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Report on ontology

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Fruits and vegetables : seasonality and locality for a better consumption

Link to download the ontology :

Github repository

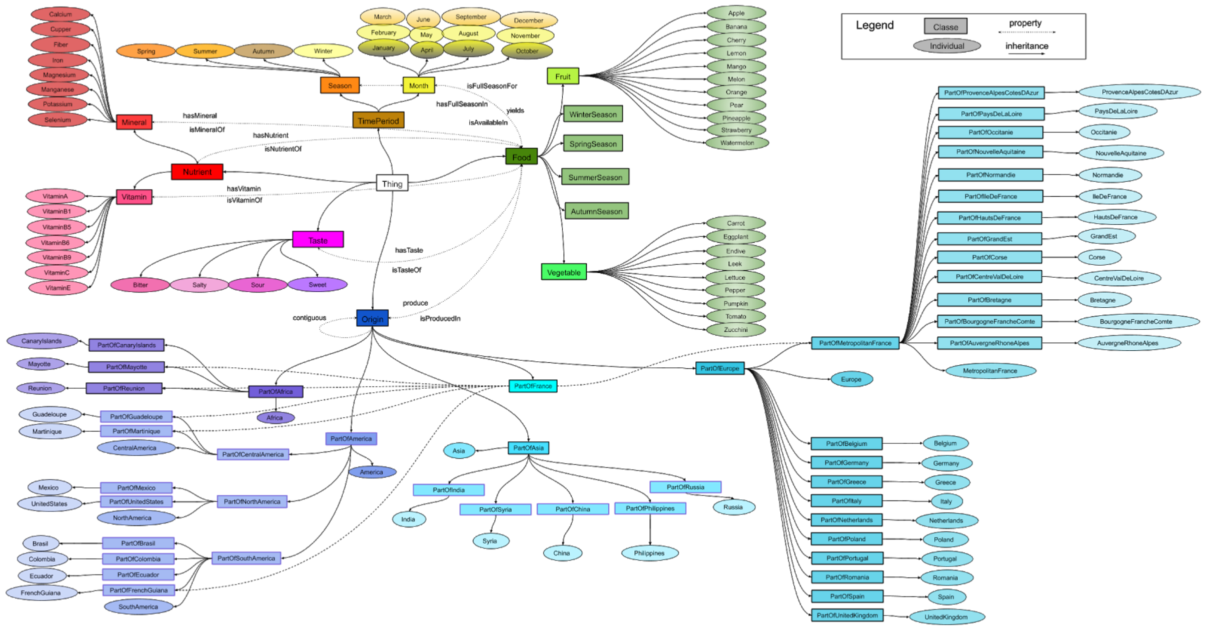
1. Description of the problem

Nowadays people try to change their consumption to reduce their ecological footprint. The goal of our ontology is to help a most eco-friendly consumption of fruits and vegetables. The knowledge gathered in the ontology enables a user to choose local and seasonal fruits and vegetables according to their tastes and nutritional properties.

This ontology is centered on the four weather seasons of Western Europe and localities are specified by countries or regions of Metropolitan France. We made the choice to center it in France and in Europe as we want to encourage people to consume local food. Hence, it falls within the scope of the 12th United Nations Sustainable Development Goal, tackling in particular the problem B9 : "Supporting local entrepreneurs and fair trade".

Most of the data originates from https://www.lesfruitsetlegumesfrais.com/. All the components are available with both English and French labels.

2. Main classes



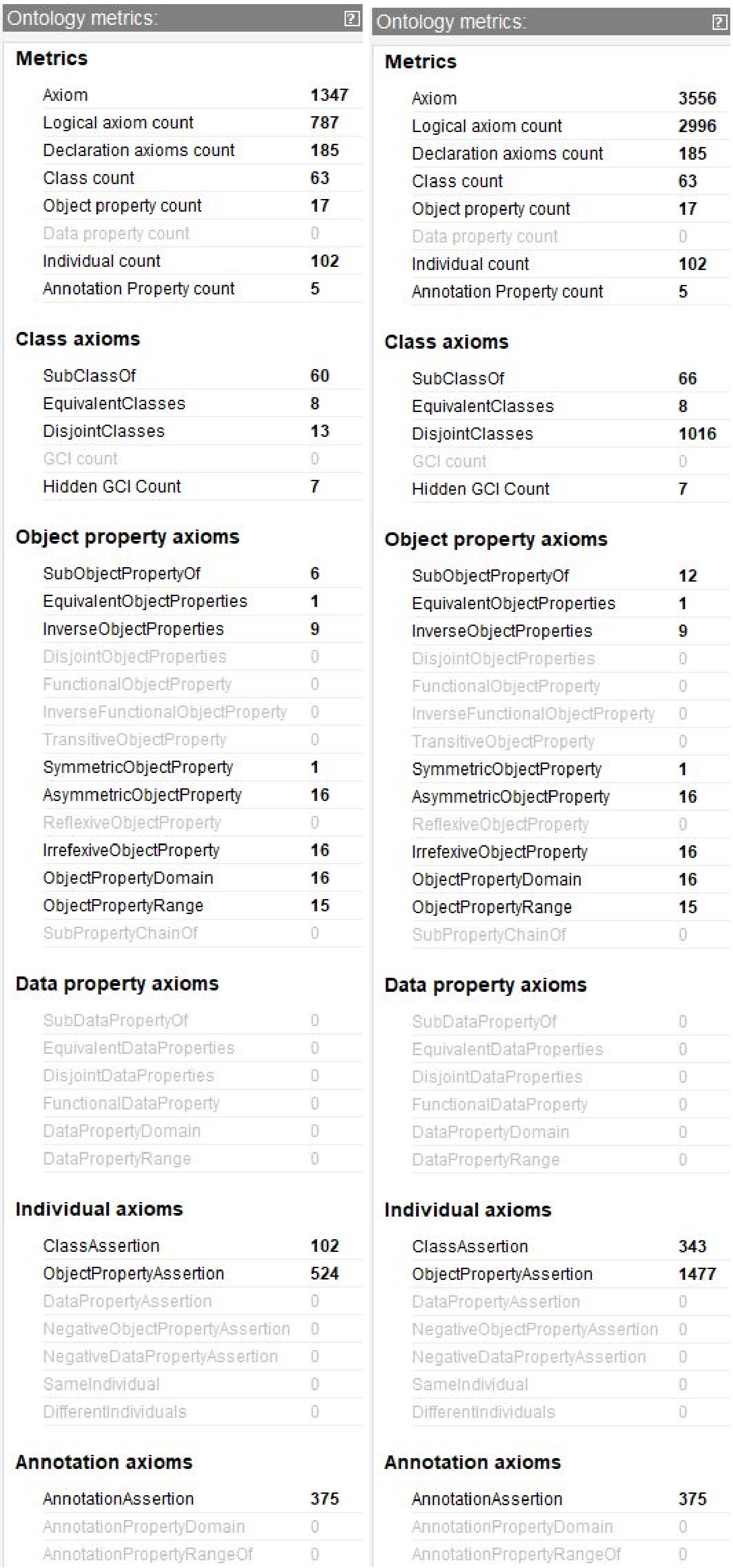
Graph of the classes

The main classes are **Food**, **TimePeriod**, **Origin**, **Nutrient** and **Taste**.

- The class **Food** contains the subclasses **Fruit** and **Vegetable**. They respectively contain culinary fruits (vegetables), which means the plants cooked and consumed as vegetables. **SummerProduct** and its siblings for the three other seasons gather the individuals which are in full season in at least one of the months of this season.
- **TimePeriod** contains **Season** and **Month**. They are linked with the property **hasMonth**, which is **belongsToSeason** inverse. More importantly, they are used to add seasonal information to Food instances : a fruit or vegetable **isAvailableIn** a given month and in some cases it also **hasFullSeasonIn** this particular month.
- The **Origin** corresponds to the possible locations where the food is produced. Initially, we modeled regions as classes with respect to their nesting, as **PartOf...** : regions, in countries, in continents. For the origin, we chose a french point of view and France is the only country divided in regions. We distinguish the **PartOfMetropolitanFrance** from the **PartOfFrance** class. The former is included in the latter, along with overseas regions which do not meet our geographical needs. Neighboring regions and countries are linked with the property **contiguous** - which is symmetric and reflexive for each location.
  To infer the inverse properties of food production (**produce** and **isProducedIn**), we added individuals at all levels - but the main structure remains for it is readable and can be easily extended with precise territorial decomposition, by adding subregions.
- Finally, **Nutrient** and **Taste** give additional characteristics to fruits and vegetables, and link them with the explicit **hasTaste** and **hasNutrient** and their inverse. The latter is decomposed in two sub properties **hasMineral** and **hasVitamin**.

3. Classification power

After running the HermiT reasoner lots of axioms have been generated. The generated axioms are all logical axioms : disjoint classes axioms, objects properties assertions, class assertion and subobjects property of.



Ontology metrics:

Metrics

Axiom	1347
Logical axiom count	787
Declaration axioms count	185
Class count	63
Object property count	17
Data property count	0
Individual count	102
Annotation Property count	5

Class axioms

SubClassOf	60
EquivalentClasses	8
DisjointClasses	13
GCI count	0
Hidden GCI Count	7

Object property axioms

SubObjectPropertyOf	6
EquivalentObjectProperties	1
InverseObjectProperties	9
DisjointObjectProperties	0
FunctionalObjectProperty	0
InverseFunctionalObjectProperty	0
TransitiveObjectProperty	0
SymmetricObjectProperty	1
AsymmetricObjectProperty	16
ReflexiveObjectProperty	0
IrrefexiveObjectProperty	16
ObjectPropertyDomain	16
ObjectPropertyRange	15
SubPropertyChainOf	0

Data property axioms

SubDataPropertyOf	0
EquivalentDataProperties	0
DisjointDataProperties	0
FunctionalDataProperty	0
DataPropertyDomain	0
DataPropertyRange	0

Individual axioms

ClassAssertion	102
ObjectPropertyAssertion	524
DataPropertyAssertion	0
NegativeObjectPropertyAssertion	0
NegativeDataPropertyAssertion	0
SameIndividual	0
DifferentIndividuals	0

Annotation axioms

AnnotationAssertion	375
AnnotationPropertyDomain	0
AnnotationPropertyRangeOf	0

Ontology metrics:

Metrics

Axiom	3556
Logical axiom count	2996
Declaration axioms count	185
Class count	63
Object property count	17
Data property count	0
Individual count	102
Annotation Property count	5

Class axioms

SubClassOf	66
EquivalentClasses	8
DisjointClasses	1016
GCI count	0
Hidden GCI Count	7

Object property axioms

SubObjectPropertyOf	12
EquivalentObjectProperties	1
InverseObjectProperties	9
DisjointObjectProperties	0
FunctionalObjectProperty	0
InverseFunctionalObjectProperty	0
TransitiveObjectProperty	0
SymmetricObjectProperty	1
AsymmetricObjectProperty	16
ReflexiveObjectProperty	0
IrrefexiveObjectProperty	16
ObjectPropertyDomain	16
ObjectPropertyRange	15
SubPropertyChainOf	0

Data property axioms

SubDataPropertyOf	0
EquivalentDataProperties	0
DisjointDataProperties	0
FunctionalDataProperty	0
DataPropertyDomain	0
DataPropertyRange	0

Individual axioms

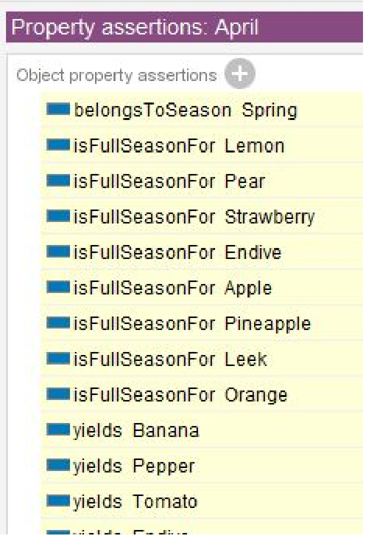
ClassAssertion	343
ObjectPropertyAssertion	1477
DataPropertyAssertion	0
NegativeObjectPropertyAssertion	0
NegativeDataPropertyAssertion	0
SameIndividual	0
DifferentIndividuals	0

Annotation axioms

AnnotationAssertion	375
AnnotationPropertyDomain	0
AnnotationPropertyRangeOf	0

Figure : Comparison of the ontology metrics before (on the left) and after (on the right) running the reasoner - Screenshots from Protégé

4. Exemple



Property assertions: April

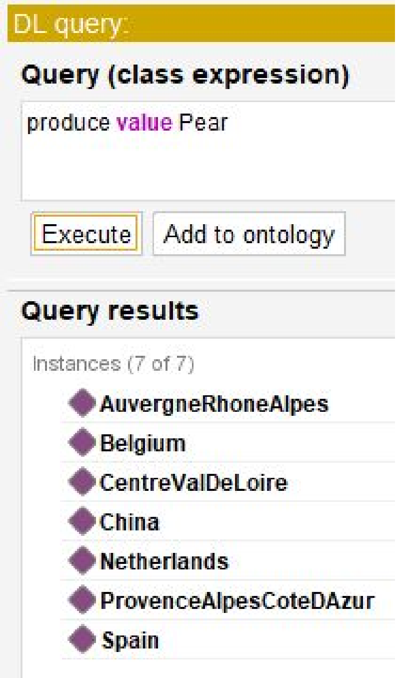
Object property assertions

- belongsToSeason Spring
- isFullSeasonFor Lemon
- isFullSeasonFor Pear
- isFullSeasonFor Strawberry
- isFullSeasonFor Endive
- isFullSeasonFor Apple
- isFullSeasonFor Pineapple
- isFullSeasonFor Leek
- isFullSeasonFor Orange
- yields Banana
- yields Pepper
- yields Tomato

In this part, we show some use cases of our ontology.

Let's find what we can preferably eat in April. In Protégé, select the **April** individual. After running the reasoner, we can read the newly inferred properties. In particular, we see the fruits and vegetables we can find - after **yields** property - and more importantly what the best to eat are - after **isFullSeasonFor** (**Lemon**, **Pear**, **Strawberry**, **Endive**...). See figure to the left.

For example, we could buy pears. To know where this fruit is produced, we can click on the corresponding individual and find this information after **isProducedIn** property. To extract it more precisely, DL queries can be used. In the "DL Query" menu, make sure you select the right checkbox to query for "Instances". With the command "*produce value Pear*", you access all the registered possible **Origin** for pears. See figure to the right.



DL query:

Query (class expression)

produce value Pear

Query results

Instances (7 of 7)

- AuvergneRhoneAlpes
- Belgium
- CentreValDeLoire
- China
- Netherlands
- ProvenceAlpesCoteDAzur
- Spain

Now, we want to restrict to French local products. Enter "*isProducedIn some PartOfMetropolitanFrance*". Note that if we used **PartOfFrance** instead, it would also contribute to French economy (which is not the goal here), but it would allow non local products, coming for example from Guadeloupe or La Réunion.

If you live in the region Hauts-de-France, you should favor local endives, for example (use the query "*isProducedIn value HautsDeFrance*"). You can add variety by allowing products coming from neighboring regions : "*isProducedIn some (contiguous value HautsDeFrance)*" yields **Endive**, but also **Carrot** and **Leek** produced in **Normandy**, which is contiguous to **HautsDeFrance**.

Finally, we can try more complicated examples. "AutumnProduct and (isProducedIn some PartOfEurope) and (hasTaste value Sweet) and (hasVitamin value VitaminE)" yields **Apple** and **Pumpkin**. "*(hasFullSeason value October) and (hasMineral value Cupper) and (isProducedIn some (contiguous value IleDeFrance))*" yields only **Leek**. "*(hasMineral value Magnesium) and* *(isProducedIn value Belgium)*" yields nothing : it does not mean that no product exists with these characteristics since we work with the Open-World Assumption, and with limited samples, but it can always be added one day in this ontology.

5. Improvements

Our ontology may be improved by adding more information, so the ontology deals with more fields linked to the responsible consumption of fruits and vegetables. It could be extended with related features: storage conditions and ways to regulate temperature, light or humidity; consumption information like mode (raw, baked) and water/CO2 expenses; or cooking information such as baking time, peeling or pitting. The ontology can also be enhanced by adding more fruits and vegetables to the database.