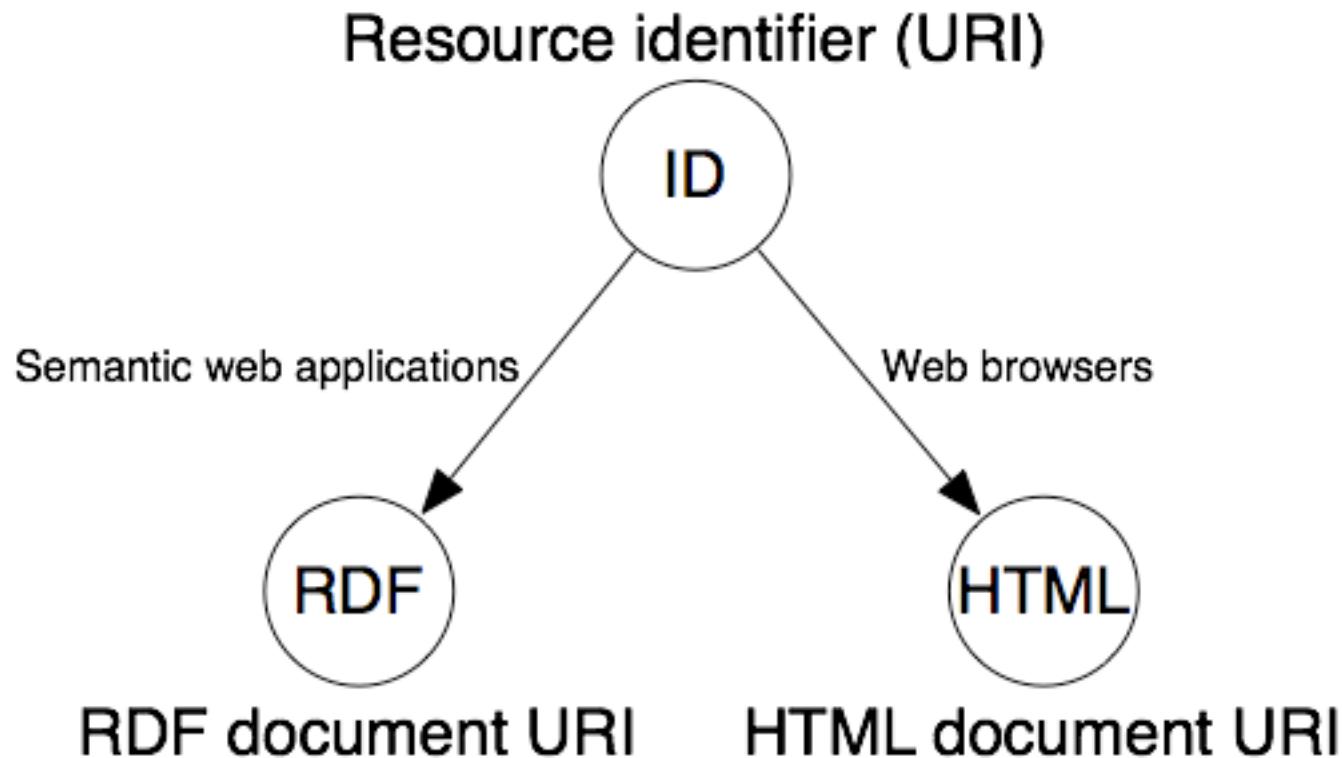
[relationship, properties]

[thing]

RDF Data Model



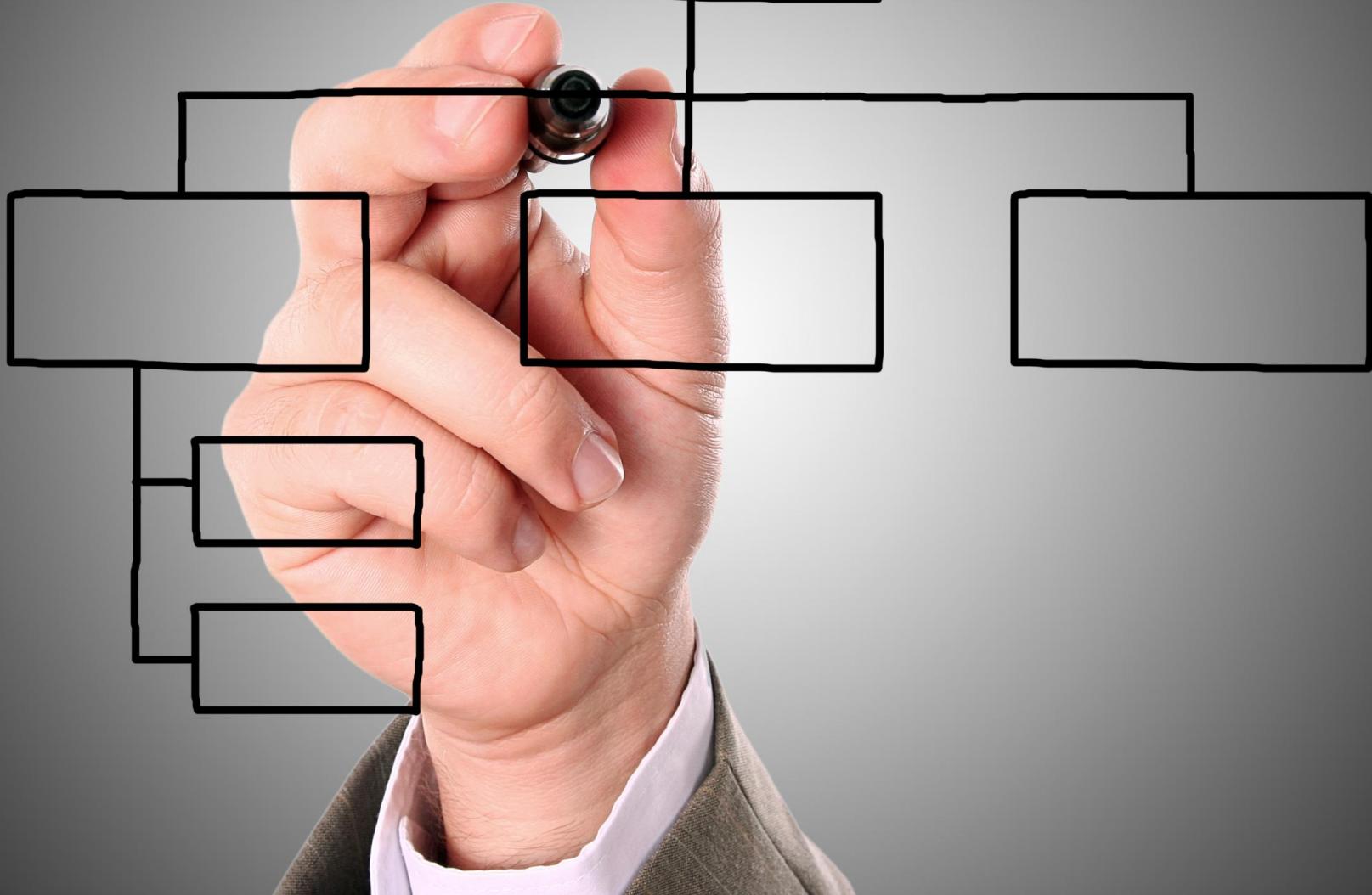
Content Negotiation



Linked Data In Action

- Learning Analytics and Knowledge (LAK),
<http://lak.linkededucation.org>
- LACE, <http://www.laceproject.eu/lace/>
- Dbpedia.org (knowledgebase of linked data to wikipedia)
- Schema.org (Bing, Google, Yahoo!)
 - <http://schema.rdfs.org>
- Dublin Core (DC) Metadata
- Wordnet, <http://wordnet-rdf.princeton.edu>
- CKAN.org (open data, uses DCAT and DC)
- Databhub.io (datasets repository)
- Google search (rich snippets using RDFa)
- Facebook Open Graph (uses FOAF)

WHAT ARE THE VOCABULARY USE CASES FOR XAPI?



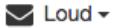
Case Number	Title
UC#1	Designer Searching A Verb (For Reuse) (Bruno W.)
UC#2	Browseable Taxonomy of Verb Relationships (Bruno W.)
UC#3	Multilingual Support for Vocabulary Term Search (Bruno W.)
UC#4	Updating Verb Terms (Adam C.)
UC#5	Machine Search for a Verb / Harvesting Verbs (Verb Server) Federated Approach (Jason L.)
UC#6	Namespaces & Lexical vs. Semantic Use (Adam C., Jason L.)
UC#7	Disambiguation of Terms (Jason H.)
UC#8	Simple Provision of Vocabulary (Ingo D.)
UC#9	Ontology / RDF Schema for xAPI Controlled Vocabularies (Jason H.)
UC#10	Provenance (Attribution) Metadata (Jason H.)
UC#11	Defining Additional Constraints for Verb Usage (Ingo D.)
UC#12	Verb Reuse (Ingo D.)
UC#13	Controlled Vocabulary as a Dataset or Collection (Jason H.)
UC#14	Advanced Verb Search (Ingo D.)
UC#15	Resolving Conflicts on Verb Re-Use (Ingo D.)
UC#16	xAPI Verb Identifiers / URI Persistence for xAPI (Jason H.)

Working group interested in investigating verb terms published as linked datasets, and improving the general semantic interoperability and machine readability of xAPI.

Filter: [Unread](#)

Requirement #2: Add Multilingual Support for xAPI Controlled Vocabularies



Loud 

Started 18 days ago by Jason Haag

Edited

This requirement would initially provide a way CoPs for adding multilingual support to their controlled vocabulary datasets. This requirement is supported / justified by the following use cases:

UC#3: Multilingual Support for Vocabulary Term Search

https://docs.google.com/document/d/1H4uXVFOWDgdnsRlcIRn_ShzPK0UFWwsbZDTzyjk-hJg/edit

 Edit

Discussion

 Jason Haag created a proposal: *Research and apply various multilingual options*
18 days ago

 Jason Haag agreed.
18 days ago

 Ingo Dahn agreed: *For use in Europe this is absolutely necessary*
12 days ago

 Pankaj Agrawal agreed.
12 days ago

 Adam Cooper agreed: *I suggest a preferred (not required) approach to decorating existing terms (defined by others) with additional human language labels. I don't know if there is existing SemWeb stuff about this, but even if there is, it wouldn't harm to sign-post.*
9 days ago

Current decision

Research and apply various multilingual options

Closing in 12 days
Proposed by Jason Haag 18 days ago 

Multilingual support can be provided by RDF labels, SKOS prefLabel, etc. We should investigate what else (if anything) is needed in order for these to be equally interpreted by RDF-aware registries, repositories, and LRS applications.



Agree (4)
Abstain (0)
Disagree (0)
Block (0)

36% of members have stated their position (4/11)

WG Objectives



- Identify requirements / document use cases pertaining to xAPI vocabulary usage (discoverability, reusability, and interoperability).
- Determine the vocabulary metadata properties that are needed. What do machines need? What do humans need?
- Discuss and determine options for vocabulary publishing and management



Draft CV Ontology/RDF Schema

Human Readable: <http://purl.org/xapi/ontology>



Native Classes

Name	Description	IRI	Type	Sub Class
ActivityType	The Activity Type is the identifier of the Activity Definition in an xAPI statement and when dereferenced can provide more information (metadata) about the activity type.	http://purl.org/xapi/ontology#ActivityType	rdfs:Class	skos:Concept
Verb	The Verb in an xAPI Statement describes the action performed during the learning experience.	http://purl.org/xapi/ontology#Verb	rdfs:Class	skos:Concept

Native Properties

Name	Description	IRI	Type	Sub Property	Domain	Range
xapi:closelyRelatedNaturalLanguageTerm	A custom property used to provide an authoritative source of the term and definition for word-sense disambiguation (WSD).	http://purl.org/xapi/ontology#closelyRelatedNaturalLanguageTerm	rdfs:Property	skos:relatedMatch	skos:Concept	wordnet:Synset

Available as dereferenced HTML/RDFa (human + machine readable)

Classes & Properties



- Classes:
 - Verb, ActivityType (xAPI Specific)
 - Concept, ConceptScheme, Collection (reused)
- Properties:
 - title
 - description
 - created
 - modified
 - creator
 - license
 - closelyRelatedNaturalLanguageTerm

Example Controlled Vocabulary



Human Readable: <http://adlnet.gov/expapi/verbs>

ADL's Controlled Vocabulary

Contact

xAPI ▾

Verbs ▾

Activity Types ▾

ADL Verbs Dataset

A dataset of ADL's controlled vocabulary of verbs and their metadata properties.

Date Created: 2015-04-27

Date Modified: 2015-07-08

License: [Creative Commons 3.0](#)

Publisher: [ADL Initiative](#)

Verbs

RDF Serialization Examples: [RDFa](#) | [XML](#) | [N-otation3](#) | [N-Triples](#) | [JSON-LD](#)

Verb Term	Usage Description	IRI	Related Match
abandoned	The verb "Abandoned" indicates that the AU session was abnormally terminated by a learner's action (or due to a system failure).	http://purl.org/xapi/adl/verbs/abandoned	http://wordnet-rdf.princeton.edu/wn31/202080923-v
answered	Used to record a learner action of answering a specific question.	http://adlnet.gov/expapi/verbs/answered	http://wordnet-rdf.princeton.edu/wn31/200637941-v
asked	Used to make an inquiry of an actor with the expectation of a response. May be used to ask a question, typically the system would be the primary actor, with the learner being the recipient of the question. The question could also be asked into a vacuum, with the eventual response (statement with verb responded) providing the actual context of the recipient.	http://adlnet.gov/expapi/verbs/asked	http://wordnet-rdf.princeton.edu/wn31/200786389-v
attempted	Used at the initiation of many experienced activities to mark the entry. Attempts without	http://adlnet.gov/expapi/verbs/attempted	http://wordnet-rdf.princeton.edu/wn31/200786389-v

Example Controlled Vocabulary

As RDF/XML, JSON-LD



```
<?xml version="1.0" encoding="UTF-8"?>
<rdf:RDF
  xmlns:cc="http://creativecommons.org/ns#"
  xmlns:dcterms="http://purl.org/dc/terms/"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:skos="http://www.w3.org/2004/02/skos/core#"
  xmlns:xapi="http://purl.org/xapi/ontology#"
>
<rdf:Description rdf:about="http://adlnet.gov/expapi/verbs/registered">
  <dcterms:title xml:lang="en">registered</dcterms:title>
  <dcterms:description xml:lang="en">Indicates the actor registered for a learnin
  <rdf:type rdf:resource="http://purl.org/xapi/ontology#Verb"/>
  <xapi:closelyRelatedNaturalLanguageTerm rdf:resource="http://wordnet-rdf.prince
  <skos:inScheme rdf:resource="http://adlnet.gov/expapi/verbs"/>
</rdf:Description>
<rdf:Description rdf:about="http://adlnet.gov/expapi/verbs/exited">
  <dcterms:description xml:lang="en">Used to leave an activity attempt with no in
  <rdf:type rdf:resource="http://purl.org/xapi/ontology#Verb"/>
  <skos:inScheme rdf:resource="http://adlnet.gov/expapi/verbs"/>
  <dcterms:title xml:lang="en">exited</dcterms:title>
  <xapi:closelyRelatedNaturalLanguageTerm rdf:resource="http://wordnet-rdf.prince
</rdf:Description>
<rdf:Description rdf:about="http://adlnet.gov/expapi/verbs/launched">
  <dcterms:description xml:lang="en">Starts the process of launching the next pie
  <rdf:type rdf:resource="http://purl.org/xapi/ontology#Verb"/>
  <skos:inScheme rdf:resource="http://adlnet.gov/expapi/verbs"/>
  <xapi:closelyRelatedNaturalLanguageTerm rdf:resource="http://wordnet-rdf.prince
  <dcterms:title xml:lang="en">launched</dcterms:title>
</rdf:Description>
<rdf:Description rdf:about="https://adlnet.gov/expapi/verbs/voided">
```

```
{
  "@context": {
    "cc": "http://creativecommons.org/ns#",
    "dcterms": "http://purl.org/dc/terms/",
    "foaf": "http://xmlns.com/foaf/0.1/",
    "owl": "http://www.w3.org/2002/07/owl#",
    "prov": "http://www.w3.org/ns/prov#",
    "rdf": "http://www.w3.org/1999/02/22-rdf-syntax-ns#",
    "rdfs": "http://www.w3.org/2000/01/rdf-schema#",
    "skos": "http://www.w3.org/2004/02/skos/core#",
    "xapi": "http://purl.org/xapi/ontology#",
    "xsd": "http://www.w3.org/2001/XMLSchema#"
  },
  "@graph": [
    {
      "@id": "http://adlnet.gov/expapi/verbs/initialized",
      "@type": "xapi:Verb",
      "dcterms:description": {
        "@language": "en",
        "@value": "Begins the formal tracking of learning content, any statements ."
      },
      "dcterms:title": {
        "@language": "en",
        "@value": "initialized"
      },
      "skos:inScheme": {
        "@id": "http://adlnet.gov/expapi/verbs"
      },
      "xapi:closelyRelatedNaturalLanguageTerm": {
        "@id": "http://wordnet-rdf.princeton.edu/wn31/200702662-v"
      }
    }
  ]
}
```

Vocabulary Working Group

Progress (so far)



- WG Charter: <http://purl.org/xapi/vocab-wg-charter>
- Vocab Use Cases: <http://purl.org/xapi/vocab-use-cases>
- WG Files: <http://purl.org/xapi/vocab-wg-files>
- Ontology / RDF Schema: <http://purl.org/xapi/ontology>
- Controlled Vocabulary Datasets
 - ADL Example (HTML/RDFa): <http://adlnet.gov/expapi/verbs>
 - Verb & Activity Type Concepts
 - Currently uses Dublin Core, SKOS
- On Github: <https://github.com/adlnet/xapi-vocabulary>
- IRI Design Guidelines: <http://purl.org/xapi/iri-design>

Persistent & Stable IRI Design

- Reasons why an IRI target might change/move
 - CoP change in membership or turnover
 - Dependency on an organization, application, system, tool, or server
 - Rapid design and prototyping
 - Controlled Vocabulary lifecycle maintenance
 - Change in structure
- Recommended Practices (for NEW IRIs)
 - Follow strong pattern for IRI persistence
 - Use dedicated service when minting IRIs

Vocab WG Next Steps

- Apply approach to new CoP controlled vocabularies
- Add new Classes to the ontology (Attachments, Extensions, Profiles, Recipes)
 - SKOS Labels for multilingual support
 - SKOS for broader/narrower relationships
 - PROV for versioning and provenance metadata
- Update the core xAPI specification (IRI metadata)
- Process documentation, refined examples
- Automated tools for xAPI Community, repository (evaluate open source options)
- Registry support (e.g., TinCan Registry)



Summary/Big Picture Opportunities

- Learning analytics require consistent approaches to describing controlled vocabularies and domain-specific concepts such as xAPI Verbs
- Concepts in xAPI should be "*thing, not a string*"
- Machine readability/understanding could result in opportunities for machine learning, recommendation algorithms/engine, competency definitions
- If accessible as linked data, we have new opportunities for dynamic vocabulary look-up in authoring tools
- Improve potential discoverability and reuse of existing xAPI vocabularies (semantic search) by CoPs



Thank You!



Need support in applying this approach? Or Interested in participating?
Contact us: xapi-vocabulary@adlnet.gov

