

# Alcoholic Drinks Ontology

## Introduction

This ontology will collate facts and relationships surrounding things that are generally agreed by citizens of the UK to be part of the group of things formally known as **alcoholic drinks**. More specifically the ontology will consist largely of drinks popular in the UK and will only include drinks which have some alcohol content greater than 1% by volume. The ontology will allow queries to be made by a user or agent for a selection of competency questions, these include but are not limited to the following. In some cases the queries will simply be responded to by repetition of a rule, in others reasoning would be used to resolve the truth value for a statement.

Where *Russian Vodka* is a single member of the knowledge base, and could be any given drink that in this world is bound by the rules and relationships set out in the ontology:

What colour is <i>Russian Vodka</i> ?	What ingredient makes the alcohol in <i>Russian Vodka</i> ?
What is the origin of <i>Russian Vodka</i> ?	Does <i>Russian Vodka</i> go well with a curry?
Which Alcoholic Drinks owe their alcohol content to Barley?	What ingredients does <i>Russian Vodka</i> have?

## Scope

Alcoholic drinks will be formalised within a limited scope, the key concepts and relationships below. This ontology will use the Open World Assumption, i.e. if the knowledge base reports that fact that *Lager* goes well with *Chicken Curry* and makes no further mentions of other dishes that it accompanies well this does not mean that one finding themselves with a *Lager* would, according to the ontology, be recommended to seek out a *Chicken Curry* with exclusive prejudice, the fact that other dishes not mentioned in the ontology go well with *Lager* is possible. Similarly food dishes are explicit and facts and relationships mentioned relate to that specific dish, with *Chicken Curry*'s properties having no impact on the properties of *Lamb Curry*.

## Key Concepts

### Drinks

Throughout this ontology and report drinks will refer to Alcoholic Drinks, by definition a consumable liquid that is currently available in the UK, availability is out of the scope of the ontology and this reference merely limits the objects described to those that, informally, have been consumed by at least one person in the UK within the last month.

### Colour

The colour of the object, under natural light conditions (daylight or electric light).

The scope here will be limited to observed colour, other concepts such as **Pale** will remain disconnected from the colour, i.e. Open World Assumption allows an *Indian Pale Ale* to be *Red* in colour.

### Ingredients

Ingredients will be a key theme for this ontology, with a distinction between the main ingredient that is fermented to produce the alcoholic content for each drink (rice, barley)<sup>1</sup> and other ingredients that add flavouring or function as a preservative.

### Alcohol Source

A member of the complete (super)set of **Ingredients** in the knowledge base. The ingredient that is responsible for the presence of alcohol in the drink, during brewing, distillation and/or fermentation. Each drink must have at least one ingredient with the property of being an alcohol source. Drinks can of course have other ingredients.

### Food

Limited in scope to a finite selection of dishes available from at least one restaurant / food outlet in the UK. Again this is based in limited personal research and included as a marker for the dishes existence in the current diet of people (or at least some people) in the UK. Each dish will be a member of a group of dishes that roughly describes flavour and/or 'spiciness'.

### Origin

The first country in the world to produce this drink. The origin recorded will represent available information from basic research, informally the use of "average opinion" resources such as Wikipedia. This means that in some cases the origin recorded may represent the place which is most commonly believed to be the origin of a drink, which for the purposes of this ontology is likely to be more relevant than any 'trivia' challenging common misconceptions.

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## Drink Type

High level categories for alcoholic drinks, e.g. Wine, Beer. Some sub categories exists also e.g. Beer = (Porter, Lager, Ale...). If a drink is of a type with sub types, then it must have one and only one of the subtype. I.e. in the previous example *Drink is a beer* would be invalid due to the sub categories, *Beer is an ale* would be correct.

## Key Relationships

- *Russian Vodka goes well with food Caviar*
- *Russian Vodka has at least one of the properties:*
  - *Colour*
  - *Alcohol Source*
  - *Origin*
  - *DrinkType*
- *Russian Vodka is of colour transparent*
- *Drinks of colour transparent go well with Caviar*

This association between a group of drinks based on commonality in colour will allow the knowledge base to reason deductively through more than one level of information, as in the example above where because we know that because *transparency* in a drink suggests that it **goes well** with Caviar, *Russian Vodka* will therefore go well with *Caviar*. This and other relationships are formally set out in the later sections of the report.

## Specification of Concept Hierarchy

The figure below outlines the concepts in my ontology. Disjoint classes are shown on the figure for one example, Red Wine which was selected as the screenshot was taken.



To reiterate and clarify Description Logic is used in the following formulae to express some class / subclass hierarchy.

FruitBeer  $\sqsubseteq$  BeerDrink

Stout  $\sqsubseteq$  BeerDrink

Ale  $\sqsubseteq$  BeerDrink

Ale  $\sqsubseteq$  Drink

Lager  $\sqsubseteq$  BeerDrink

Porter  $\sqsubseteq$  BeerDrink

And a couple of examples of the information represented in first order logic.

$\forall x (\text{FriedFoodDish}(x) \rightarrow \text{Food}(x))$

$\forall x (\text{Lager}(x) \rightarrow \neg \text{Wine}(x))$

And some examples of the disjunction that exists in the ontology.

$\neg(\exists x \text{FriedFoodDish}(x) \wedge \text{Wine}(x))$

Relationships between Drink Attributes and Drinks / Types will be expressed in further sections, there is no link from this diagram between a drink and it's implied properties.

## Identification of Relations

Relationships in this ontology are predominantly “member of” or “had property” links. The relations can be considered in two groups, a link from a drink to a property or a link from a drink to a super-class determining type or higher category.

**Drink to Property** Relations, with an example for each:

**hasColour**(*IndianPaleAle*, *StawColour*)

**hasIngredient**(*RussianVodka*, *Water*)

**hasAlcoholSource**(*RussianVodka*, *Grain*)

Note that members of the relation AlcoholSource also come from the object class **Ingredient**.

**hasOrigin**(*RussianVodka*, *Russia*)

**goesWellWith**(*Lager*, *ChickenCurry*)

**isType** (*Fosters*, *Beer*)

Relations of membership exist between individual drinks, eg *Stella* and super classes they reside within. These relationships are expressed in the concept diagrams.

## Semantic Domain Axioms

This section contains examples of axioms that constrain and describe this ontology.

To begin I will express what properties a **drink** must have:

All **drinks** have:

At least one: **Ingredient**  
Only one: **Origin, Colour**

$$\forall x (\text{Drink}(x) \rightarrow (\exists c \text{ hasColour}(x,c) \wedge \exists o \text{ hasOrigin}(x,o) \wedge \exists i \text{ hasIngredient}(x,i) )$$

### Implicit Axioms

These rules are implied by the class hierarchy structure but could also be represented with description logic.

$$\forall x [\text{WineDrink}(x) \rightarrow \text{Drink}(x)]$$

$$\forall x [\text{BeerDrink}(x) \rightarrow \text{Drink}(x)]$$

$$\forall x [\text{SpiritDrink}(x) \rightarrow \text{Drink}(x)]$$

$$\forall x [\text{FruitBeerDrink}(x) \rightarrow \text{Drink}(x)]$$

$$\forall x [\text{StoutBeerDrink}(x) \rightarrow \text{Drink}(x)]$$

$$\forall x [\text{FruitBeerDrink}(x) \rightarrow \text{isType}(x, \text{Beer})]$$

$$\forall x [\text{StoutBeerDrink}(x) \rightarrow \text{isType}(x, \text{Beer})]$$

$$\forall x [\text{RoseWine}(x) \rightarrow \text{isType}(x, \text{Wine})]$$

## Relation Axioms

**goesWellWith** is an optional relation that not all drinks have. It can be used to pair **drinks** with **dishes** it can also pair a **DrinkType** with a dish or similarly a **Colour**.

The relation can be used inherently as below:

Beer goes well with SpicyFood

If Stella is a Beer then Stella goes with Chicken curry

**Stella(x)**

**isType(x, Beer)**

**goesWellWith(Beer, SpicyFood)**

so we can deduce:

$\forall x \text{ isType}(x, \text{Beer}) \rightarrow \text{goesWellWith}(x, \text{SpicyFood})$

The super-class Beer can be expressed as going well with SpicyFood, it can then be deduced that FruitBeer goes well with SpicyFood.

## Evaluation

There is some potential for the ontology to aid the deduction of facts that are not explicitly declared, for example the relation between DrinkTypes and FoodDishes makes implications about any child classes under the three main types of dish. Inheritance from the super-class allows **goes well with** information to be encoded at a higher level.

*SpiritDrink goes well with SpicyFoodDish*

Allows the deduction to be made that:

If Chicken Curry is a SpicyFood it will be well accompanied by a glass of *Russian Vodka*

Or more formally:

isFoodType (ChickenCurry, SpicyFood)

This deductive potential is limited and the ontology has potential for expansion. For example it is not possible with the current structure to suggest what *colour* a given *beer* would be. The domain provides robust models for this in some cases, e.g. Stout beer can safely be assumed to always be a member of the descriptive super-class DarkColourThing, and so a good expansion would be to encode the fact that Stouts will always be dark in colour, IPA's will always be pale and light etc.

Another limitation in the construction is apparent when considering inheritance of properties on the relation **goesWellWith**, in the case of **Beer** an expansion and improvement of the ontology should allow exceptions to be made as shown below:

*“Beer generally goes well with Spicy Food but Fruit beers do not”*

Of course this information can be encoded as an axiom, but a change to the structural design would be more preferable.

A further limitation in the scope of this ontology will be hybrid drinks, for example a Stout beer make primarily of Strawberries.

## References

Beer Colours:

<http://www.colourlovers.com/blog/2007/07/23/color-inspiration-from-ales-lagers-stouts-beer/>

[http://en.wikipedia.org/wiki/Beer\\_style#Ale](http://en.wikipedia.org/wiki/Beer_style#Ale)

<http://www.beerexpert.co.uk/BeerTypesCategory.html>

Inspired by the Wine and Pizza ontologies, with some structural elements used from:

<http://www.w3.org/2001/sw/WebOnt/guide-src/wine.rdf>

and

<http://www.co-ode.org/ontologies/pizza/2007/02/12/>