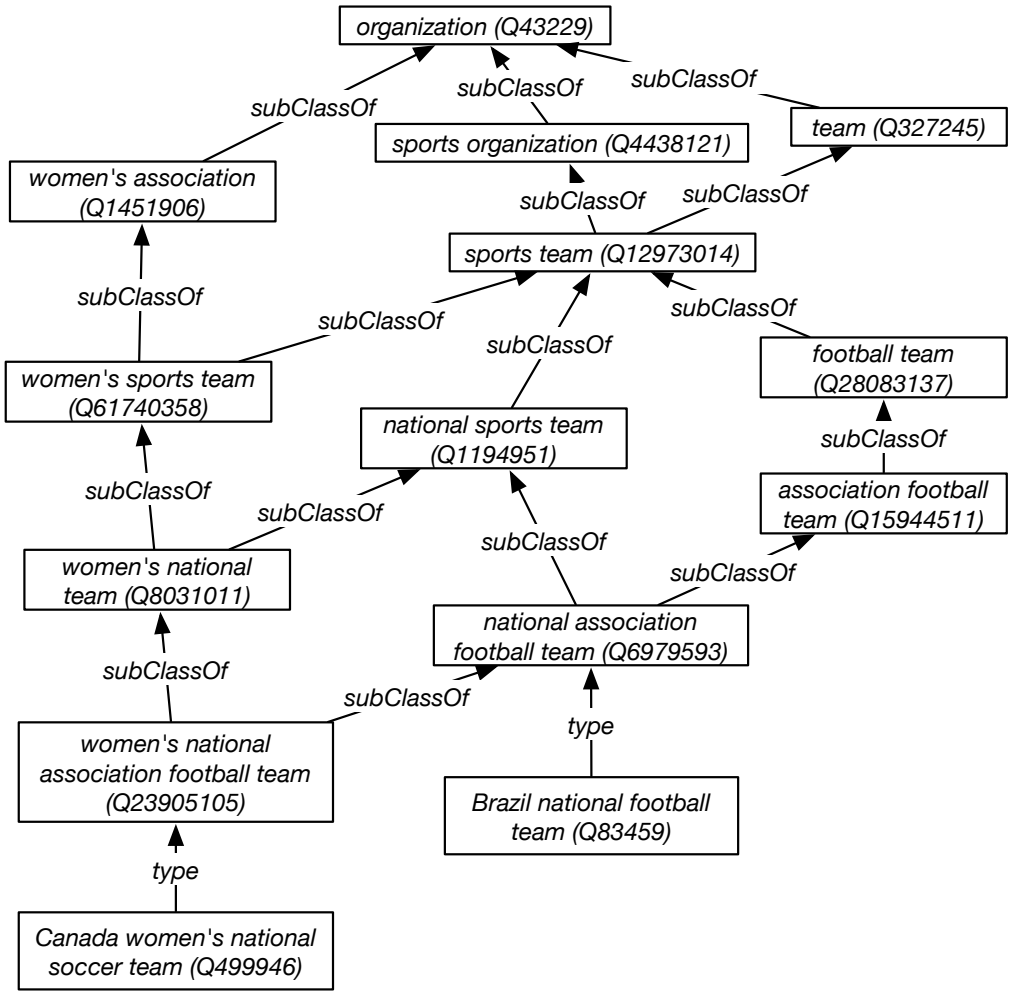
Classes and Properties

- Primitive knowledge is knowledge that is specified explicitly.
- Derived knowledge is knowledge that can be inferred from primitive knowledge and other derived knowledge.
- A standard way to use derived knowledge is to specify attributes (property–value pairs) for all members of a class.
- Individuals inherit the attributes associated with the classes they are in.
- A natural kind is a class such that describing individuals using the class is more succinct than describing individuals without the class.
- E.g., Specifying all *mammals* are warm blooded is more concise than specifying each individual is warm blooded.
- A class is the set of those actual and potential individuals that would be members of the class.
  E.g., class of chairs includes chairs that have not been build or may never be built.

Class Hierarchies

- Class S is a subclass of class C means S is a subset of C.
  $subClassOf(S, C) \wedge type(E, S) \rightarrow type(E, C)$.
- Part of the Wikidata class structure:



Property Hierarchies

- Property p_1 is a sub-property of property C if every pair related by p_1 is also related by p_2.
- $subPropertyOf(p_1, p_2) \wedge p_1(x, y) \rightarrow p_2(x, y)$

Some sub-properties in Wikidata are

- "member of sports team" (P54) is a sub-property of "member of" (P463)
- "member of" (P463) is a sub-property of "affiliation" (P1416)
- "affiliation" (P1416) is a sub-property of "part of" (P361)
- "part of" (P361) is a sub-property of "partially coincident with" (P1382)

Property

- The domain of a property is a class such that the subject of a triple with the property has to be in the class.
  $domain(p, C) \wedge p(x, y) \rightarrow type(x, C)$.
- domain of "member of sports team" (P54) is "human" (Q5)
- The range of a property is a class such that the object of a triple with the property has to be in the class.
  $range(p, C) \wedge p(x, y) \rightarrow type(y, C)$.
- range of "member of sports team" (P54) is "sports team" (Q12973014)
- Property p is functional means there is at most one object associated with any subject.
  $p(x, y_1) \wedge p(x, y_2) \rightarrow y_1 = y_2$.
- Is "member of sports team" (P54) functional?
- Is "date of birth" (P569) functional?

These are not (currently) part of Wikidata!

Designing Classes

Aristotle [350 B.C.] suggested the definition if a class C in terms of:

- Genus: a super-class
- Differentia: the attributes that make members of the class C different from other members of the super-class

"If genera are different and co-ordinate, their differentiae are themselves different in kind. Take as an instance the genus 'animal' and the genus 'knowledge'. 'With feet', 'two-footed', 'winged', 'aquatic', are differentiae of 'animal'; the species of knowledge are not distinguished by the same differentiae. One species of knowledge does not differ from another in being 'two-footed'."

Aristotle, *Categories*, 350 B.C.

Designing Classes

The art of ranking things in genera and species is quite important, and greatly helps our judgment as well as our memory. . . . Order largely depends on it, and many good authors write in such a way that their whole account could be divided and subdivided according to a procedure related to genera and species. This helps one not merely to retain things in one's memory, but also to find them there. Writers who have laid out all sorts of notions under certain headings or categories have done something very useful.

– G. W. Leibniz [1705]

Designing Classes

To design classes based on Aristotelian definitions:

- For each class: determine a relevant superclass and then select those attributes that distinguish the class from other subclasses.
- Each attribute gives a property and a value.
- For each property, define the domain to be most general class for which it makes sense.
- Make the range of the property another class that makes sense (perhaps requiring this range class to be defined, either by enumerating its values or by defining it using an Aristotelian definition).

Designing Classes

Aristotelian definitions result in class structure that is a lattice, and rarely a tree.

Example: Consider definitions of rectangle, rhombus, and square:

- A quadrilateral is a planar figure made up of four straight sides.
- A rectangle is a quadrilateral where all inside angles are right angles (90°).
- A rhombus is a quadrilateral where all four sides have the same length.
- A square is a quadrilateral where all four sides have the same length and all inside angles are right angles.

What is a most specific superclass of square?
A square is both a rectangle and a rhombus.
Neither is more specific than the other.