



FP7-ICT-611140 CARRE

Project co-funded by the European Commission
under the Information and Communication Technologies
(ICT) 7th Framework Programme



D.4.2. Schema mapping & metadata enrichment

G. Drosatos, G. Gkotsis, E. Liu, N. Portokalidis, A. Third

April 2015

CARRE Contacts

Project Coordinator: Eleni Kaldoudi kaldoudi@med.duth.gr
Project Manager: Geroge Drosatos gdrosato@ee.duth.gr

DUTH Democritus University of Thrace	Eleni Kaldoudi	kaldoudi@med.duth.gr
OU The Open University	John Domingue	john.domingue@open.ac.uk
BED: Bedfordshire University	Enjie Liu	Enjie.Liu@beds.ac.uk
VULSK: Vilnius University Hospital Santariskiu Klinikos	Domantas Stundys	Domantas.Stundys@santa.lt
KTU Kaunas University of Technology	Arunas Lukosevicius	arunas.lukosevicius@ktu.lt
PIAP Industrial Research Institute for Automation & Measurements	Roman Szewczyk	rszewczyk@piap.pl

Disclaimer

This document contains description of the CARRE project findings, work and products. The authors of this document have taken any available measure in order for its content to be accurate, consistent and lawful. However, neither the project consortium as a whole nor the individual partners that implicitly or explicitly participated in the creation and publication of this document hold any sort of responsibility that might occur as a result of using its content.

In case you believe that this document harms in any way IPR held by you as a person or as a representative of an entity, please do notify us immediately.

The content of this publication is the sole responsibility of CARRE consortium and can in no way be taken to reflect the views of the European Union.

CARRE is a Specific Targeted Research Project partially funded by the European Union, under FP7-ICT-2013-10, Theme 5.1. "Personalized health, active ageing & independent living".



Document Control Page

Project

Contract No.: 611140
Acronym: CARRE
Title: Personalized Patient Empowerment and Shared Decision Support for Cardiorenal Disease and Comorbidities
Type: STREP
Start: 1 November 2013
End: 31 October 2016
Programme: FP7-ICT-2013.5.1
Website: <http://www.carre-project.eu/>

Deliverable

Deliverable No.: D.4.2
Deliverable Title: Schema mapping & metadata enrichment
Responsible Partner: OU
Authors: G. Drosatos, G. Gkotsis, E. Liu, N. Portokalidis, A. Third
Input from: T.4.1
Peer Reviewers: Robert Ugodziński (PIAP), Darius Jegelevicius (KTU)
Task: T.4.3. Schema mapping & metadata enrichment
Task duration: 9 months: 1 August 2014 to 30 April 2015
Work Package: WP4: Data Enrichment, correlation and interlinking
Work Package Leader: OU – Allan Third

Due Date: 30 April 2015
Actual Delivery Date: 6 May 2015
Dissemination Level: PU
Nature: P
Files and format: Deliverable report: 1 pdf file
Software: 2 archives (migration script and RESTFul API)

Version: 12
Status: Draft
 Consortium reviewed
 WP leader accepted
 Coordinator accepted
 EC accepted

Document Revision History

Version	Date	Modifications	Contributors
Version	Date	Modifications	Contributors
v01	1 April 2015	new content – outline	G. Gkotsis
v02	19 April 2015	new content - section 2	G. Gkotsis
v03	22 April 2015	new content - section 3	G. Gkotsis
v05	24 April 2015	Input from BED - section 3	Enjie Liu
v06	24 April 2015	Input from DUTH - section 3, appendix	George Drosatos
v07	26 April 2015	Input from DUTH - section 3, appendix	Nick Portokallidis
v08	26 April 2015	new content - various	A. Third
v09	26 April 2015	new content - various	G. Gkotsis
v10	28 April 2015	Address review comments from PIAP	A. Third
v11	28 April 2015	Address review comments from KTU	G. Gkotsis
v12	6 May 2015	Editing to conform to deliverable format	E Kaldoudi

Table of Contents

1. Introduction	9
2. CARE-related external data sources and ontologies	10
3. Enrichment	12
3.1. <i>Risk factors</i>	12
3.1.1. RDF mapping.....	12
3.1.2. RDF migration.....	13
3.1.3. Transformation and final enrichment of Risk Factor associations	14
3.1.4. CARRE services for Risk Factor associations	15
3.2. <i>Sensor data & measurements</i>	16
3.3. <i>Personal medical & lifestyle data</i>	17
3.4. <i>Educational metadata</i>	18
3.4.1. Example #1	20
3.4.2. Example #2	21
3.4.3. Visualizations	22
3.5. <i>Web Lifestyle</i>	23
3.6. <i>Medical scientific metadata</i>	27
4. Ontology evolution management	29
Annex 1	31
1. Risk Association ontology - mappings to external vocabularies	32
2. CARRE educational ontology	71
2.1. <i>RDF results Example #1</i>	77
2.2. <i>RDF results Example #2</i>	78

List of Figures

Figure 1: A screenshot of annotation of primitive datatypes in CARRE’s objects.....	12
Figure 2: A screenshot of annotation of CARRE’s objects contained within other CARRE objects.	13
Figure 3: The interface of Drupal’s SPARQL endpoint [https://carre.kmi.open.ac.uk/sparql]	14
Figure 4: Educational metadata ontology	23
Figure 5: Diagram of the CARRE Web Lifestyle ontology. Classes and properties with green background colour denote that these entities are linked to external vocabularies.....	26
Figure 6: A screenshot of the Protégé ontology editor.	27
Figure 7: Screenshot of the medical evidence aggregation user interface.	28

List of Tables

Table 1: Educational resource ontology class and property reference	18
Table 2: Query to find the top 5 rated educational resources regarding “acute kidney disease”	20
Table 3: The top 5 rated educational resources regarding “acute kidney disease”	20
Table 4: Query to find 10 educational objects with source, url, and the regarding risk element.....	21
Table 5: 10 educational objects with source, url, and the regarding risk element.....	21
Table 6: Predefined intentions on Web Lifestyle ontology.	24

Executive Summary

This deliverable is comprised of the present document and the corresponding software that implements the Schema mapping & metadata enrichment mechanism deployed for the CARRE platform. It discusses the various external vocabularies used, together with the alignment of these vocabularies with the CARRE ontology. It also addresses the changes and the actions that take place in cases where ontologies evolve and how these actions can continue supporting already deployed software components.

About CARRE

CARRE is an EU FP7-ICT funded project with the goal to provide innovative means for the management of comorbidities (multiple co-occurring medical conditions), especially in the case of chronic cardiac and renal disease patients or persons with increased risk of such conditions.

Sources of medical and other knowledge will be semantically linked with sensor outputs to provide clinical information personalised to the individual patient, so as to be able to track the progression and interactions of comorbid conditions. Visual analytics will be employed so that patients and clinicians will be able to visualise, understand and interact with this linked knowledge and also take advantage of personalised empowerment services supported by a dedicated decision support system.

The ultimate goal is to provide the means for patients with comorbidities to take an active role in care processes, including self-care and shared decision-making, and also to support medical professionals in understanding and treating comorbidities via an integrative approach.

Terms and Definitions

The following are definitions of terms, abbreviations and acronyms used in this document.

Term	Definition
BioPortal	An open repository of biomedical ontologies that provides access via Web services and Web browsers to ontologies developed in OWL, RDF, OBO format and Protégé frames
Class (ontology)	A named set of individuals.
CMO	Clinical Measurements Ontology
Data property (ontology)	A relation between instances of classes and RDF literals and XML Schema datatypes
DoW	Description of Work
ICD	International Statistical Classifications of Diseases
Individual	A concrete object or an abstract individual member of the ontology.
Linked Data	A method of publishing structured data so that it can be interlinked and become more useful
MedLinePlus	An educational resource database provided by the US National Library of Medicine
Object property (ontology)	A relation between instances of two classes
OWL	Web Ontology Language: A language that can be used to describe the classes and relations between them that are inherent in Web documents and applications
QUDT	Quantities, Units, Dimensions and Data Types Ontologies
Property (ontology)	A general fact about the members of classes and specific facts about individuals
PUBMED	A service of the US National Library of Medicine that provides free access the NLM database of indexed citations and abstracts to health sciences journals
RDF	Resource Description Framework: a standard model for data interchange on the Web
SNOMED SNOME-CT	Systematically organized computer processable collection of medical terms providing codes, terms, synonyms and definitions used in clinical documentation and reporting
SPARQL	An RDF query language
Subject, predicate, object (triple)	A subject denotes the resource, and the predicate denotes traits or aspects of the resource and expresses a relationship between the subject and the object
Triple	A statement in the subject-predicate-object expression.
UMLS	Unified Medical Language System: is a compendium of many controlled vocabularies in the biomedical sciences
UMLS CUI	UMLS Concept Unique Identifier
UO	Ontology of Units of Measurement
URI	A string of characters used to identify a name of a resource
URL	A specific character string that constitutes a reference to a resource
Vocabulary/ Ontology	The concepts and relationships (also referred to as “terms”) used to describe and represent an area of concern

XML	A markup language that defines a set of rules for encoding documents in a format which is both human-readable and machine-readable
XSD	A recommendation of the World Wide Web Consortium (W3C), specifies how to formally describe the elements in an Extensible Markup Language (XML) document
W3C	World Wide Web Consortium, http://www.w3.org

1. Introduction

This document reports on the work conducted in Task 4.3, entitled as “Schema mapping & metadata enrichment”. More specifically, the work concerns the analysis of the schemas identified and deployed in earlier Work Packages (WP2 and WP3) and the development of a mapping scheme that aligns together the various CARRE vocabularies. At the same time, this alignment concerns the identification and analysis of relevant datasets and domain ontologies with the aim to provide additional information and position our work with respect to interlinked Linked Open Data repositories.

Section 2 presents briefly background information that relates to both general-purpose and domain-specific vocabularies. These vocabularies have been adopted by the CARRE platform and are incorporated to the developed vocabulary. For each of the external data sources and vocabularies used, this document presents how CARRE makes use of it.

Section 3 describes at great detail the mapping that takes place within the various CARRE sub-domains. More specifically, the section is divided into the following subsections:

- risk factor associations,
- sensor data & measurements,
- personal medical & lifestyle data,
- educational metadata,
- web lifestyle,
- medical scientific metadata.

For each of the above sub-domains a discussion on design decisions is provided, together with concrete examples of how the RDF data are enriched and ingested into the repository, and ultimately exploited by the CARRE platform.

Section 4 discusses about the management of the continuously-evolving CARRE ontology. More specifically, it discusses the various types of changes which can be made to an ontology and the actions that take place in order to maintain the stability of software operating on top of our ontology.

Finally, Annex 1 provides the ontology mappings, examples of RDF data referenced in section 3 as well as the educational and lifestyle ontologies discussed in the same section.

2. CARE-related external data sources and ontologies

CARRE's semantic repository is enriched with data sources and controlled vocabularies already created and published by third parties. This section presents the data sources, ontologies and vocabularies we used for annotating and enriching the data collected within CARRE. This process allows stakeholders (initially systems and users thereafter) to boost identifying and retrieving useful information.

Bioportal

Bioportal¹ constitutes a rich, crowdsourced library of BioMedical ontologies. More specifically, as of April 2015, there are 437 ontologies. Moreover, BioPortal allows developers to upload their own mapping between their ontology and external ontologies. As a result, an arbitrary number of mappings between various ontologies is already available. In addition to the above, BioPortal provides services for annotating² free-text using vocabularies or recommending ontologies³ based on the same input. Finally, Bioportal allows accessing of its content through a RESTful API⁴.

CARRE is using bioportal for accessing ontologies and enriching the RDF repository in multiple occasions, such as descriptions of measurements and units.

UMLS

Unified Medical Language System (UMLS) is compendium of many controlled vocabularies in the biomedical sciences⁵. It was created in 1986 in order to accommodate the interoperation of different systems and services, such as Electronic Health Records. Previously, systems that did not use UMLS have limited capacity in transferring machine-readable information to other systems; UMLS allows the usage of disparate databases and systems. In addition to a comprehensive thesaurus, UMLS provides a semantic network of concepts having in mind services running on top of them. Finally, UMLS incorporates 79 vocabularies, including ICD9 and ICD10, SNOMED and SNOMED CT that are discussed in the sections below.

In our approach, CARRE risk factor associations are annotated using the UMLS Concept Unique Identifiers (CUI) (e.g. "Acute kidney injury" is marked with CUI C0022660).

SNOMEDCT

Systematized Nomenclature of Medicine (SNOMED), currently acquired and maintained by International Health Terminology Standards Development Organisation⁶. Its aim was to generate a systematic, computer-processable collection of medical terms. As part of this initiative, SNOMED Clinical Terms (SNOMED CT) was released in 2002 and adopts a more formal way of describing medical terminology and is considered the most "mature" product of SNOMED and as a result all SNOMED versions except SNOMED CT will be formally deprecated.

CARRE is using SNOMEDCT as a result of the adoption of UMLS and the various mappings that are produced by the research community.

ICD

International Classification of Diseases (ICD) is the "standard diagnostic tool for epidemiology, health management and clinical purposes"⁷. It is a project that started more than 100 years ago and is currently maintained by the World Health Organisation (WHO) . ICD is being adopted globally for various healthcare applications. Furthermore, this classification of diseases is revised regularly and ICD10 is the latest version since 1992. A new version of ICD (ICD11) is expected to be released in 2017.

We discuss below the two major versions used within CARRE: ICD9 and ICD10

¹ <http://bioportal.bioontology.org/>

² <http://bioportal.bioontology.org/annotator>

³ <http://bioportal.bioontology.org/recommender>

⁴ <http://data.bioontology.org/documentation>

⁵ http://en.wikipedia.org/wiki/Unified_Medical_Language_System

⁶ <http://www.ihtsdo.org/>

⁷ <http://www.who.int/classifications/icd>

CARRE is using both ICD9 and ICD10. ICD9 provides 6,969 codes, as opposed to ICD10 which provides more than 12,000 codes. Additionally, since ICD10 expands massively over ICD9, it is not possible to convert ICD9 data into ICD10 directly⁸. The decision to use, where needed, ICD9 stems from the extended body of research with respect to the 9th version of ICD.

HL7

HL7 (“Health Level 7”) is a “set of international standards for transfer of clinical and administrative data between Hospital Information Systems”⁹, which includes a controlled vocabulary for referring to terms which occur in such clinical and administrative data. It is, therefore, a useful vocabulary for mapping between concepts in different Electronic Health Records (EHRs), including Personal Health Records (PHRs) as used by CARRE. As outlined in D.2.4, the CARRE Ontology also uses HL7 to record information relating to ethnicity.

CMO (Clinical Measurements Ontology)

The Clinical Measurements Ontology aims to be a standard ontology for representing “morphological and physiological measurement records generated from clinical and model organism research and health programs”¹⁰. It is developed as part of the Phenotype Ontologies project^{11,12}, which also includes the Measurement Method Ontology and Experimental Condition Ontology. The latest version of CMO is, at the time of writing, 2.34, and provides a structured taxonomy of 2633 classes representing different kinds of clinical measurement. It is used in the CARRE Readings and Measurements Ontology to represent the measurement type of a sensor value.

Unit Ontology and QUDT

The Ontology of Units of Measurement (UO)¹³ is part of the OBO Foundry initiative¹⁴, designed as a component of the Phenotypic Quality ontology (PATO)¹⁵. It contains definitions and taxonomic relations for a very wide range of units of measurement, and was chosen in D.2.4 to be the primary ontology to represent units of measurement in the CARRE Readings and Measurements Ontology. It contains 331 classes representing different kinds of unit. Supplemental information, largely to cover some small gaps in UO, was drawn from the Quantities, Units, Dimensions and Types ontology (QUDT)¹⁶, which contain 204 classes representing measurements and units¹⁷.

Educational resources

The presented ontology describes the model of the educational resources aggregated for CARRE. It provides structure and data mappings for the resources that are fetched from unstructured web repositories (Wikipedia, MedlinePLUS). Furthermore, it enriches the educational resource with mappings from standard medical ontologies and code bases (ICD10, MESH, UMLS).

Web lifestyle

This ontology is designed and developed in order to represent the detected intentions from the Web Lifestyle Data Aggregator, which is presented in Deliverable 3.3, in the private RDF repository of user. In particular, it seeks to represent what is involved in the gathering of data from the web and social lifestyle of user on the Internet.

⁸ <http://www.who.int/classifications/help/icdfaq/en/>

⁹ http://en.wikipedia.org/wiki/Health_Level_7

¹⁰ <http://bioportal.bioontology.org/ontologies/CMO>

¹¹ Shimoyama M, Nigam R, McIntosh LS, et al. Three Ontologies to Define Phenotype Measurement Data. *Frontiers in Genetics*. 2012;3:87. doi:10.3389/fgene.2012.00087.

¹² <http://sourceforge.net/projects/phenoonto/>

¹³ <https://code.google.com/p/unit-ontology/>

¹⁴ <http://www.obofoundry.org>

¹⁵ <http://www.obofoundry.org/cgi-bin/detail.cgi?id=quality>

¹⁶ <http://qudt.org>

¹⁷ <http://bioportal.bioontology.org/ontologies/QUDT>

3. Enrichment

This section presents the implementation that took place in order to prepare all data to be stored in CARRE’s RDF repository. More specifically, we discuss separately the implementation for the insertion and enrichment of

- Risk factors
- Sensor data and measurements
- Personal medical and lifestyle data
- Educational metadata
- Web lifestyle
- Medical scientific metadata

Following the preparation of the above data, we discuss how the state in which this data is stored can be used for enrichment.

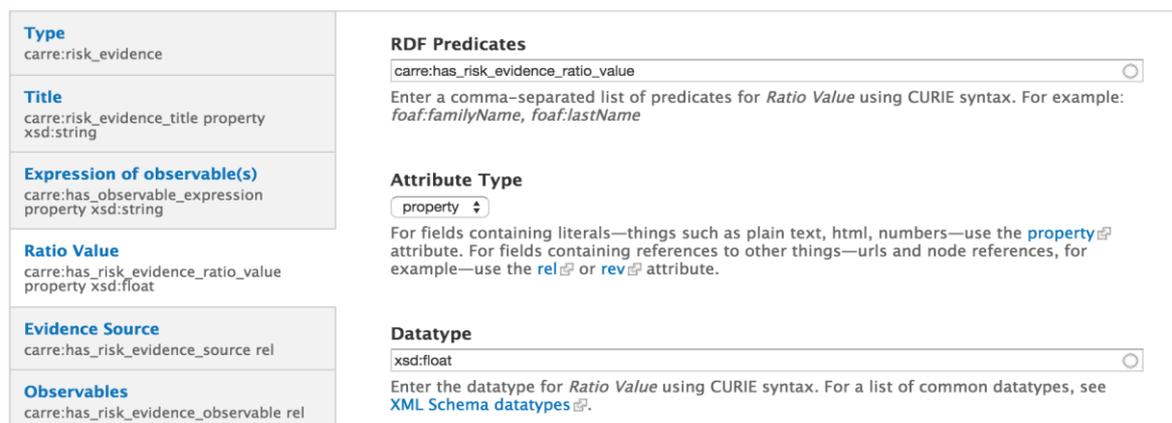
3.1. Risk factors

As already presented in D.2.4, OU has developed a platform for entering risk factor associations. This platform, powered by the Drupal CMS, has been used by the medical experts of CARRE and all risk factor associations presented in D.2.2 are now stored into the platform. Hereby, we present the implementation that was conducted in order to enrich the data stored into Drupal’s MySQL database and migrate them into Virtuoso as RDF triple statements. The steps carried out are the following:

3.1.1. RDF mapping

The latest stable release, Drupal 7, which is being used in CARRE supports out-of-the-box mapping of data stored in Drupal in RDF. In our approach, we have used this built-in module to annotate all data fields appropriately. In our approach, the data concern either primitive datatypes (e.g. string, integer, date), annotated through XSD (XML Schema Definition) or more complex objects introduced by the Risk associations ontology. An example of a primitive datatype is the ratio value in a piece of risk evidence, which is declared as float (see Figure 1).

Manage the way this bundle and its fields are represented in RDF. The mappings defined here will be used to publish RDFa in the site’s HTML pages.



The screenshot shows a configuration interface for an RDF bundle. On the left, a table lists fields and their mappings:

Type carre:risk_evidence
Title carre:risk_evidence_title property xsd:string
Expression of observable(s) carre:has_observable_expression property xsd:string
Ratio Value carre:has_risk_evidence_ratio_value property xsd:float
Evidence Source carre:has_risk_evidence_source rel
Observables carre:has_risk_evidence_observable rel

On the right, the configuration for the 'Ratio Value' field is shown:

- RDF Predicates:** A text input field containing 'carre:has_risk_evidence_ratio_value'.
- Attribute Type:** A dropdown menu set to 'property'.
- Datatype:** A text input field containing 'xsd:float'.

Instructions for the fields are provided: 'Enter a comma-separated list of predicates for Ratio Value using CURIE syntax. For example: foaf:familyName, foaf:lastName' and 'Enter the datatype for Ratio Value using CURIE syntax. For a list of common datatypes, see XML Schema datatypes'.

Figure 1: A screenshot of annotation of primitive datatypes in CARRE’s objects.

The example of Figure 1 shows that ratio value is described using the following RDF predicate:

`http://carre.kmi.open.ac.uk/ontology/risk.owl#has_risk_evidence_ratio_value`

Furthermore, the figure shows that the object value is of type `xsd:float`. As a result of the above mapping, Drupal is making use of the above information to describe the HTML documents; an example of an HTML snippet is the following:

```
<div class="field-item even" property="carre:has_risk_evidence_ratio_value"
      datatype="xsd:float">1.61</div>
```

An example of Drupal's HTML annotation of data [<https://carre.kmi.open.ac.uk/node/365>].

An example of more complex objects used is the case of Risk Factor itself. Since a Risk factor contains one or more risk elements as *Source*, a link to the risk elements is used to annotate the data accordingly. This relationship is implemented using the `rel` attribute¹⁸, as shown in Figure 2.

Manage the way this bundle and its fields are represented in RDF. The mappings defined here will be used to publish RDFa in the site's HTML pages.

<p>Type carre:risk_factor</p>	<p>RDF Predicates carre:has_risk_factor_source</p> <p>Enter a comma-separated list of predicates for <i>Sources</i> using CURIE syntax. For example: <i>foaf:familyName, foaf:lastName</i></p>
<p>Title carre:risk_factor_title property xsd:string</p>	<p>Attribute Type rel</p> <p>For fields containing literals—things such as plain text, html, numbers—use the property attribute. For fields containing references to other things—urls and node references, for example—use the rel or rev attribute.</p>
<p>Sources carre:has_risk_factor_source rel</p>	
<p>Target carre:has_risk_factor_target rel</p>	
<p>Risk Evidence carre:has_risk_evidence rel</p>	

Figure 2: A screenshot of annotation of CARRE's objects contained within other CARRE objects.

Figure 2 shows the annotation of sources in Risk Factor objects. This information is also presented in the HTML document, as follows:

```
<div class="field-item even"
      rel="carre:has_risk_factor_source">Obesity</div>
```

An example of Drupal's HTML annotation of data [<https://carre.kmi.open.ac.uk/node/366>].

3.1.2. RDF migration

So far we have shown how Drupal built-in RDF module allows to declare content types' RDF mapping and how these mapping are accessed through HTML documents. In our case, we also wanted to export the same information in a convenient way in order to migrate the data into CARRE's Virtuoso repository. To achieve this,

¹⁸ <http://www.w3.org/2006/07/SWD/RDFa/syntax/#id103235>

we installed a dedicated sparql module¹⁹ in Drupal. The module installs a SPARQL endpoint²⁰, which allows accessing all of the data inserted, through SPARQL queries. Figure 3 shows the interface for this endpoint.

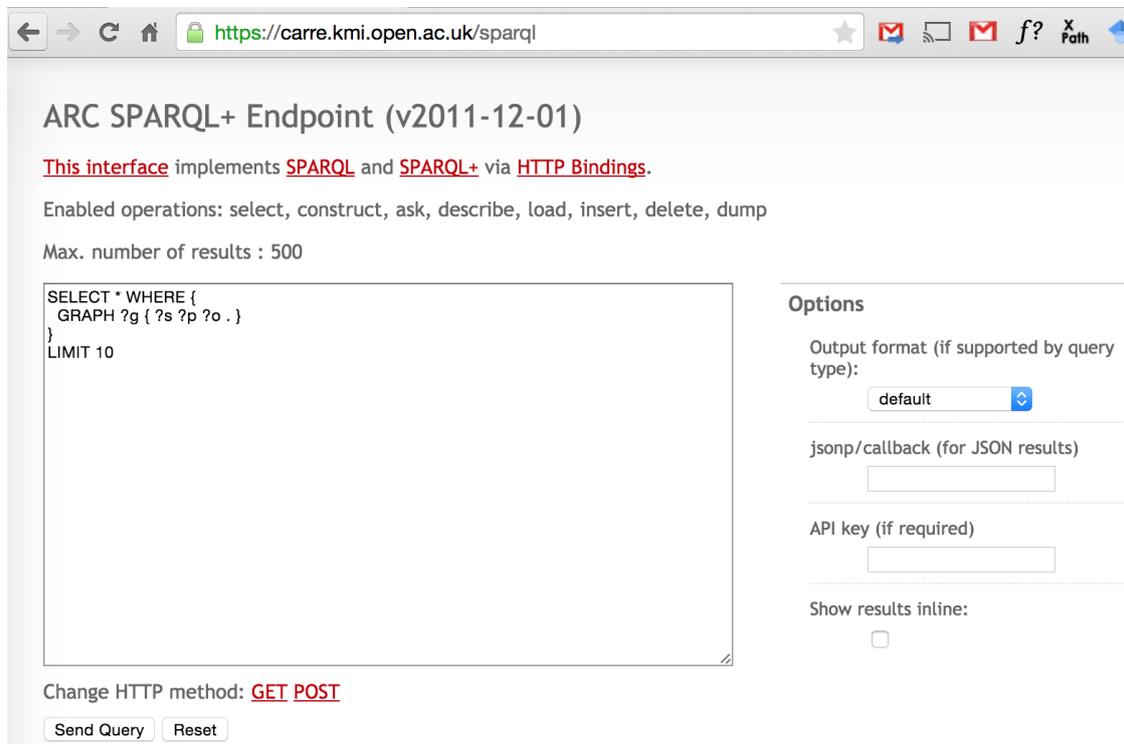


Figure 3: The interface of Drupal's SPARQL endpoint [<https://carre.kmi.open.ac.uk/sparql>]

3.1.3. Transformation and final enrichment of Risk Factor associations

Up until now, we have represented all data stored in Drupal as RDF and then we discussed how using a SPARQL module, the same data are accessible through SPARQL over HTTP. The final step is to export the RDF triples from Virtuoso and deposit them onto Virtuoso. To achieve this, some transformations were needed. These transformations are implemented through a script file²¹, as a one-time batch job. The transformations concern the following actions:

- Literals lookup
 - When using values that are the result of lookup fields (e.g. a publication can be a cohort study, these values are represented as Drupal IRIs). These IRIs are looked up separately in order to fetch the actual values.
- Generation of IRIs
 - Some fields, such as the Concept Unique Identifier (CUI) of Risk Elements, are filled in as code values (e.g. "Acute kidney injury" has CUI value "C0022660"). The transformation takes the value and generates the appropriate IRI, pointing to a valid external ontology (e.g. for the example above the value is transformed to the following IRI: <http://umls.nlm.nih.gov/sab/mth/cui/c0022660>)

¹⁹ <https://carre.kmi.open.ac.uk/sparql>

²⁰ <https://carre.kmi.open.ac.uk/sparql>

²¹ The script file is attached in this deliverable.

- Some IRIs refer to the Drupal content (e.g. a risk element is represented under <http://carre.kmi.open.ac.uk/node/<nodeid>>). These IRIs are replaced with a more appropriate naming scheme (for instance, in the example above the IRI is turned into http://carre.kmi.open.ac.uk/elements/acute_kidney_injury)
- The IRIs generated above are escaped appropriately with the symbols < and >.
- Text cleanup
 - Simple actions, such as the capitalisation of the first letter, removal of extra white characters, appropriate escaping of multiline literals, removal of break lines where not needed.
- Generation of extra triple statements
 - Composite attributes such as confidence interval are broken down into 2 triples, one for minimum and one for maximum confidence interval.
- Removal of redundant triples
 - Some triples contain the same value as others. This was the case for Drupal's title and name of each node.
 - Some triples contain metadata that is already existent in external RDF repositories. This was the case of PubMed publications and their metadata. To avoid redundancy, only the PubMed ID was kept.
 - Triples that concern optional attributes that have not been filled in are removed.

Following the above actions, triples are ready to be deposited onto Virtuoso. The script (attached in the current deliverable) is generating SPARQL queries that implements the above.

3.1.4. CARRE services for Risk Factor associations

An arbitrary number of SPARQL queries can be executed for exploiting the risk factors associations captured within CARRE. CARRE's RESTful API component²² has implemented a number of representative methods that allow developers with very little knowledge of the underlying scheme to efficiently make use of the repository's data. These methods are presented below:

- instances²³

This method queries CARRE's repository for all instances of a certain Class. It may take as input one of the pre-defined Classes: observable, clinical_observable, personal_observable, risk_element, biomedical_risk_element, behavioural_risk_element, genetic_risk_element, demographic_risk_element, risk_factor, risk_evidence, citation.
- riskEvidencePublications²⁴

This method takes as input the IRI of a CARRE risk evidence and returns all publications that are used to describe it. The available IRIs can be found using the previous method (/instances).
- PubMedPublication²⁵

This method takes as input a PubMed's publication unique identifier and implements a remote query to linkedlifedata sparql endpoint²⁶ to fetch all metadata concerning a PubMed publication.
- UMLsCUI²⁷

Similarly to the previous method, this method takes as input a UMLs Concept Unique Identifier and connects to linkedlifedata endpoint to fetch all metadata of the UMLs entry.

²² <https://carre.kmi.open.ac.uk/ws>

²³ <https://carre.kmi.open.ac.uk/ws/instances>

²⁴ <https://carre.kmi.open.ac.uk/ws/riskEvidencePublications>

²⁵ <https://carre.kmi.open.ac.uk/ws/PUBMedPublication>

²⁶ <http://linkedlifedata.com/sparql>

²⁷ <https://carre.kmi.open.ac.uk/ws/UMLsCUI>

3.2. Sensor data & measurements

The sensor data and measurements ontology presented in D.2.4 describes the structure of the RDF data generated by the sensor aggregators presented in D.3.2. In particular, each individual type of measurement has two points of contact with the outside world of Linked Data: its *type* and its *unit*. For example, a type might be an external (CMO) term referring to “blood pressure measurement”, and the corresponding unit may be an external (UO or QUDT) term referring to “mmHg”.

There are two main envisaged uses of these mappings. One is for linking data. While, for privacy reasons, there is very little opportunity (or demand) to link multiple sets of private sensor data from different, non-CARRE, sources together, there are useful situations where linking private data to public data can be a good idea. For example, supposing the CARRE medical scientific metadata mining service (discussed in 3.6 below) identifies a new piece of medical evidence regarding, for the sake of argument, the relationship between average daily distance walked in kilometres and systolic blood pressure in mmHg. Because the mining service will mark up this evidence with semantic terms reflecting such of its content as can be extracted, it will be possible to match it to patients in the CARRE system for whom these measurements have been recorded, and notify the patient’s clinician. Note that such linking, by design, only happens in one direction: a CARRE user (perhaps the patient him or herself) with appropriately controlled access to the patient data can query and link in public data from outside CARRE. It is not possible for anyone unauthenticated querying from the public Internet to access a patient’s data.

The other envisaged use is more ontological, so to speak. The data recorded from CARRE sensors contains as much specific information as is made available by the sensors and the CARRE enrichment to RDF provided by the aggregators. Further detail about these measurements, such as human-friendly unit names, or taxonomic relationships between types of measurement (e.g., that a systolic blood pressure measurement is a kind of blood pressure measurement), are not stored in the CARRE repositories, nor, according to Linked Data good practice, should they be. Instead, these pieces of information can be extracted by taking advantage of the mappings for external ontologies presented here.

The following SPARQL queries return the ontological details of these terms from Bioportal corpus.

```
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX : <http://carre.kmi.open.ac.uk/ontology/sensors.owl#>

SELECT ?cType ?s ?p ?p2 ?o WHERE
{
  GRAPH <http://carre.kmi.open.ac.uk/public> {
    ?measurementPredicate rdfs:domain
    <http://carre.kmi.open.ac.uk/ontology/sensors.owl#individual_sleep_measurement> .
    ?measurementPredicate rdfs:range ?measurementTypeValue .
    ?measurementTypeValue rdfs:subClassOf ?value .
    ?value rdfs:subClassOf ?entity .
    ?entity owl:onProperty :has_unit .
    ?entity owl:someValuesFrom ?unit .
    ?unit rdfs:subClassOf ?cType .
  }
  SERVICE <http://sparql.bioontology.org/ontologies/sparql?apikey=XXXXXX>
  {
    GRAPH ?g {
      OPTIONAL {?s ?p ?cType }.
      OPTIONAL { ?cType ?p2 ?o }.
      OPTIONAL {?s2 ?cType ?o2 }.
    }
  }
} GROUP BY ?cType
```

The query above takes as input a unit of type `individual_sleep_measurement`.

```
PREFIX foaf: <http://xmlns.com/foaf/0.1/>
```

```
PREFIX dbo: <http://dbpedia.org/ontology/>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX rdfs2: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX : <http://carre.kmi.open.ac.uk/ontology/sensors.owl#>
PREFIX carreManufacturer: <http://carre.kmi.open.ac.uk/manufacturers/>
PREFIX carreUsers: <https://carre.kmi.open.ac.uk/users/>
PREFIX owl: <http://www.w3.org/2002/07/owl#>

SELECT ?cType ?s ?p ?p2 ?o WHERE
{
  GRAPH <http://carre.kmi.open.ac.uk/public> {
    ?measurementPredicate rdfs:domain
    <http://carre.kmi.open.ac.uk/ontology/sensors.owl#individual_sleep_measurement> .
    ?measurementPredicate rdfs:range ?measurementTypeValue .
    ?measurementTypeValue rdfs:subClassOf ?value .
    ?value rdfs:subClassOf ?entity .
    ?entity owl:onProperty :has_measurement_type .
    ?entity owl:someValuesFrom ?measurementType .
    ?measurementType rdfs:subClassOf ?cType .
  }
  SERVICE <http://sparql.bioontology.org/ontologies/sparql?apikey=XXXXXX>
  {
    GRAPH ?g {
      OPTIONAL {?s ?p ?cType }.
      OPTIONAL { ?cType ?p2 ?o }.
      OPTIONAL {?s2 ?cType ?o2 }.
    }
  }
} GROUP BY ?cType
```

The query above takes as input a unit of type `individual_sleep_measurement`.

Together the results of these queries allow simple mapping of sensor data types to external vocabularies and data sources, and the retrieval of general ontological data relating to them. These queries have been mapped as methods in the CARRE RESTful API, producing the corresponding JSON objects, as follows:

- `getBioPortalUnitDesc`²⁸
Parameter: URI of individual reading type, e.g., `carreSensors:individual_sleep_measurement`
- `getBioPortalMeasurementDesc`²⁹
Parameter: URI of individual reading type, e.g., `carreSensors:individual_sleep_measurement`

Any application may call these methods and use the results as required.

3.3. Personal medical & lifestyle data

The personal medical and lifestyle data aggregator (PMLDA) is designed to retrieve information relating to a patient from the PHR systems intended for use by CARRE patients, specifically, VivaPort³⁰ and Microsoft HealthVault³¹. The aggregator is designed to be generic, supporting the observable biometrics used in the CARRE Risk Association data and to retrieve, automatically, the corresponding data from a patient's PHR. The design is also intended to be agnostic with regard to particular PHR systems, allowing the addition of "PHR data readers", each of which handles the specific communication and term matching with a PHR system, before passing the relevant data back to the aggregator core for storage in the CARRE repository.

Observable metrics in the Risk Association model are annotated with terms from UMLS. The PMLDA retrieves these terms from the public repository to obtain a list of types of clinical data known to CARRE. These terms

²⁸ <https://carre.kmi.open.ac.uk/ws/BioPortalUnitDesc>

²⁹ <https://carre.kmi.open.ac.uk/ws/BioPortalMeasurementDesc>

³⁰ <https://vivaport.eu>

³¹ <https://www.healthvault.com/gb/en>

can then be mapped into whichever vocabulary is used by a particular PHR in order to identify specific pieces of information which can be retrieved for an individual patient. For example, VivaPort primarily uses SNOMED-CT; the UMLS Metathesaurus can provide mappings to SNOMED-CT from UMLS terms, and these mappings then inform the VivaPort PHR data reader which SNOMED-CT terms to match in a patient’s record in VivaPort. The data thus identified can be passed back to the CARRE private repository for that patient, annotated in RDF with the relevant terms from the CARRE Readings and Measurements ontology. That is to say, output from the PMLDA are represented in a similar way to sensor readings – diagnosis, age, sex, etc., each have their own measurement types whose values are, for example, a number (in years) for age, or UMLS codes for diagnoses, and so on. Personal medical data can therefore be queried and understood by all CARRE components developed against the Readings and Measurements Ontology. Recent versions of HealthVault also provide SNOMED-CT support³², allowing a very similar approach to be taken.

The private data thus annotated is thereby semantically enriched, enabling the full semantic linking tools of the CARRE system to be applied. As with every CARRE component involved in handling private data, the strictest security processes are followed throughout, as detailed in D.4.1.

3.4. Educational metadata

The educational resource ontology is designed in order to provide structure to resources aggregated by the educational resource aggregator. A brief description is provided from deliverable T3.4.

The aim of the educational resource aggregator is to harvest educational resources from 3rd party repositories, present these to the medical expert for annotation and rating, and output the results of the annotation (together with resource metadata) to the CARRE public RDF repository.

The main parts of this aggregator are: the **Resource Retriever**, the **Resource Rating**, the **Resource Metadata Processing**, and the **User Application**.

The educational metadata involve the **Resource Metadata processing** module. This module is a combination of 3 services that collect data per article, making multiple SPARQL requests to enrich the data and finally store it as a unique identified resource into the local datastore. Then data is transformed into RDF triples in order to be inserted to CARRE educational repository.

The ontology is developed using the Protégé v5.0³³ (see Figure 4), a free, open-source ontology editor from the Stanford University. The ontology is available on CARRE RDF repository among the other ontologies. CARRE URL : <http://carre.kmi.open.ac.uk/ontology/educational.owl>

As a standard practice, the ontology has been uploaded to bioportal and linked to CARRE project.

The bioportal URL: <http://bioportal.bioontology.org/ontologies/MERA> (Medical Educational Resource Aggregator)

Below is a table (Table 1) describing all available (as of V0.01 of the ontology) classes and properties.

Table 1: Educational resource ontology class and property reference

CLASSES	OBJECT PROPERTIES	DATA PROPERTIES
ENRICHMENT (ICD10,UMLS,MESH codebase)	date_accepted (it refers to the main educational OBJECT)	wordcount (resource words)
OBJECT (educational resource)	date_ranked	webservice (wikipedia,medlineplus urls)

³² <http://blogs.msdn.com/b/healthvault/archive/2010/07/01/healthvault-1006-release.aspx>

³³ <http://protege.stanford.edu/>

RANK (includes user query, ranking position, date)	date_rated	source (wikipedia, medlineplus)
RATING (rating properties, date, user)	enrichment_for_article (refers to educational resource id)	url (resource url)
USER (links to CARRE user)	rank_for_article (refers to educational resource id)	total (search query total number)
	rating_for_article (refers to educational resource id)	title (resource title)
	rated_by_user (refers to CARRE user)	snippet (resource mini description)
		query (query made by user)
		position (ranking per user query)
CLASSES	OBJECT PROPERTIES	DATA PROPERTIES
		accuracy (rating criteria)
		comprehensiveness (rating criteria)
		depth_of_coverage (rating criteria)
		educational_level (rating criteria)
		relevancy (rating criteria)
		validity (rating criteria)
		rating_criteria (group property)
		date (time date property)
		categories (categories fetched from bioportal for this educational resource)
		language (only english as of V0.01)
		alternative_title (based on bioportal)
		MESH (standard identifier)
		UMLS (standard identifier)

		ICD10 (standard identifier)

3.4.1. Example #1

We will now present an example case scenario that is mapped using this ontology in the public rdf graph.

Case scenario : A patient diagnosis for acute kidney disease.

Example risk element : **acute kidney disease**

Query to find the top 5 rated educational resources regarding “acute kidney disease” is shown in and the results are shown in Table 3.

Table 2: Query to find the top 5 rated educational resources regarding “acute kidney disease”

```

PREFIX edu: <http://carre.kmi.open.ac.uk/ontology/educational.owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>

SELECT ?Article (AVG(?ratingval) as ?Rating) ?Url ?Source ?Query
FROM <http://carre.kmi.open.ac.uk/public>
WHERE {
  ?s a edu:object ;
    edu:title ?Article;
    edu:webservice ?Source;
    edu:url ?Url.
  ?r edu:for_article ?s ;
    rdf:type edu:rating;
    ?any ?ratingval.
  ?rank rdf:type edu:rank;
    edu:for_article ?s;
    edu:query ?Query.

  FILTER (datatype(?ratingval) = xsd:integer && ?Query="acute kidney injury"^^xsd:string)
}
ORDER BY DESC(?Rating)
LIMIT 5
  
```

Table 3: The top 5 rated educational resources regarding “acute kidney disease”

Article	Rating	Url	Source	Query
Myocardial infarction	5	http://en.wikipedia.org/wiki/Myocardial infarction	wikipedia	acute kidney injury
Liver Diseases	4.666666666666667	http://www.nlm.nih.gov/medlineplus/liverdiseases.html	medlineplus	acute kidney injury

Analgesic nephropathy	4.5	http://en.wikipedia.org/wiki/Analgesic_nephropathy	wikipedia	acute kidney injury
Acute kidney injury	4.5	http://en.wikipedia.org/wiki/Acute_kidney_injury	wikipedia	acute kidney injury
Transplant rejection	4.3333333333333333	http://en.wikipedia.org/wiki/Transplant_rejection	wikipedia	acute kidney injury

Live results on RDF repository (results may change according to data) :

Short URL : <http://goo.gl/0qWzz2>

3.4.2. Example #2

Another sample of the data aggregated combining this ontology is the following:

Sample data of 10 educational object with source, URL, and the regarding risk element they link to. The query is shown in Table 4 and the results in Table 5.

Table 4: Query to find 10 educational objects with source, url, and the regarding risk element

```

PREFIX edu: <http://carre.kmi.open.ac.uk/ontology/educational.owl#>
PREFIX risk: <http://carre.kmi.open.ac.uk/ontology/risk.owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>

SELECT ?Educational_Resource ?Source ?Resource_URL ?Risk_Element
FROM <http://carre.kmi.open.ac.uk/public>
WHERE {
  ?Risk_Element risk:has_educational_material ?Educational_IRI .
  ?Educational_IRI a edu:object ;
  edu:title ?Educational_Resource;
  edu:webservice ?Source;
  edu:url ?Resource_URL.
} LIMIT 10

```

Table 5: 10 educational objects with source, url, and the regarding risk element

Educational_Resource	Source	Resource_URL	Risk_Element
Comorbidity	wikipedia	http://en.wikipedia.org/wiki/Comorbidity	http://carre.kmi.open.ac.uk/elements/progression_of_ckd
Schizophrenia	wikipedia	http://en.wikipedia.org/wiki/Schizophrenia	http://carre.kmi.open.ac.uk/elements/depression
Kidney disease	wikipedia	http://en.wikipedia.org/wiki/Kidney_disease	http://carre.kmi.open.ac.uk/elements/acute_kidney_injury

Kidney disease	wikipedia	http://en.wikipedia.org/wiki/Kidney_disease	http://carre.kmi.open.ac.uk/elements/chronic_kidney_disease
Atrial fibrillation	wikipedia	http://en.wikipedia.org/wiki/Atrial_fibrillation	http://carre.kmi.open.ac.uk/elements/atrial_fibrillation
Renal failure	wikipedia	http://en.wikipedia.org/wiki/Renal_failure	http://carre.kmi.open.ac.uk/elements/heart_failure
Renal failure	wikipedia	http://en.wikipedia.org/wiki/Renal_failure	http://carre.kmi.open.ac.uk/elements/acute_kidney_injury
Urinary Tract Infections	medlineplus	http://www.nlm.nih.gov/medlineplus/urinarytractinfections.html	http://carre.kmi.open.ac.uk/elements/acute_kidney_injury
Kidney Diseases	medlineplus	http://www.nlm.nih.gov/medlineplus/kidneydiseases.html	http://carre.kmi.open.ac.uk/elements/acute_kidney_injury
Acute kidney injury	wikipedia	http://en.wikipedia.org/wiki/Acute_kidney_injury	http://carre.kmi.open.ac.uk/elements/acute_kidney_injury

Live results on RDF repository can be found online (short URL: <http://goo.gl/4rjfzC>)

3.4.3. Visualizations

You can visualize live the ontology using the bioportal storage engine and WebVOWL

We provide a linkable live view of the ontology using WebVOWL

- Short URL : <http://goo.gl/S1rCuY>
- Long URL : <http://vowl.visualdataweb.org/webvowl/index.html#iri=http://data.bioontology.org/ontologies/MERA/submissions/1/download?apikey=a15281a9-d87d-4c0f-b7aa-31debe0f6449>

Below is a screenshot of the graphical representation of the ontology using WebVOWL.

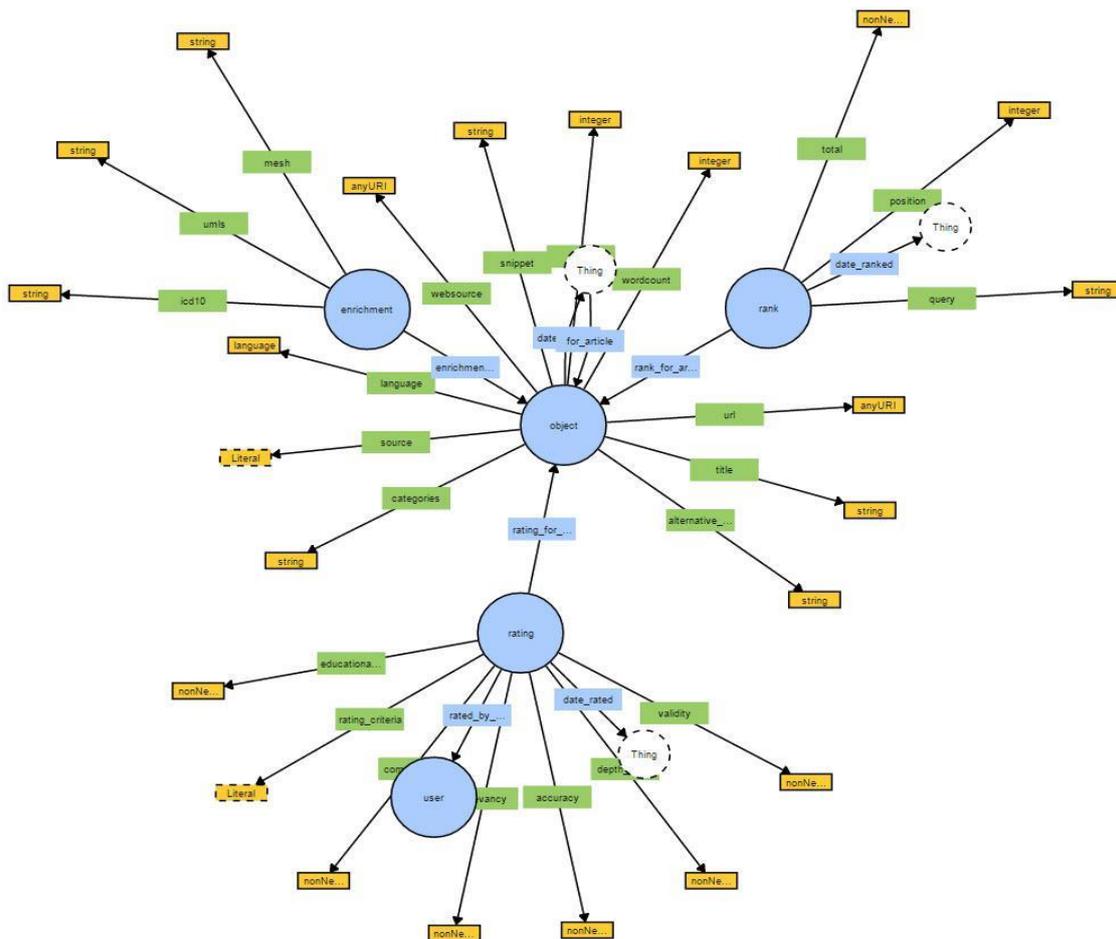


Figure 4: Educational metadata ontology

3.5. Web Lifestyle

Figure 5 illustrates the ontology for the CARRE Web Lifestyle data. This ontology designed and developed in order to represent the detected intentions from the Web Lifestyle Data Aggregator, which presented in Deliverable 3.3, in the private RDF repository of user. In particular, it seeks to represent what is involved in the gathering of data from the web and social lifestyle of user on the Internet. We decided, therefore, to develop the ontology using the Protégé v5.0³⁴ (see Figure 6), a free, open-source ontology editor from the Stanford University. The outcome of Protégé is available on the following URL:

<http://carre.kmi.open.ac.uk/ontology/lifestyle.owl>

The ontology is also available in Biportal : <http://biportal.bioontology.org/ontologies/MWLA> .

The presented ontology (Figure 5) is generic and can support different type of providers (e.g. web searches, Facebook, Twitter etc.). Additionally, the predefined intentions are also generic supporting the majority of intentions in the Web. In the context of CARRE, we utilize, as a first attempt, the web searches as provider and we only upload the relevant intentions (health and travel) to CARRE in the private RDF repository.

A user (representing an individual person whose data is being represented using the terms of this ontology) has connections. A connection represents that a Web Lifestyle Data Aggregator of a particular personal computer of user provides intentions for particulars providers. A connection is therefore associated with a UUID (Universal Unique Identifier) that represents an installation of the aggregator. A provider can be the web searches, Facebook or Twitter. A measurement is associated with a provider and a connection in order to

³⁴ <http://protege.stanford.edu/>

declare the connection (i.e. the Web Lifestyle Data Aggregator of a particular personal computer) from which a measurement came.

Every measurement must have a date at which the detected intention was taken, a weight which defines the importance of an intention and of course the detected intention that is only relevant to CARRE. An intention consists of 25 subclasses that represent the different groups of intentions and every subclass consists of particular predefined intentions³⁵ that are shown in Table 6.

Table 6: Predefined intentions on Web Lifestyle ontology.

Arts and Entertainment	Animation and Comics, Architecture, Awards, Celebrities and Entertainment News, Fashion and Modeling, Humor, Movies, Music and Audio, Performing Arts, Photography, TV and Video, Visual Arts and Design
Autos and Vehicles	Automotive Industry, Automotive News, Aviation, Boating, Car Buying, Car Rentals, Makes and Models, Motorcycles, Motorsports, Trains and Railroads
Beauty and Fitness	Beauty, Bodyart, Cosmetics, Fitness, Hair, Skin Care, Weight Loss
Books and Literature	Book Retailers, E Books, Folklore, Guides and Reviews
Business and Industry	Aerospace and Defence, Agriculture and Forestry, Associations, Biotechnology and Pharmaceuticals, Business Services, Chemicals, Construction and Maintenance, Customer Service, E Commerce, Energy, Industrial Goods and Services, Marketing and Advertising, Metals and Mining, Publishing and Printing, Real Estate, Textiles and Nonwovens, Transportation and Logistics, Wholesale Trade
Career and Education	Business Training, Education, Human Resources, Jobs and Employment, Universities and Colleges
Computer and Electronics	Computer Hardware, Computer Security, Consumer Electronics, Graphics and Multimedia Tools, Networking, Programming, Software
Finance	Accounting, Banking, "Credit, Loans and Mortgages", Financial Management, Grants and Scholarships, Insurance, Investing
Food and Drink	Beverages, Catering, Cooking and Recipes, Food and Grocery Retailers, Restaurants and Delivery, Vegetarian and Vegan
Gambling	Bingo, Casinos, Lottery, Poker, Regulation and Organizations, Sports
Games	Board and Card Games, Miniatures, Online, Puzzles and Brainteasers, Roleplaying, Video Games
Health	Addictions, Alternative and Natural Medicine, Child Health, Conditions and Diseases, Dentistry, Education and Resources, Healthcare Industry, Medicine, Mens Health, Mental Health, Nutrition, Pharmacy, Products and Shopping, Public Health and Safety,

³⁵ Based on: <http://www.similarweb.com/category>

	Reproductive Health, Senior Health, Womens Health, Drugs and Therapy, Diagnostic Tests, Medical Equipment and Sensors, Exercise and Physical Activity, Dietary Supplements
Home and Garden	Gardening, Home Improvement, Interior Decor, Moving and Relocating, Nursery and Playroom
Internet and Telecom	Ad Network, Chats and Forums, Domain Names and Register, Email, File Sharing, Mobile Developers, Online Marketing, Search Engine, Social Network, Telecommunications, Web Design, Web Hosting
Law and Government	Government, Immigration and Visas, Law, Military and Defense
News and Media	Business News, College and University Press, Magazines and E Zines, Newspapers, Sports News, Technology News, Weather
People and Society	Crime and Prosecution, Death, Disabled and Special Needs, "Gay, Lesbian, and Bisexual", Genealogy, History, Holidays, Philanthropy, Philosophy, Relationships and Dating, Religion and Spirituality, Womens Interests
Pets and Animals	Animal Products and Service, Birds, Fish and Aquaria, Horses, Pets
Recreation and Hobbies	Antiques, Camps, Climbing, Collecting, Crafts, Models, Nudism, Outdoors, Scouting, Theme Parks, Tobacco, Weapons
Reference	Archives, Ask an Expert, Dictionaries and Encyclopedias, Directories, Libraries and Museums, Maps
Shopping	Antiques and Collectibles, Auctions, Children, Classifieds, Clothing, Consumer Electronics, Coupons, Ethnic and Regional, Flowers, Furniture, General Merchandise, Gifts, Home and Garden, Jewelry, Music, Office Products, Publications, Sports, Weddings
Sports	Baseball, Basketball, Boxing, Cycling and Biking, Equestrian, Extreme Sports, Fantasy Sports, Fishing, Football, Golf, Martial Arts, Rugby, Running, Soccer, Tennis, Volleyball, Water Sports, Winter Sports
Travel	Accommodation and Hotels, Airlines and Airports, Roads and Highways, Tourism
Adult	Adult



Figure 5: Diagram of the CARRE Web Lifestyle ontology. Classes and properties with green background colour denote that these entities are linked to external vocabularies.

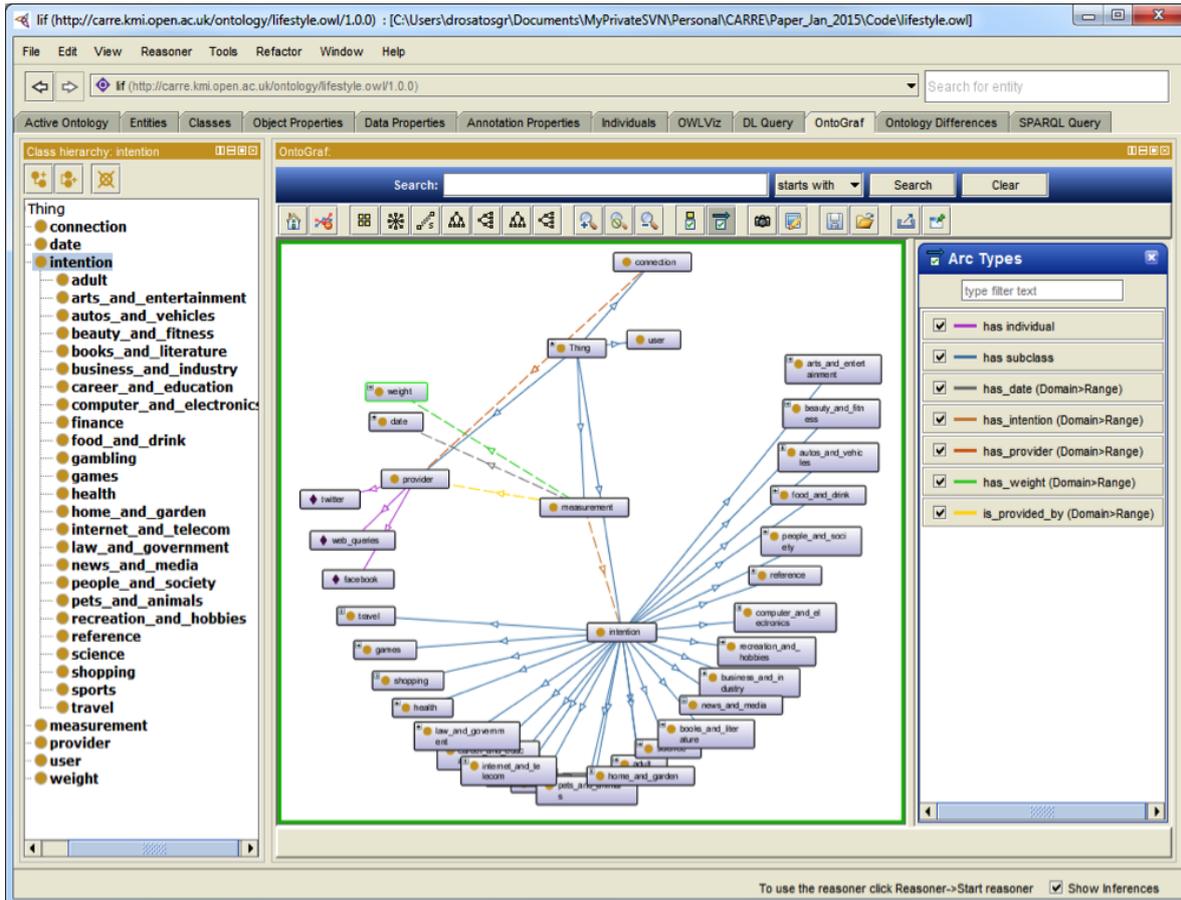


Figure 6: A screenshot of the Protégé ontology editor.

3.6. Medical scientific metadata

The purpose of the task is to gather medical knowledge with the aims to 1) enrich the evidence of the existing risk descriptions as entered manually by medical experts and 2) identify new risk associations for cardiorenal diseases and comorbidity as published in medical literature during and beyond the project's lifetime. This aggregator extracts and summarises key information from popular and trusted medical publications as they are indexed in PubMed.

T3.4 reported the details about the medical data aggregator. Users can use the purposely built portal (shown in the following figure) to use key words to search, then based on the automatically highlighted new evidences and suggest possible new risk associations, to analyse and confirm the mined evidences and associations.

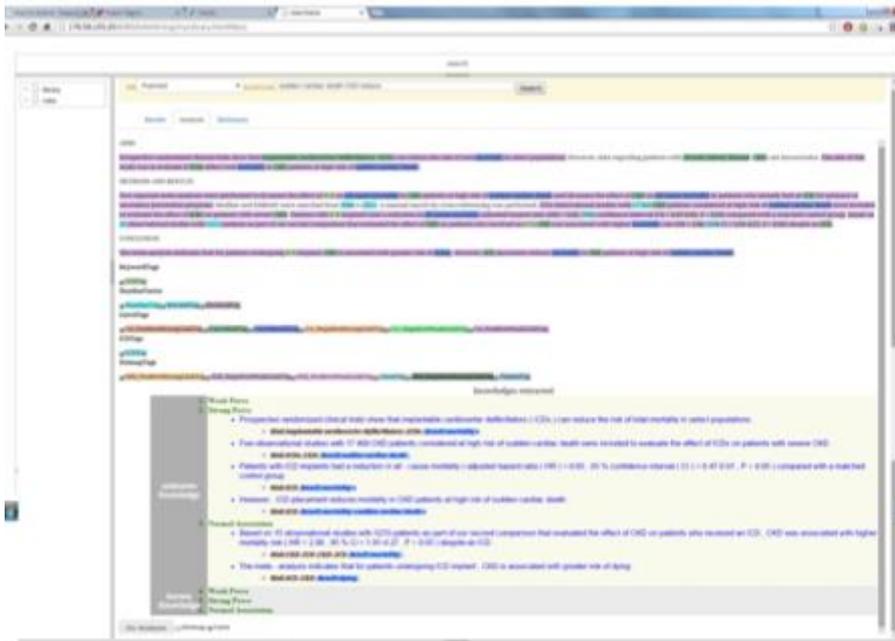


Figure 7: Screenshot of the medical evidence aggregation user interface.

The fourth step identified in T3.4 is to output the mined data to the CARRE RDF repository. Once the professionals validated the suggested additional medical evidences and new risk associations, users can use the Risk Model Semantic Data Entry system (RMSDE) to manually record the new findings. By annotating the mined data with terms from the CARRE Ontologies, the mined data is thus semantically enriched and made available as a public Linked Data resource.

4. Ontology evolution management

Ontologies are not static documents but evolve over time, as bugs are corrected, new concepts and definitions are added and obsolete ones removed. Of course, this can cause problems for software developed against a particular ontology version, and so it is important to take care to allow the process of ontology evolution to be managed.

The proper management of ontology versioning is an open research area³⁶³⁷. We give a brief overview of the main issues and standard solutions, where they exist, before presenting the CARRE approach to ontology evolution.

We distinguish three types of change which can be made to an ontology, ordered by severity for applications.

1. Syntactic - cosmetic

Actions such as reformatting or reordering the contents of an ontology, or changing the comments on an ontology entity, will lead to a detectable difference in the ontology file, but will not in any way affect the interpretation of terms. These changes are harmless, and nothing needs to be done to accommodate them. It is unlikely that any such changes would lead to a formal new version of an ontology.

2. Syntactic - non-cosmetic

If, for example, the URI of an entity in an OWL ontology is modified, this can affect applications which use the original URI.

If the sole purpose of a change is entity renaming, with no associated semantic change, a responsible ontology author will accommodate these changes by making use of predicates such as `owl:sameAs` and `owl:equivalentProperty`, and so on, to assert the semantic identity of old and new URIs in a machine-processable form. An application which follows, e.g., `owl:sameAs` links will be unaffected by any changes of this type.

3. Semantic

Changes in the axioms defining the meaning of a term can of course have significant consequences for any applications written using the original definitions. The difficulty is in determining when a substantive change has been made. Different formulations and combinations of axioms can turn out to be logically equivalent. It can be hard for human authors or reviewers to tell when this is the case, and it can be impossible, and, even more often, extremely impractical, for these situations to be identified automatically. There are proposals or in-development systems³⁸ to handle these situations but none are in a sufficient state for use in a healthcare project.

The OWL standard does allow for ontology authors to indicate backwards (in)compatibility in the case where deliberate known semantic changes have been made, via predicates such as `owl:backwardCompatibleWith` and `owl:incompatibleWith`.

In many cases, it may not be possible to tell automatically which of the preceding situations have occurred without the active support of ontology authors, e.g., in the use of `owl:sameAs` or compatibility predicates. We make the assumption that purely cosmetic syntactic changes (1 above) would not be indicated by a change of ontology version number.

Where possible, the CARRE system will identify the following situations automatically:

1. The CARRE ontologies or public RDF graph contain references to two external terms which both come from the same ontology, but from potentially incompatible versions of it.

³⁶ P. Kremen, M. Smid, and Z. Kouba. "OWLDiff: A practical tool for comparison and merge of OWL ontologies." Database and Expert Systems Applications (DEXA), 2011 22nd International Workshop on. IEEE, 2011.

³⁷ P. Pittet, C. Nicolle, and C. Cruz. "Guidelines for a dynamic ontology-integrating tools of evolution and versioning in ontology." arXiv preprint arXiv:1208.1750 (2012).

³⁸ P. Plessers, O. De Troyer, S. Casteleyn, Understanding ontology evolution: A change detection approach, Web Semantics, 5:1, March 2007, pp 39-49, ISSN 1570-8268, <http://dx.doi.org/10.1016/j.websem.2006.11.001>

2. The source ontology for any external term used in the CARRE ontologies or public graph is detected to have changed.

In either of these circumstances, an alert will be sent to the CARRE administrators and, where relevant, to any clinical authors and reviewers involved in adding the term(s) in question to CARRE.

Thankfully, the vast majority of external ontologies used by CARRE at the time of writing are either largely stable (e.g., CMO, UO) or are subject to highly-controlled and very public versioning processes, e.g., UMLS, SNOMED-CT and ICD.

In order to implement the above process, the following pieces of information are stored alongside each use of an external term in the CARRE ontology.

1. Its type (e.g., class, property, individual, etc.)
2. A list of known equivalences (from, e.g., its original source, sameas.org, etc.)
3. A version string of the ontology or vocabulary from which it is drawn
4. The date it was added to the ontology
5. A checksum (md5) of the full source ontology file, where available.

A periodic check (once per week) is made to identify the situations mentioned earlier, and to send any alerts.

Beyond these automatic checks, the CARRE ontology authors and clinical experts will remain up to date with major changes in the main ontologies and vocabularies used, and this process for maintaining the data will be continued as an important part of the ongoing CARRE medical knowledge curation process.

Annex 1

1. Risk Association ontology - mappings to external vocabularies

```
@prefix carreSensors: <http://carre.kmi.open.ac.uk/ontology/sensors.owl#> .
@prefix carreRisk: <http://carre.kmi.open.ac.uk/ontology/risk.owl#> .

<http://carre.kmi.open.ac.uk/ontology/mappings>
  rdf:type owl:Ontology ;
  rdfs:label "Ontology Mappings;
  rdfs:comment "This document contains the mappings of the CARRE ontologies' terms to LOD
vocalbaries for ease of alignment of terms and data from multiple domains.".

carreRisk:boolean rdfs:subClassOf <xsd:boolean> .

carreRisk:string rdfs:subClassOf <xsd:string> .

carreRisk:real_number rdfs:subClassOf <xsd:float> .

carreRisk:integer rdfs:subClassOf <xsd:integer> .

carreRisk:date rdfs:subClassOf <xsd:datetime> .

carreRisk:website rdfs:subClassOf <xsd:anyURI> .

carreRisk:P00ToP96 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/P00-P96.9> .
carreRisk:A00ToB99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/A00-B99.9> .
carreRisk:Q00ToQ99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/Q00-Q99.9> .
carreRisk:D50ToD89 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/D50-D89.9> .
carreRisk:I00ToI99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/I00-I99.9> .
carreRisk:K00ToK93 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/K00-K93.9> .
carreRisk:H60ToH95 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/H60-H95.9> .
carreRisk:H00ToH59 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/H00-H59.9> .
carreRisk:N00ToN99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/N00-N99.9> .
carreRisk:M00ToM99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/M00-M99.9> .
carreRisk:J00ToJ99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/G00-G99.9> .
carreRisk:L00ToL99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/J00-J99.9> .
carreRisk:L00ToL99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/L00-L99.9> .
carreRisk:E00ToE90 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/E00-E90.9> .
```

```
carreRisk:V01ToY98 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/V01-Y98.9> .
carreRisk:Z00ToZ99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/Z00-Z99.9> .
carreRisk:S00ToT98 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/S00-T98.9> .
carreRisk:F00ToF99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/F00-F99.9> .
carreRisk:C00ToD48 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/C00-D48.9> .
carreRisk:O00ToO99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/O00-O99.9> .
carreRisk:R00ToR99 rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD10/R00-R99.9> .
carreRisk:icd9code rdfs:subClassOf <http://purl.bioontology.org/ontology/ICD9CM/001-999.99> .
carreRisk:snomedctcode rdfs:subClassOf <http://purl.bioontology.org/ontology/SNOMEDCT/404684003> .

carreRisk:intervention_identifier rdfs:subClassOf
<http://purl.bioontology.org/ontology/ICD10PCS/0> .

carreRisk:hl7_identifier rdfs:subClassOf <http://purl.bioontology.org/ontology/HL7/C1561446> .

carreRisk:gender_identifier rdfs:subClassOf <http://xmlns.com/foaf/0.1/gender> .

carreRisk:age_identifier rdfs:subClassOf <http://xmlns.com/foaf/0.1/age> .

carreRisk:umlscode rdfs:subClassOf <umls:cui> .

carreRisk:educational_material_identifier rdfs:subClassOf
<http://purl.bioontology.org/ontology/MEDLINEPLUS/C1456590> .

carreRisk:pubmed_identifier rdfs:subClassOf <http://bio2rdf.org/pubmed_vocabulary:PubMedRecord> .

carreRisk:document rdfs:subClassOf <http://xmlns.com/foaf/0.1/Document> .

carreRisk:person rdfs:subClassOf <http://xmlns.com/foaf/0.1/Person> .

carreRisk:author rdfs:subClassOf <http://purl.org/dc/elements/1.1/creator> .
```

A1.2 Readings and Measurement ontology - mappings to external vocabularies

```
@prefix carreSensors: <http://carre.kmi.open.ac.uk/ontology/sensors.owl#> .
@prefix carreRisk: <http://carre.kmi.open.ac.uk/ontology/risk.owl#> .

<http://carre.kmi.open.ac.uk/ontology/mappings>
  rdf:type owl:Ontology ;
  rdfs:label "Ontology Mappings;
```

```
rdfs:comment "This document contains the mappings of the CARRE ontologies' terms to LOD vocabularies for ease of alignment of terms and data from multiple domains."
```

```
carreSensors:user rdfs:subClassOf <http://purl.org/cpr/0.9#patient> .
```

```
carreSensors:longitude rdfs:subClassOf <http://www.w3.org/2003/01/geo/wgs84_pos#long> .
```

```
carreSensors:degrees_unit rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000185> .
```

```
carreSensors:latitude rdfs:subClassOf <http://www.w3.org/2003/01/geo/wgs84_pos#lat> .
```

```
carreSensors:count_unit rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000189> .
```

```
carreSensors:kilometer_unit rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_1000008> .
```

```
carreSensors:calories_metabolised_value_measurement_type rdfs:subClassOf  
<http://purl.bioontology.org/ontology/LNC/LP35952-8> .
```

```
carreSensors:calorie_unit rdfs:subClassOf <http://qudt.org/vocab/unit#CalorieNutritional> .
```

```
carreSensors:distance_moved_by_unspecified_means rdfs:subClassOf  
<http://purl.obolibrary.org/obo/CMO_0000955> .
```

```
carreSensors:duration rdfs:subClassOf <http://www.w3.org/2006/time#Interval> .
```

```
carreSensors:seconds_unit rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000010> .
```

```
carreSensors:timezone_value_measurement_type rdfs:subClassOf  
<http://www.w3.org/2006/timezone#TimeZone> .
```

```
carreSensors:bicep_value_measurement_type rdfs:subClassOf  
<http://purl.obolibrary.org/obo/CMO_0000317> .
```

```
carreSensors:centimeter_unit rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000015> .
```

```
carreSensors:calf_value_measurement_type rdfs:subClassOf  
<http://purl.obolibrary.org/obo/CMO_0000186> .
```

```
carreSensors:chest_value_measurement_type rdfs:subClassOf  
<http://purl.obolibrary.org/obo/CMO_0000316> .
```

```
carreSensors:forearm_value_measurement_type rdfs:subClassOf  
<http://purl.obolibrary.org/obo/CMO_0000187> .
```

```
carreSensors:hips_value_measurement_type rdfs:subClassOf  
<http://purl.obolibrary.org/obo/CMO_0000014> .
```

```
carreSensors:neck_value_measurement_type rdfs:subClassOf  
<http://purl.obolibrary.org/obo/CMO_0000021> .
```

```
carreSensors:thigh_value_measurement_type rdfs:subClassOf  
<http://purl.obolibrary.org/obo/CMO_0000019> .
```

```
carreSensors:waist_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000242> .

carreSensors:calories_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0002208> .

carreSensors:unspecified_nutrition_value rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0002210> .

carreSensors:grams_value rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000021> .

carreSensors:water_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000774> .

carreSensors:liter_value rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000099> .

carreSensors:glucose_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000046> .

carreSensors:hba1c_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000508> .

carreSensors:height_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000106> .

carreSensors:pulse_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000294> .

carreSensors:count_per_minute_unit rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000148> .

carreSensors:percentage_unit rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000187> .

carreSensors:weight_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000012> .

carreSensors:kilogram_unit rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000009> .

carreSensors:bmi_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000105> .

carreSensors:kilogram_per_square_meter_unit rdfs:subClassOf
<http://purl.obolibrary.org/obo/UO_0000086> .

carreSensors:body_fat_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000302> .

carreSensors:mass_percentage_unit rdfs:subClassOf <http://purl.obolibrary.org/obo/UO_0000163> .

carreSensors:calculated_whole_body_lean_mass_measurement rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0002184> .

carreSensors:muscle_mass_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000448> .
```

```
carreSensors:calculated_whole_body_water_measurement rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000000> .

carreSensors:fat_mass_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000305> .

carreSensors:bone_mass_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000461> .

carreSensors:body_dci_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0002253> .

carreSensors:blood_pressure_systolic_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000004> .

carreSensors:millimeters_of_mercury_unit rdfs:subClassOf
<http://purl.obolibrary.org/obo/UO_0000272> .

carreSensors:blood_pressure_diastolic_value_measurement_type rdfs:subClassOf
<http://purl.obolibrary.org/obo/CMO_0000005> .
```

CARRE Lifestyle ontology

```
<?xml version="1.0"?>

<!DOCTYPE rdf:RDF [
  <!ENTITY owl "http://www.w3.org/2002/07/owl#" >
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
  <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#" >
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns#" >
]>

<rdf:RDF xmlns="https://carre.kmi.open.ac.uk/ontology/lifestyle.owl#"
  xml:base="https://carre.kmi.open.ac.uk/ontology/lifestyle.owl"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:owl="http://www.w3.org/2002/07/owl#"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#">
  <owl:Ontology rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl">
    <owl:versionIRI rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl/1.0.0"/>
  </owl:Ontology>

  <!--
  //////////////////////////////////////
  //
  // Object Properties
  //
  //////////////////////////////////////
  -->

  <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_connection -->

  <owl:ObjectProperty
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_connection">
    <rdfs:range rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#connection"/>
    <rdfs:domain>
```

```
        <owl:Class>
          <owl:unionOf rdf:parseType="Collection">
            <rdf:Description
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#measurement"/>
            <rdf:Description
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#user"/>
          </owl:unionOf>
        </owl:Class>
      </rdfs:domain>
    </owl:ObjectProperty>

    <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_date -->

    <owl:ObjectProperty rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_date">
      <rdfs:range rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#date"/>
      <rdfs:domain
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#measurement"/>
    </owl:ObjectProperty>

    <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_intention -->

    <owl:ObjectProperty
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_intention">
      <rdfs:range rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
      <rdfs:domain
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#measurement"/>
    </owl:ObjectProperty>

    <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_provider -->

    <owl:ObjectProperty
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_provider">
      <rdfs:domain
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#connection"/>
      <rdfs:range rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#provider"/>
    </owl:ObjectProperty>

    <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_weight -->

    <owl:ObjectProperty rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_weight">
      <rdfs:domain
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#measurement"/>
      <rdfs:range rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weight"/>
    </owl:ObjectProperty>

    <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#is_provided_by -->

    <owl:ObjectProperty
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#is_provided_by">
      <rdfs:domain
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#measurement"/>
      <rdfs:range rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#provider"/>
    </owl:ObjectProperty>

    <!--
    ///////////////////////////////////////////////////////////////////
    //
    // Data properties
    //
    ///////////////////////////////////////////////////////////////////
    -->
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_date_value -->
<owl:DatatypeProperty
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_date_value">
  <rdfs:domain rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#date"/>
  <rdfs:subPropertyOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_value"/>
  <rdfs:range rdf:resource="&xsd;dateTime"/>
</owl:DatatypeProperty>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_value -->
<owl:DatatypeProperty
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_value"/>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_weight_value -->
<owl:DatatypeProperty
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_weight_value">
  <rdfs:subPropertyOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#has_value"/>
  <rdfs:domain rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weight"/>
  <rdfs:range rdf:resource="&xsd;integer"/>
</owl:DatatypeProperty>

<!--
////////////////////////////////////
//
// Classes
//
////////////////////////////////////
-->

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#adult -->
<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#adult">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment -->
<owl:Class
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles -->
<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty_and_fitness -->
```

```
<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty_and_fitness">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#books_and_literature -->

<owl:Class
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#books_and_literature">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry -->

<owl:Class
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#career_and_education -->

<owl:Class
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#career_and_education">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_and_electronics -->

<owl:Class
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_and_electronics">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#connection -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#connection"/>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#date -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#date"/>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#finance -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#finance">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_drink -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_drink">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
```

```
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gambling -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gambling">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#games -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#games">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_and_garden -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_and_garden">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom -->

<owl:Class
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#law_and_government -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#law_and_government">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#measurement -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#measurement"/>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#news_and_media -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#news_and_media">
```

```
    <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
  </owl:Class>

  <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society -->

  <owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society">
    <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
  </owl:Class>

  <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pets_and_animals -->

  <owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pets_and_animals">
    <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
  </owl:Class>

  <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#provider -->

  <owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#provider"/>

  <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies -->

  <owl:Class
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies">
    <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
  </owl:Class>

  <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reference -->

  <owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reference">
    <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
  </owl:Class>

  <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science -->

  <owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science">
    <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
  </owl:Class>

  <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping -->

  <owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping">
    <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
  </owl:Class>

  <!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports -->

  <owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports">
    <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
  </owl:Class>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#travel -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#travel">
  <rdfs:subClassOf
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#intention"/>
</owl:Class>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#user -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#user"/>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weight -->

<owl:Class rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weight"/>

<!--
////////////////////////////////////
//
// Individuals
//
////////////////////////////////////
-->

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#accommodation_and_hotels -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#accommodation_and_hotels">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#travel"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#accounting -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#accounting">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#finance"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#ad_network -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#ad_network">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#addictions -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#addictions">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#adult -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#adult">
```

```
<rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#adult"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#aerospace_and_defence -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#aerospace_and_defence">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#agriculture -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#agriculture">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#agriculture_and_forestry -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#agriculture_and_forestry">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#airlines_and_airports -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#airlines_and_airports">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#travel"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#alternative_and_natural_medicine -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#alternative_and_natural_medicine">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#animal_products_and_service -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#animal_products_and_service">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pets_and_animals"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#animation_and_comics -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#animation_and_comics">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#antiques -->
```

```
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#antiques">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#antiques_and_collectibles -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#antiques_and_collectibles">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#architecture -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#architecture">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#archives -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#archives">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reference"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#ask_an_expert -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#ask_an_expert">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reference"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#associations -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#associations">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#astronomy -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#astronomy">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#auctions -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#auctions">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#automotive_industry -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#automotive_industry">
  <rdf:type
```

```
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#automotive_news -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#automotive_news">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#aviation -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#aviation">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#awards -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#awards">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#banking -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#banking">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#finance"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#baseball -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#baseball">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#basketball -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#basketball">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty_and_fitness"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beverages -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beverages">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_drink"/>
  </owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#bingo -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#bingo">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gambling"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#biology -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#biology">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#biotechnology_and_pharmaceuticals -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#biotechnology_and_pharmaceuticals">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#birds -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#birds">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pets_and_animals"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#board_and_card_games -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#board_and_card_games">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#games"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#boating -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#boating">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#bodyart -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#bodyart">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty_and_fitness"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#book_retailers -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#book_retailers">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#books_and_literature"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#boxing -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#boxing">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_news -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_news">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#news_and_media"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_services -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_services">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_training -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_training">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#career_and_education"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#camps -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#camps">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#car_buying -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#car_buying">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#car_rentals -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#car_rentals">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#casinos -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#casinos">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gambling"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#catering -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#catering">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_drink"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#celebrities_and_entertainment_news -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#celebrities_and_entertainment_news">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#chats_and_forums -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#chats_and_forums">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#chemicals -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#chemicals">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#chemistry -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#chemistry">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#child_health -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#child_health">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#children -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#children">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#classifieds -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#classifieds">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#climbing -->
```

```
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#climbing">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#clothing -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#clothing">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#collecting -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#collecting">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#college_and_university_press -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#college_and_university_press">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#news_and_media"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_hardware -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_hardware">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_and_electronics"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_security -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_security">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_and_electronics"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#conditions_and_diseases -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#conditions_and_diseases">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#construction_and_maintenance -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#construction_and_maintenance">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#consumer_electronics -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#consumer_electronics">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_and_electronics"/>
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#cooking_and_recipes -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#cooking_and_recipes">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_drink"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#cosmetics -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#cosmetics">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty_and_fitness"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#coupons -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#coupons">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#crafts -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#crafts">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#crime_and_prosecution -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#crime_and_prosecution">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#customer_service -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#customer_service">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#cycling_and_biking -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#cycling_and_biking">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#death -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#death">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#dentistry -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#dentistry">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#diagnostic_tests -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#diagnostic_tests">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#dictionaries_and_encyclopedias -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#dictionaries_and_encyclopedias">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reference"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#dietary_supplements -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#dietary_supplements">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#directories -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#directories">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reference"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#disabled_and_special_needs -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#disabled_and_special_needs">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#domain_names_and_register -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#domain_names_and_register">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#drugs_and_therapy -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#drugs_and_therapy">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#e_books -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#e_books">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#books_and_literature"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#e_commerce -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#e_commerce">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#earth_sciences -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#earth_sciences">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#education -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#education">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#career_and_education"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#education_and_resources -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#education_and_resources">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#educational_resources -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#educational_resources">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#email -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#email">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#energy -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#energy">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#engineering_and_technology -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#engineering_and_technology">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#environment -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#environment">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#equestrian -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#equestrian">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#ethnic_and_regional -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#ethnic_and_regional">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#exercise_and_physical_activity -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#exercise_and_physical_activity">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#extreme_sports -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#extreme_sports">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fantasy_sports -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fantasy_sports">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fashion_and_modeling -->
```

```
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fashion_and_modeling">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#file_sharing -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#file_sharing">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#financial_management -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#financial_management">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#finance"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fish_and_aquaria -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fish_and_aquaria">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pets_and_animals"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fishing -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fishing">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fitness -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#fitness">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty_and_fitness"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#flowers -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#flowers">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#folklore -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#folklore">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#books_and_literature"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_grocery_retailers -->
```

```
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_grocery_retailers">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_drink"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#football -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#football">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#furniture -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#furniture">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gardening -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gardening">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_and_garden"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#genealogy -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#genealogy">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#general_merchandise -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#general_merchandise">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gifts -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gifts">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#golf -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#golf">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#government -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#government">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#law_and_government"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#grants_and_scholarships -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#grants_and_scholarships">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#finance"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#graphics_and_multimedia_tools -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#graphics_and_multimedia_tools">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_and_electronics"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#guides_and_reviews -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#guides_and_reviews">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#books_and_literature"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#hair -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#hair">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty_and_fitness"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#healthcare_industry -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#healthcare_industry">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#history -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#history">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#holidays -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#holidays">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_and_garden -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_and_garden">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_improvement -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_improvement">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_and_garden"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#horses -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#horses">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pets_and_animals"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#human_resources -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#human_resources">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#career_and_education"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#humor -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#humor">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#immigration_and_visas -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#immigration_and_visas">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#law_and_government"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#industrial_goods_and_services -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#industrial_goods_and_services">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#instruments_and_supplies -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#instruments_and_supplies">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#insurance -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#insurance">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#finance"/>
```

```
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#interior_decor -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#interior_decor">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_and_garden"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#investing -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#investing">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#finance"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#jewelry -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#jewelry">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#jobs_and_employment -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#jobs_and_employment">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#career_and_education"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#law -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#law">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#law_and_government"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#libraries_and_museums -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#libraries_and_museums">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reference"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#lottery -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#lottery">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gambling"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#magazines_and_e_zines -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#magazines_and_e_zines">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#news_and_media"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#makes_and_models -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#makes_and_models">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#maps -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#maps">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reference"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#marketing_and_advertising -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#marketing_and_advertising">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#martial_arts -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#martial_arts">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#math -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#math">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#medical_equipment_and_sensors -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#medical_equipment_and_sensors">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#medicine -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#medicine">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#mens_health -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#mens_health">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#mental_health -->
```

```
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#mental_health">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#metals_and_mining -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#metals_and_mining">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#military_and_defense -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#military_and_defense">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#law_and_government"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#miniatures -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#miniatures">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#games"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#mobile_developers -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#mobile_developers">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#models -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#models">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#motorcycles -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#motorcycles">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#motorsports -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#motorsports">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#movies -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#movies">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#moving_and_relocating -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#moving_and_relocating">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_and_garden"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#music -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#music">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#music_and_audio -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#music_and_audio">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#networking -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#networking">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_and_electronics"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#newspapers -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#newspapers">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#news_and_media"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#nudism -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#nudism">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#nursery_and_playroom -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#nursery_and_playroom">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#home_and_garden"/>
```

```
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#nutrition -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#nutrition">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#office_products -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#office_products">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#online -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#online">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#games"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#online_marketing -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#online_marketing">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#outdoors -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#outdoors">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#performing_arts -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#performing_arts">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pets -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pets">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pets_and_animals"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pharmacy -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#pharmacy">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#philanthropy -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#philanthropy">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#philosophy -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#philosophy">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#photography -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#photography">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#physics -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#physics">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#poker -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#poker">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gambling"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#products_and_shopping -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#products_and_shopping">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#programming -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#programming">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_and_electronics"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#public_health_and_safety -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#public_health_and_safety">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#publications -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#publications">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#publishing_and_printing -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#publishing_and_printing">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#puzzles_and_brainteasers -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#puzzles_and_brainteasers">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#games"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#real_estate -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#real_estate">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#regulation_and_organizations -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#regulation_and_organizations">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gambling"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#relationships_and_dating -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#relationships_and_dating">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#religion_and_spirituality -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#religion_and_spirituality">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reproductive_health -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#reproductive_health">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#restaurants_and_delivery -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#restaurants_and_delivery">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_drink"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#roads_and_highways -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#roads_and_highways">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#travel"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#roleplaying -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#roleplaying">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#games"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#rugby -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#rugby">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#running -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#running">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#scouting -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#scouting">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#search_engine -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#search_engine">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#senior_health -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#senior_health">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#skin_care -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#skin_care">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty_and_fitness"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#soccer -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#soccer">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#social_network -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#social_network">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#social_sciences -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#social_sciences">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#science"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#software -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#software">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#computer_and_electronics"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gambling"/>
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports_news -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports_news">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#news_and_media"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#technology_news -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#technology_news">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#news_and_media"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#telecommunications -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#telecommunications">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#tennis -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#tennis">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#textiles_and_nonwovens -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#textiles_and_nonwovens">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#theme_parks -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#theme_parks">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#tobacco -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#tobacco">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#tourism -->
<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#tourism">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#travel"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#trains_and_railroads -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#trains_and_railroads">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#autos_and_vehicles"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#transportation_and_logistics -->
<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#transportation_and_logistics">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>
```

```
<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#tv_and_video -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#tv_and_video">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#universities_and_colleges -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#universities_and_colleges">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#career_and_education"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#vegetarian_and_vegan -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#vegetarian_and_vegan">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#food_and_drink"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#video_games -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#video_games">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#games"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#visual_arts_and_design -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#visual_arts_and_design">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#arts_and_entertainment"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#volleyball -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#volleyball">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#water_sports -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#water_sports">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weapons -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weapons">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#recreation_and_hobbies"/>
```

```
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weather -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weather">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#news_and_media"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#web_design -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#web_design">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#web_hosting -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#web_hosting">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#internet_and_telecom"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weddings -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weddings">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#shopping"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weight_loss -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#weight_loss">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#beauty_and_fitness"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#wholesale_trade -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#wholesale_trade">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#business_and_industry"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#winter_sports -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#winter_sports">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#sports"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#womens_health -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#womens_health">
```

```
<rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#health"/>
</owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#womens_interests -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#womens_interests">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#credit_loans_and_mortgages -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#credit_loans_and_mortgages">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#finance"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gay_lesbian_and_bisexual -->

<owl:NamedIndividual
rdf:about="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#gay_lesbian_and_bisexual">
  <rdf:type
rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#people_and_society"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/providers/facebook -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/providers/facebook">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#provider"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/providers/twitter -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/providers/twitter">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#provider"/>
  </owl:NamedIndividual>

<!-- http://carre.kmi.open.ac.uk/providers/web_queries -->

<owl:NamedIndividual rdf:about="http://carre.kmi.open.ac.uk/providers/web_queries">
  <rdf:type rdf:resource="http://carre.kmi.open.ac.uk/ontology/lifestyle.owl#provider"/>
  </owl:NamedIndividual>
</rdf:RDF>

<!-- Generated by the OWL API (version 3.5.0) http://owlapi.sourceforge.net -->
```

2. CARRE educational ontology

```
<?xml version="1.0"?>

<!DOCTYPE Ontology [
  <!ENTITY xsd "http://www.w3.org/2001/XMLSchema#" >
  <!ENTITY xml "http://www.w3.org/XML/1998/namespace" >
  <!ENTITY rdfs "http://www.w3.org/2000/01/rdf-schema#" >
  <!ENTITY rdf "http://www.w3.org/1999/02/22-rdf-syntax-ns#" >
]>

<Ontology xmlns="http://www.w3.org/2002/07/owl#"
  xml:base="https://carre.kmi.open.ac.uk/ontology/educational.owl"
  xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
  xmlns:xml="http://www.w3.org/XML/1998/namespace"
  xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
  xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
  ontologyIRI="https://carre.kmi.open.ac.uk/ontology/educational.owl"
  versionIRI="https://carre.kmi.open.ac.uk/ontology/educational.owl/1.0.0">
  <Prefix name="" IRI="http://www.w3.org/2002/07/owl#" />
  <Prefix name="owl" IRI="http://www.w3.org/2002/07/owl#" />
  <Prefix name="rdf" IRI="http://www.w3.org/1999/02/22-rdf-syntax-ns#" />
  <Prefix name="xsd" IRI="http://www.w3.org/2001/XMLSchema#" />
  <Prefix name="rdfs" IRI="http://www.w3.org/2000/01/rdf-schema#" />
  <Declaration>
    <Class IRI="#enrichment" />
  </Declaration>
  <Declaration>
    <Class IRI="#object" />
  </Declaration>
  <Declaration>
    <Class IRI="#rank" />
  </Declaration>
  <Declaration>
    <Class IRI="#rating" />
  </Declaration>
  <Declaration>
    <Class IRI="#user" />
  </Declaration>
  <Declaration>
    <ObjectProperty IRI="#date_accepted" />
  </Declaration>
  <Declaration>
    <ObjectProperty IRI="#date_ranked" />
  </Declaration>
  <Declaration>
    <ObjectProperty IRI="#date_rated" />
  </Declaration>
  <Declaration>
    <ObjectProperty IRI="#enrichment_for_article" />
  </Declaration>
  <Declaration>
    <ObjectProperty IRI="#for_article" />
  </Declaration>
  <Declaration>
    <ObjectProperty IRI="#rank_for_article" />
  </Declaration>
  <Declaration>
    <ObjectProperty IRI="#rated_by_user" />
  </Declaration>
  <Declaration>
    <ObjectProperty IRI="#rating_for_article" />
  </Declaration>
  <Declaration>
    <DataProperty IRI="#accuracy" />
  </Declaration>
  <Declaration>
    <DataProperty IRI="#alternative_title" />
  </Declaration>
</Ontology>
```

```
</Declaration>
<Declaration>
  <DataProperty IRI="#categories"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#comprehensiveness"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#date"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#depth_of_coverage"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#educational_level"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#icd10"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#language"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#mesh"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#position"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#query"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#rating_criteria"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#relevancy"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#snippet"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#source"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#title"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#total"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#umls"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#url"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#validity"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#views"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#webservice"/>
</Declaration>
<Declaration>
  <DataProperty IRI="#wordcount"/>
</Declaration>
<SubObjectPropertyOf>
  <ObjectProperty IRI="#enrichment_for_article"/>
  <ObjectProperty IRI="#for_article"/>
</SubObjectPropertyOf>
<SubObjectPropertyOf>
  <ObjectProperty IRI="#rank_for_article"/>
  <ObjectProperty IRI="#for_article"/>
</SubObjectPropertyOf>
```

```
</SubObjectPropertyOf>
<SubObjectPropertyOf>
  <ObjectProperty IRI="#rating_for_article"/>
  <ObjectProperty IRI="#for_article"/>
</SubObjectPropertyOf>
<ObjectPropertyDomain>
  <ObjectProperty IRI="#date_accepted"/>
  <Class IRI="#object"/>
</ObjectPropertyDomain>
<ObjectPropertyDomain>
  <ObjectProperty IRI="#date_ranked"/>
  <Class IRI="#rank"/>
</ObjectPropertyDomain>
<ObjectPropertyDomain>
  <ObjectProperty IRI="#date_rated"/>
  <Class IRI="#rating"/>
</ObjectPropertyDomain>
<ObjectPropertyDomain>
  <ObjectProperty IRI="#enrichment_for_article"/>
  <Class IRI="#enrichment"/>
</ObjectPropertyDomain>
<ObjectPropertyDomain>
  <ObjectProperty IRI="#rank_for_article"/>
  <Class IRI="#rank"/>
</ObjectPropertyDomain>
<ObjectPropertyDomain>
  <ObjectProperty IRI="#rated_by_user"/>
  <Class IRI="#rating"/>
</ObjectPropertyDomain>
<ObjectPropertyDomain>
  <ObjectProperty IRI="#rating_for_article"/>
  <Class IRI="#rating"/>
</ObjectPropertyDomain>
<ObjectPropertyRange>
  <ObjectProperty IRI="#date_accepted"/>
  <DataSomeValuesFrom>
    <DataProperty IRI="#date"/>
    <Datatype abbreviatedIRI="xsd:dateTime"/>
  </DataSomeValuesFrom>
</ObjectPropertyRange>
<ObjectPropertyRange>
  <ObjectProperty IRI="#date_ranked"/>
  <DataSomeValuesFrom>
    <DataProperty IRI="#date"/>
    <Datatype abbreviatedIRI="xsd:dateTime"/>
  </DataSomeValuesFrom>
</ObjectPropertyRange>
<ObjectPropertyRange>
  <ObjectProperty IRI="#date_rated"/>
  <DataSomeValuesFrom>
    <DataProperty IRI="#date"/>
    <Datatype abbreviatedIRI="xsd:dateTime"/>
  </DataSomeValuesFrom>
</ObjectPropertyRange>
<ObjectPropertyRange>
  <ObjectProperty IRI="#enrichment_for_article"/>
  <Class IRI="#object"/>
</ObjectPropertyRange>
<ObjectPropertyRange>
  <ObjectProperty IRI="#for_article"/>
  <Class IRI="#object"/>
</ObjectPropertyRange>
<ObjectPropertyRange>
  <ObjectProperty IRI="#rank_for_article"/>
  <Class IRI="#object"/>
</ObjectPropertyRange>
<ObjectPropertyRange>
  <ObjectProperty IRI="#rated_by_user"/>
  <Class IRI="#user"/>
</ObjectPropertyRange>
<ObjectPropertyRange>
  <ObjectProperty IRI="#rating_for_article"/>
  <Class IRI="#object"/>
</ObjectPropertyRange>
```

```
<SubDataPropertyOf>
  <DataProperty IRI="#accuracy"/>
  <DataProperty IRI="#rating_criteria"/>
</SubDataPropertyOf>
<SubDataPropertyOf>
  <DataProperty IRI="#comprehensiveness"/>
  <DataProperty IRI="#rating_criteria"/>
</SubDataPropertyOf>
<SubDataPropertyOf>
  <DataProperty IRI="#depth_of_coverage"/>
  <DataProperty IRI="#rating_criteria"/>
</SubDataPropertyOf>
<SubDataPropertyOf>
  <DataProperty IRI="#educational_level"/>
  <DataProperty IRI="#rating_criteria"/>
</SubDataPropertyOf>
<SubDataPropertyOf>
  <DataProperty IRI="#relevancy"/>
  <DataProperty IRI="#rating_criteria"/>
</SubDataPropertyOf>
<SubDataPropertyOf>
  <DataProperty IRI="#validity"/>
  <DataProperty IRI="#rating_criteria"/>
</SubDataPropertyOf>
<DataPropertyDomain>
  <DataProperty IRI="#accuracy"/>
  <Class IRI="#rating"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#alternative_title"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#categories"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#comprehensiveness"/>
  <Class IRI="#rating"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#depth_of_coverage"/>
  <Class IRI="#rating"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#educational_level"/>
  <Class IRI="#rating"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#icd10"/>
  <Class IRI="#enrichment"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#language"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#mesh"/>
  <Class IRI="#enrichment"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#position"/>
  <Class IRI="#rank"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#query"/>
  <Class IRI="#rank"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#rating_criteria"/>
  <Class IRI="#rating"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#relevancy"/>
```

```
<Class IRI="#rating"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#snippet"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#source"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#title"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#total"/>
  <Class IRI="#rank"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#umls"/>
  <Class IRI="#enrichment"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#url"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#validity"/>
  <Class IRI="#rating"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#views"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#webservice"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyDomain>
  <DataProperty IRI="#wordcount"/>
  <Class IRI="#object"/>
</DataPropertyDomain>
<DataPropertyRange>
  <DataProperty IRI="#accuracy"/>
  <Datatype abbreviatedIRI="xsd:nonNegativeInteger"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#alternative_title"/>
  <Datatype abbreviatedIRI="xsd:string"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#categories"/>
  <Datatype abbreviatedIRI="xsd:string"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#comprehensiveness"/>
  <Datatype abbreviatedIRI="xsd:nonNegativeInteger"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#date"/>
  <Datatype abbreviatedIRI="xsd:dateTime"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#depth_of_coverage"/>
  <Datatype abbreviatedIRI="xsd:nonNegativeInteger"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#educational_level"/>
  <Datatype abbreviatedIRI="xsd:nonNegativeInteger"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#icd10"/>
  <Datatype abbreviatedIRI="xsd:string"/>
</DataPropertyRange>
```

```
<DataPropertyRange>
  <DataProperty IRI="#language"/>
  <Datatype abbreviatedIRI="xsd:language"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#mesh"/>
  <Datatype abbreviatedIRI="xsd:string"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#position"/>
  <Datatype abbreviatedIRI="xsd:integer"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#query"/>
  <Datatype abbreviatedIRI="xsd:string"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#relevancy"/>
  <Datatype abbreviatedIRI="xsd:nonNegativeInteger"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#snippet"/>
  <Datatype abbreviatedIRI="xsd:string"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#source"/>
  <Datatype abbreviatedIRI="rdfs:Literal"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#title"/>
  <Datatype abbreviatedIRI="xsd:string"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#total"/>
  <Datatype abbreviatedIRI="xsd:nonNegativeInteger"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#umls"/>
  <Datatype abbreviatedIRI="xsd:string"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#url"/>
  <Datatype abbreviatedIRI="xsd:anyURI"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#validity"/>
  <Datatype abbreviatedIRI="xsd:nonNegativeInteger"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#views"/>
  <Datatype abbreviatedIRI="xsd:integer"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#webservice"/>
  <Datatype abbreviatedIRI="xsd:anyURI"/>
</DataPropertyRange>
<DataPropertyRange>
  <DataProperty IRI="#wordcount"/>
  <Datatype abbreviatedIRI="xsd:integer"/>
</DataPropertyRange>
<DisjointDataProperties>
  <DataProperty IRI="#icd10"/>
  <DataProperty IRI="#mesh"/>
</DisjointDataProperties>
<DisjointDataProperties>
  <DataProperty IRI="#icd10"/>
  <DataProperty IRI="#umls"/>
</DisjointDataProperties>
<DisjointDataProperties>
  <DataProperty IRI="#mesh"/>
  <DataProperty IRI="#umls"/>
</DisjointDataProperties>
<AnnotationAssertion>
  <AnnotationProperty abbreviatedIRI="rdfs:label"/>
```

```

    <IRI>#icd10</IRI>
    <Literal datatypeIRI="&xsd:anyURI">ICD10</Literal>
  </AnnotationAssertion>
</AnnotationAssertion>
  <AnnotationProperty abbreviatedIRI="rdfs:label"/>
  <IRI>#mesh</IRI>
  <Literal datatypeIRI="&xsd:anyURI">MESH</Literal>
</AnnotationAssertion>
</AnnotationAssertion>
  <AnnotationProperty abbreviatedIRI="rdfs:label"/>
  <IRI>#object</IRI>
  <IRI>#object</IRI>
</AnnotationAssertion>
</AnnotationAssertion>
  <AnnotationProperty abbreviatedIRI="rdfs:label"/>
  <IRI>#umls</IRI>
  <Literal datatypeIRI="&xsd:anyURI">UMLS</Literal>
</AnnotationAssertion>
</Ontology>

<!-- Generated by the OWL API (version 3.5.1) http://owlapi.sourceforge.net -->

```

2.1. RDF results Example #1

```

<rdf:RDF xmlns:res="http://www.w3.org/2005/sparql-results#"
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
<rdf:Description rdf:nodeID="rset">
<rdf:type rdf:resource="http://www.w3.org/2005/sparql-results#ResultSet" />
  <res:resultVariable>Article</res:resultVariable>
  <res:resultVariable>Rating</res:resultVariable>
  <res:resultVariable>Url</res:resultVariable>
  <res:resultVariable>Source</res:resultVariable>
  <res:resultVariable>Query</res:resultVariable>
  <res:solution rdf:nodeID="r0">
    <res:binding rdf:nodeID="r0c0"><res:variable>Article</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Myocardial infarction</res:value></res:binding>
    <res:binding rdf:nodeID="r0c1"><res:variable>Rating</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#decimal">5</res:value></res:binding>
    <res:binding rdf:nodeID="r0c2"><res:variable>Url</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Myocardial_infarction"/></res:binding>
    <res:binding rdf:nodeID="r0c3"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
    <res:binding rdf:nodeID="r0c4"><res:variable>Query</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">acute kidney injury</res:value></res:binding>
  </res:solution>
  <res:solution rdf:nodeID="r1">
    <res:binding rdf:nodeID="r1c0"><res:variable>Article</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Analgesic nephropathy</res:value></res:binding>
    <res:binding rdf:nodeID="r1c1"><res:variable>Rating</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#decimal">4.5</res:value></res:binding>
    <res:binding rdf:nodeID="r1c2"><res:variable>Url</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Analgesic_nephropathy"/></res:binding>
    <res:binding rdf:nodeID="r1c3"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
    <res:binding rdf:nodeID="r1c4"><res:variable>Query</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">acute kidney injury</res:value></res:binding>
  </res:solution>
  <res:solution rdf:nodeID="r2">
    <res:binding rdf:nodeID="r2c0"><res:variable>Article</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Acute kidney injury</res:value></res:binding>
    <res:binding rdf:nodeID="r2c1"><res:variable>Rating</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#decimal">4.5</res:value></res:binding>
    <res:binding rdf:nodeID="r2c2"><res:variable>Url</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Acute_kidney_injury"/></res:binding>
    <res:binding rdf:nodeID="r2c3"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
    <res:binding rdf:nodeID="r2c4"><res:variable>Query</res:variable><res:value

```

```

datatype="http://www.w3.org/2001/XMLSchema#string">acute kidney injury</res:value></res:binding>
</res:solution>
<res:solution rdf:nodeID="r3">
  <res:binding rdf:nodeID="r3c0"><res:variable>Article</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Transplant rejection</res:value></res:binding>
  <res:binding rdf:nodeID="r3c1"><res:variable>Rating</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#decimal">4.333333333333333</res:value></res:binding>
  <res:binding rdf:nodeID="r3c2"><res:variable>Url</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Transplant_rejection"/></res:binding>
  <res:binding rdf:nodeID="r3c3"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
  <res:binding rdf:nodeID="r3c4"><res:variable>Query</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">acute kidney injury</res:value></res:binding>
</res:solution>
<res:solution rdf:nodeID="r4">
  <res:binding rdf:nodeID="r4c0"><res:variable>Article</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Glomerulonephritis</res:value></res:binding>
  <res:binding rdf:nodeID="r4c1"><res:variable>Rating</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#decimal">4.166666666666667</res:value></res:binding>
  <res:binding rdf:nodeID="r4c2"><res:variable>Url</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Glomerulonephritis"/></res:binding>
  <res:binding rdf:nodeID="r4c3"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
  <res:binding rdf:nodeID="r4c4"><res:variable>Query</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">acute kidney injury</res:value></res:binding>
</res:solution>
</rdf:Description>
</rdf:RDF>

```

2.2. RDF results Example #2

```

<rdf:RDF xmlns:res="http://www.w3.org/2005/sparql-results#"
xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#">
<rdf:Description rdf:nodeID="rset">
<rdf:type rdf:resource="http://www.w3.org/2005/sparql-results#ResultSet" />
  <res:resultVariable>Educational_Resource</res:resultVariable>
  <res:resultVariable>Source</res:resultVariable>
  <res:resultVariable>Resource_URL</res:resultVariable>
  <res:resultVariable>Risk_Element</res:resultVariable>
  <res:solution rdf:nodeID="r0">
    <res:binding rdf:nodeID="r0c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Comorbidity</res:value></res:binding>
    <res:binding rdf:nodeID="r0c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
    <res:binding rdf:nodeID="r0c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Comorbidity"/></res:binding>
    <res:binding rdf:nodeID="r0c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/progression_of_ckd"/></res:binding>
  </res:solution>
  <res:solution rdf:nodeID="r1">
    <res:binding rdf:nodeID="r1c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Schizophrenia</res:value></res:binding>
    <res:binding rdf:nodeID="r1c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
    <res:binding rdf:nodeID="r1c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Schizophrenia"/></res:binding>
    <res:binding rdf:nodeID="r1c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/depression"/></res:binding>
  </res:solution>
  <res:solution rdf:nodeID="r2">
    <res:binding rdf:nodeID="r2c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Kidney disease</res:value></res:binding>
    <res:binding rdf:nodeID="r2c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
    <res:binding rdf:nodeID="r2c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Kidney_disease"/></res:binding>
    <res:binding rdf:nodeID="r2c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/acute_kidney_injury"/></res:binding>
  </res:solution>

```

```
<res:solution rdf:nodeID="r3">
  <res:binding rdf:nodeID="r3c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Kidney disease</res:value></res:binding>
  <res:binding rdf:nodeID="r3c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
  <res:binding rdf:nodeID="r3c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Kidney_disease"/></res:binding>
  <res:binding rdf:nodeID="r3c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/chronic_kidney_disease"/></res:binding>
</res:solution>
<res:solution rdf:nodeID="r4">
  <res:binding rdf:nodeID="r4c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Atrial fibrillation</res:value></res:binding>
  <res:binding rdf:nodeID="r4c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
  <res:binding rdf:nodeID="r4c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Atrial_fibrillation"/></res:binding>
  <res:binding rdf:nodeID="r4c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/atrial_fibrillation"/></res:binding>
</res:solution>
<res:solution rdf:nodeID="r5">
  <res:binding rdf:nodeID="r5c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Renal failure</res:value></res:binding>
  <res:binding rdf:nodeID="r5c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
  <res:binding rdf:nodeID="r5c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Renal_failure"/></res:binding>
  <res:binding rdf:nodeID="r5c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/heart_failure"/></res:binding>
</res:solution>
<res:solution rdf:nodeID="r6">
  <res:binding rdf:nodeID="r6c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Renal failure</res:value></res:binding>
  <res:binding rdf:nodeID="r6c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
  <res:binding rdf:nodeID="r6c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Renal_failure"/></res:binding>
  <res:binding rdf:nodeID="r6c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/acute_kidney_injury"/></res:binding>
</res:solution>
<res:solution rdf:nodeID="r7">
  <res:binding rdf:nodeID="r7c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Urinary Tract
Infections</res:value></res:binding>
  <res:binding rdf:nodeID="r7c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">medlineplus</res:value></res:binding>
  <res:binding rdf:nodeID="r7c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://www.nlm.nih.gov/medlineplus/urinarytractinfections.html"/></res:binding>
  <res:binding rdf:nodeID="r7c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/acute_kidney_injury"/></res:binding>
</res:solution>
<res:solution rdf:nodeID="r8">
  <res:binding rdf:nodeID="r8c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Kidney Diseases</res:value></res:binding>
  <res:binding rdf:nodeID="r8c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">medlineplus</res:value></res:binding>
  <res:binding rdf:nodeID="r8c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://www.nlm.nih.gov/medlineplus/kidneydiseases.html"/></res:binding>
  <res:binding rdf:nodeID="r8c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/acute_kidney_injury"/></res:binding>
</res:solution>
<res:solution rdf:nodeID="r9">
  <res:binding rdf:nodeID="r9c0"><res:variable>Educational_Resource</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">Acute kidney injury</res:value></res:binding>
  <res:binding rdf:nodeID="r9c1"><res:variable>Source</res:variable><res:value
datatype="http://www.w3.org/2001/XMLSchema#string">wikipedia</res:value></res:binding>
  <res:binding rdf:nodeID="r9c2"><res:variable>Resource_URL</res:variable><res:value
rdf:resource="http://en.wikipedia.org/wiki/Acute_kidney_injury"/></res:binding>
  <res:binding rdf:nodeID="r9c3"><res:variable>Risk_Element</res:variable><res:value
rdf:resource="http://carre.kmi.open.ac.uk/elements/acute_kidney_injury"/></res:binding>
</res:solution>
</rdf:Description>
</rdf:RDF>
```